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ENCYCLOPÆDIA BRITANNICA.

Burke.

BURKE, EDMUND, a writer, orator, and statesman, was born in Dublin, on the first January, in the year 1730. His father was an attorney, first in Limerick, and afterwards in Dublin. Young Burke received the first rudiments of his education at Ballytore, in the county of Kildare, under the tuition of Abraham Shackleton, a Quaker of considerable celebrity. Committed to the care of a master so admirably qualified for the important business of instruction, young Burke applied to his studies with commendable assiduity, and became one of the numerous examples that might be adduced, to demonstrate the falsehood of that popular but dangerous maxim, *that young men of genius are always destitute of application.*

In this seminary he laid the foundation of his knowledge in the languages of antiquity; whence he was hereafter to borrow the elegance of his taste, and the models and imagery of his eloquence. From this source was also, most probably, derived that love of liberty, which, germinating at certain periods in his bosom, so often pointed his oratory, inflamed his passions, and animated his sentiments; and which in his best days acquired him a reputation almost unequalled in our times.

At this respectable school several years of his life were spent: and the attachment of the master, and the gratitude of the pupil, reflect honour on both. The former lived to see his scholar attain a considerable degree of reputation; and he on his part was accustomed to spend a portion of his annual visit to Ireland at Ballytore.

From a provincial seminary Edmund was sent to the university of Dublin. Here, however, he does not appear to have distinguished himself either by application or talents. His character, as a student, was merely negative. He exhibited no symptoms of early genius, obtained no palms in the academic race, and departed even without a degree. During this period, however, he commenced author. His first essays were of a political nature.

Mr Burke now addicted himself to other pursuits, particularly logic and metaphysics: and is said to have planned a refutation of the systems of Berkeley and Hume. While thus employed in treasuring up the means of attaining a species of celebrity, which far different avocations prevented him afterwards from aspiring to, he was not inattentive to the grand object of obtaining a suitable settlement in life; for his family was not opulent, and he already panted after independence. He accordingly became a candidate for a vacant chair at the university of Glasgow. The immediate reason of his failure is not directly known; but on this he repaired to the metropolis, and enrolled his name as a student of the Inner Temple.

It appears from his speeches, his writings, and his conversation, that he studied the grand outline of our municipal jurisprudence with particular attention; but it may be doubted whether he ever entered into the minutiæ. Indeed, the versatility of his talents, and his avocations, were but little calculated for that dull and plodding circuit which can alone lead to an intimate knowledge of our laws. Besides, if he had been gifted with the necessary application, both time and opportunity were wanting: for it is well known that at this period of his life the "*res angusta domi*" did not permit the student to dedicate his attention solely to this, or indeed to any other single object.

The exhausted state of his finances called frequently for a speedy supply; and, instead of perusing the pages of Bracton, Fleta, Littleton, and Coke, he was obliged to write essays, letters, and paragraphs, for the periodical publications of the day. But if these pursuits diverted his attention from graver studies, they acquired him a facility of composition, and a command of style and of language, which proved eminently serviceable in the course of his future life.

His health, however, became at length impaired, and a nervous fever ensued. This circumstance induced him to call in the aid of Dr Nugent, one of his own countrymen, a medical man, whose manners were more amiable than his practice was extensive. This gentleman, who had travelled on the continent, and was an author himself, readily discovered the source of his malady, and, by removing him from books and business to his own house, soon effected a cure. That event is said to have been hastened, if not entirely completed, by a physician of another kind; the accomplished daughter of his host. This lady was destined to become his wife; a circumstance particularly fortunate for him, as her disposition was mild and gentle, and she continued through a long series of years, and many vicissitudes of fortune, to soothe and tranquillize passions always violent, and often tumultuous.

Our student seems at length to have determined once more to endeavour to distinguish himself as an author,

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thor, and he accordingly took advantage of the death of a celebrated peer to write a work after the manner of that nobleman; in which, by exaggerating his principles, he should be enabled to bring them into contempt: but this effort proved unsuccessful, for the treatise in question was for a long time consigned to oblivion, and would never have been heard of, had it not been resuscitated by his future fame. Another performance made ample amends: his "Essay on the Sublime and Beautiful" attracted a high degree of reputation, and acquired him considerable celebrity as a man of letters. In addition to the profits of the publication, he is said on this occasion to have received a present from his father of 100l. But his circumstances must have been greatly embarrassed about this time, as he was obliged to sell his books; and surely nothing but the extremity of distress could have forced a man of letters to such a measure.

The work we have just mentioned, having an immediate relation to taste, excited a desire in Sir Joshua Reynolds, even then at the head of his profession, to become acquainted with Mr Burke; and a friendship ensued which continued uninterrupted during the life of the painter, and was unequivocally testified by a handsome bequest in his will. Dr Johnson also sought and obtained an intimacy with him, and he now became the constant frequenter of two clubs, composed of some of the most celebrated men of that day. One of these met at the Turk's Head tavern in Gerrard-street, and consisted of the following members: Dr Johnson, Mr (afterwards Sir Joshua) Reynolds, Dr Goldsmith, Mr Topham Beauclerc, Dr Nugent, Sir John Hawkins, Mr Bennet Langton, Mr Chamier, Mr Garrick, and Mr Burke.

The other assembled at the St James's coffee-house, and besides many of the above, was composed of the following members: Mr Cumberland, Dr Douglas bishop of Salisbury, Dr Bernard dean of Derry, Mr Richard Burke, Mr William Burke, Mr Hickey, &c. Dr Goldsmith, who was Mr Burke's contemporary at Dublin College, was a member of both, and wrote the epitaphs of those who composed the latter. That on Mr Burke has often been praised.

Here lies our good Edmund whose genius was such,
We scarcely can praise it or blame it too much;
Who, born for the universe, narrowed his mind,
And to party gave up what was meant for mankind.
Though fraught with all learning, yet straining his throat
To persuade Tommy Townshend to lend him a vote;
Who, too deep for his hearers, still went on refining,
And thought of convincing while they thought of dining;
Though equal to all things, for all things unfit;
Too nice for a statesman, too proud for a wit;
For a patriot too cool, for a drudge disobedient;
And too fond of the *right*, to pursue the *expedient*.
In short, 'twas his fate, unemployed, or in place, Sir,
To eat mutton cold, and cut blocks with a razor.

A literary work on a new plan, first suggested in 1750, and by some attributed to the Dodsleys, and by others to Mr Burke, became, for some time, a considerable source of emolument to him. This was called the "Annual Register;" a publication that soon obtained considerable celebrity, and of which he had the superintendence for several years.

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He was at length called off from his literary labours by avocations of a far different kind. A gentleman who afterwards derived the *cognomen* of "single-speech Hamilton," from a celebrated oration, having been appointed secretary to the lord-lieutenant of Ireland, invited his friend Mr Burke to accompany him thither; this offer he readily complied with, and although he acted in no public station, and performed no public service while he remained in that country, he was rewarded with a pension of 300l. per annum, which he soon after disposed of for a sum of money.

On his return to England he amused himself, as usual, with literary composition. A series of essays, written by him in a newspaper, which, at one time, obtained great celebrity, attracted the notice of the late Marquis of Rockingham; and Mr Fitzherbert, a member of parliament, and father of the present Lord St Helen's, in consequence of this circumstance, introduced him to that nobleman. From this moment he was destined to become a public man, and to dedicate his studies, his eloquence, and his pen, to politics.

Lord Rockingham having proved more compliant than the Earl of Chatham, the former nobleman was brought into power, and seated on the treasury bench. On this occasion he selected Mr Burke as his private secretary, an office of no power and very little emolument, but which naturally leads to both. As it was now necessary he should have a seat in parliament, although it cannot be supposed that he was legally qualified in respect to property, he applied to Lord Verney, who was patron of Wendover, a borough at that time dependent on him, and principally occupied by his tenants.

Having thus obtained a seat in 1765, he prepared to fit himself for his new situation. He was already provided with all the necessary talents, and was only deficient in the forms of business, and the facility of expressing his sentiments before a public audience. The first of these was mastered by sedulous attention; and as to the second, if we are to give credit to those who pretend to be intimately acquainted with this period of his life, he overcame all difficulties by a previous initiation elsewhere. In short he had acquired celebrity at the "Robinhood," before he attempted to speak in the British senate, and vanquished an eloquent "baker" ere he began to cope with the great orators of the nation.

Holding a confidential place under the Rockingham administration, he of course supported all its measures. A former ministry, anxious to increase its influence by means of increased imposts, had conceived the idea of taxing America through the medium of a parliament in which she was not represented. Having attempted to carry this into effect by means of the famous stamp act, the Americans, alarmed at what they conceived to be a flagrant violation of every principle of the English constitution, made such a spirited resistance to the measure that it was abandoned, and the Rockingham party readily consented to the repeal. Under the pretext, however, of vindicating the honour of the crown, they unfortunately proposed and carried the declaratory

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claratory act, by means of which, although the original scheme had been abandoned, the principle on which it was built was asserted anew, and a foundation laid for all the miseries that afterwards ensued. But if this short-lived administration deserved no great credit on this occasion, it is entitled to considerable praise on account of other parts of its conduct; for it repealed the cyder act, procured a declaration of the house of commons, condemning the seizure of papers, and a resolution against general warrants. The first of these afforded great relief to such of the counties as cultivated orchard grounds, and the two last seemed to be called for by the conduct of their predecessors in respect to Mr Wilkes.

On retiring from office they, however, did not carry much popularity along with them, as Lord Chatham and his friends, who in some measure monopolized the public favour, were entrusted with the management of affairs for a short time; and it is extremely probable that they would have sunk into neglect, had not America been driven into resistance.

It now fell to the lot of Lord North to enforce the scheme which the Grenville party had projected, and wished to carry boldly into execution; which the Rockingham administration had by an unaccountable blunder at once annihilated and recognised, and which they afterwards manfully, and at length successfully opposed.

This forms the most brilliant epoch of Mr Burke's life. He was hostile to the expulsion of Mr Wilkes; an act which the house of commons afterwards rescinded from its records. On the application of the Dissenters for relief, he took up their cause, and expressed his resentment, in very animated terms, against that misguided policy, which permits all those not within the pale of establishment to enjoy liberty less by right than by connivance. But perhaps the noblest part of his conduct consisted in his steady and uniform opposition to the American war, and his marked and declared hostility to the abettors of it. His speech against the Boston Port bill was one of the most charming specimens of oratory that had ever been exhibited in the British senate; and on the 19th of April, 1774, on a motion for the repeal of the tea duty, he discovered such talents, that an old and respectable member exclaimed, "Good God! what a man is this!—How could he acquire such transcendent powers?" And when, in reply to another who had said, "That the Americans were our children, and it was horrible to revolt against their parent!" the orator uttered the following passage, the whole house was electrified:—"They are our children, it is true; but when children ask for bread, we are not to give them a stone. When those children of ours wish to assimilate with their parent, and to respect the beauteous countenance of British liberty, are we to turn to them the shameful parts of our constitution? Are we to give them our weakness for their strength; our opprobrium for their glory; and the slough of slavery, which we are not able to work off, to serve them for their freedom?"

The city of Bristol, the merchants of which had become rich by the commerce with America, were likely to suffer by its interdiction. This consideration alone rendered many of them hostile to the proceedings of the ministry; but nobler and more exalted motives actuated the bosoms of others, particularly the Quakers, Dissenters, and other sectarists who were moved by zeal against oppression, and a love of liberty imprinted on their minds by a constitution which had remained until then inviolate. Gratified by the exertions of Mr Burke in behalf of civil and religious freedom, they put him in nomination for their city, and sent into Yorkshire, to request his immediate personal attendance. After consulting with his patron concerning an offer so flattering and unexpected, accompanied at the same time with assurances most punctually fulfilled, *that he should be put to no expence whatever*, he immediately set out for the west of England, and found that no less than three candidates had started before him. The first was Lord Clare, afterwards Lord Nugent, one of the former representatives, whose unpopularity was such, that he soon discovered the necessity of resigning all his pretensions; two, therefore (Mr Cruger and Mr Brickdale), only remained in the field, and the former of these, like Mr Burke himself, was averse to a rupture with America.

The new candidate did not appear on the hustings until the afternoon of the sixth day's poll, on which occasion he addressed the electors in a very able speech, admirably calculated for the occasion. He began by expressing a modest diffidence of his own abilities, and a high opinion of the important trust they were assembled to confer. He then boldly declared himself hostile to a contest with America, and asserted, that England had been rendered flourishing by liberty and commerce, the first of which was dear to his heart, while the latter had been a favourite object of his studies, both in its principles and details.

This harangue was well received by the electors; the contest proved propitious to his wishes; and when the sheriffs had notified, at the close of the poll, that he was elected, he made the most brilliant address on the occasion that had ever been heard within the walls of a city celebrated rather for its opulence than its eloquence.

Mr Burke immediately returned from his new constituents to parliament, with increased vigour, reputation, and zeal. The Earl of Chatham, having failed, notwithstanding his reputation for wisdom, in an attempt to adjust the troubles of the colonies by means of a conciliatory bill introduced by him into the house of peers for that purpose, the obstinacy of the ministry now became apparent to every one. This circumstance, which would have appalled an inferior man, did not, however, discourage the member for Bristol from a similar attempt in another place; and accordingly, March 22. 1775, he brought forward his thirteen celebrated propositions, which were intended to close the fatal breach, and heal all the differences between the mother country and her colonies.

His plan, on this occasion, embraced not only an immediate conciliation, by a repeal of the late coercive acts, but also the creation of an independent judicature, and the regulation of the courts of admiralty. The whole, however, was quashed by a large majority on the side of the minister, who moved the previous question.

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Burke.

Mr Burke had hitherto chiefly distinguished himself in opposition to the measures of others; but in 1780, he himself stood forth as the original author and proposer of a scheme which soon engaged the attention of the public, and actually appeared big with the most prosperous results. When he found ministers obstinately persisting in a disastrous war, and perceived that the people began to bend beneath the weight of the taxes for its support, it struck him as advantageous on one hand, and political on the other, to diminish the public burdens and the number of adherents to the court at the same time. Accordingly, on the 11th of February, he brought in a bill "for the regulation of his majesty's civil establishments, and of certain public offices; for the limitation of pensions, and the suppression of sundry useless, expensive, and inconvenient places, and for applying the monies saved thereby, to the public service."

This scheme was manifestly founded on the late reforms that had taken place in France; for by an edict of the king, registered in the parliament of Paris, it appeared that he had suppressed no less than 406 places in his household by one regulation. The orator, with great judgment, fastened upon this event, and endeavoured to make use of it as an incitement to a similar attempt here; nay, he called in national rivalship itself, by way of an inducement to consent to this sacrifice on the part of the crown.

To this bill the minority did not at first give much opposition. Indeed the mover of it contrived to soften those features that appeared harsh to them. Notwithstanding this, it did not prove successful during Lord North's administration; and when it was at length carried, it was much modified and altered.

Parliament was dissolved in 1780, but Mr Burke was not re-elected for Bristol, and this is said to have made a deep impression on the mind of the orator; but this must have been obliterated by the important events that speedily ensued; for the minister now tottered on the treasury bench, being abandoned by many of his staunchest supporters, and but little confident in his own schemes, all of which had proved eminently unsuccessful, The opposition, having by this time increased to a considerable degree, unceasingly assailed him, until at length, March 28. 1782, Lord North assured the house of commons that his administration was at an end.

The day had now arrived when the ministry and opposition were to change places, and the former to be arrayed in the spoils of the latter. Of this rich booty Mr Burke, whose services had been so conspicuous in hunting the enemy into the toils prepared for them, had his portion: for he was made a privy counsellor, and invested with the lucrative appointment of paymaster-general of the forces. He was at length now enabled to enforce his plan of political economy, tendered before in vain; and the board of trade, the board of works, the offices of third secretary of state, treasurer of the chamber, cofferer of the household, the lords of police in Scotland, the master of the barriers, the master of the stag hounds, the six clerks of the board of green cloth, and the paymaster of the pensions, were abolished.

At length the reins of government were confided to the hands of the Marquis of Lansdowne, then Earl Shelburne; and this event gave such offence to those who wished to place the duke of Portland at the head of affairs, that Mr Fox, Lord John Cavendish, and Mr Burke, immediately resigned.

In the mean time, the critical state of the English East India Company had long agitated the public mind, and become occasionally a subject of discussion in parliament. The seizure, imprisonment, and confinement of Lord Pigot, by a faction in the council of Madras; the conduct of Mr Hastings, in respect to several of the native powers; the grand question of sovereignty, relative to the territorial possessions of the company in Asia: all these subjects had, at different times, excited the attention of the nation.

No sooner did Mr Fox behold himself and his friends in possession of power, than he brought in a bill, to remedy the various abuses in the government of British India. Of this bill Mr Burke is well known to have been the principal penman, and upon this occasion he defended its principles and provisions with all the zeal of a parent. In a speech of considerable length he exhibited an able retrospect of the system, both political and commercial, of the company. He then proceeded to state the benefit likely to result from the plan under contemplation, which he considered as calculated to effect "the rescue of the greatest number of the human race that ever were so grievously oppressed, from the greatest tyranny that ever was exercised." In short, he contemplated it as a measure that would "secure the rice in his pot to every man in India." "I carry my mind (adds he) to all the people, and all the names and descriptions that, relieved by this bill, will bless the labours of this parliament, and the confidence which the best house of commons has given to him who best deserves it."

This celebrated bill, notwithstanding much opposition both within and without, was carried triumphantly through the house of commons: but in the house of peers it experienced a far different fate, and with it fell the power and consequence of its authors, framers, and supporters.

In the course of the next year (February 28. 1785), he made a celebrated speech relative to the nabob of Arcot's debts; and depicted one of his creditors, who had taken an active share in the late elections, "as a criminal who long since ought to have fattened the region kites with his offal; the old betrayer, insulter, oppressor, and scourge of a country (Tanjore), which had for years been an object of an unremitted, but unhappily an unequal, struggle, between the bounties of Providence to renovate, and the wickedness of mankind to destroy."

But there appeared to Mr Burke to be a still greater delinquent, on whom he was determined to inflict all the wounds of his eloquence, and sacrifice, if possible, the powerful offender himself at the shrine of national vengeance. This was Mr Hastings; and soon after his arrival in England, the orator gave notice of his intentions. On the 17th of February, 1785, he opened the accusation by a most eloquent speech; in which he depicted the supposed crimes of the late governor-general, in the most glowing and animated colours. This trial, however, turned out in the event far

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Burke. far different from his hopes and expectations; while the length of it failed not to involve both himself and party in reproach.

During the debate on the commercial treaty with France (January 23. 1787), the member for Malton exhibited an undiminished versatility of talents, and pointed his ridicule with no common success at Mr Pitt, who, according to him, contemplated the subject with a narrowness peculiar to limited minds:— "He seems to consider it (adds he) as an affair of two little compting-houses, and not of two great nations. He seems to consider it as a contention between the sign of the *fleur-de-lis* and the sign of the old *red lion*, for which should obtain the best custom."

The next public event of importance in which we find Mr Burke engaged, occurred in consequence of his majesty's indisposition. On this occasion he took an active part in the debates of the house of commons; and is supposed to have penned a letter for one, and a speech for another, branch of the royal family. When Mr Pitt moved his declaratory resolutions relative to the provisional exercise of the royal authority, he attacked him with much asperity of language, and was particularly severe on the manner in which the royal assent was to be given to all future acts of parliament. The men who held most of the high places under the government were treated as "jobbers, old hacks of the court, and the supporters and betrayers of all parties; and it was a mock crown, a tinsel robe, and a sceptre from the theatre, lackered over and unreal," which were about to be conferred on the prince of Wales.

The opposition, lessened indeed by a few occasional desertions, had hitherto acted as a great public body, supposed to be united in general principles, for the common welfare and prosperity of the state; but the French revolution thinned their ranks, dispelled their consequence, and, by sowing jealousy between the chiefs, spread consternation and dismay among their followers.

It was on the 2d of March 1790, when Mr Fox moved for leave to bring in a bill to repeal the corporation and test-acts, that this disunion became evident; and soon after this Mr Burke declared, "that his honourable friend and he were separated in their politics for ever."

The ministry now seemed anxious to provide for their new associate; and he, on his part, certainly appeared deserving of some remuneration at their hands, for he had abandoned all his old friends, and not a few of his old principles. In addition to this, his "Reflections on the Revolution in France," had afforded some degree of countenance, and even popularity, to the measures of administration; and, not content with his own exertions, he had enlisted his son on the same side, and even sent him to Coblentz. The royal munificence at length gratified his warmest wishes; for by a warrant, dated September 24. 1795, and made to commence January 5. 1793, he received a pension of 1200l. for his own life, and that of his wife, on the civil list; while two other pensions of 2500l. a-year for three lives, payable out of the four and a half per cent. fund, dated October 24. 1795, were made to commence from July 24. 1793. Honours as well as wealth now seemed to await him, for he was about to be ennobled, when the untimely death of an only child put an end to his dreams of ambition, and contributed not a little to hasten his own, which occurred at his house at Beaconsfield, July 8. 1797.

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Thus died, in the 68th year of his age, Edmund Burke, one of the greatest orators, statesmen, and authors, of his age; one whose name will long continue to be celebrated; and who, had he fallen during the meridian of his fame and character, would have scarcely been considered as second to any man, either of ancient or modern times.

As a man of letters, he ranks high in point of genius, learning, and composition; and his works are attended with this peculiarity, that they are the production of almost the only orator of his day, who could wield his pen with as much fluency as his tongue, and shine equally in the senate and the closet. His dissertation on the "Sublime and Beautiful" acquired him the applause of all, and secured him the friendship and assistance of many men of taste in the nation. His political tracts betoken much reading, deep thought, uncommon sagacity; and even those who may be disposed to object to his doctrines, cannot but admire his various talents, his happy allusions, and his acute penetration. There is no species of composition which he has not attempted; no subject on which he has not occasionally treated: his first and his last days were equally dedicated to literature, and he disdained not any species of it, from the newspaper column, that supplied needful bread to his early youth, to the more elaborate performance that procured unnecessary opulence to his old age.

As an orator, notwithstanding some glaring defects, he stands almost unrivalled. His gesticulation was at times violent and repulsive, his manner harsh and overbearing, his epithets coarse and disgusting; on many occasions he made use of assertions which were not bottomed in fact, and on one in particular, toward the latter end of his life, had recourse to stage trick and pantomime, instead of sense and argument. But on the other hand, no man was better calculated to arouse the dormant passions, to call forth the glowing affections of the human heart, and to "harrow up" the inmost recesses of the soul. Venality and meanness stood appalled in his presence; he who was dead to the feelings of his own conscience, was still alive to his animated reproaches; and corruption for a while became alarmed at the terrors of his countenance. His powers were never more conspicuous than on that memorable day on which he exposed the enormities of a subaltern agent of oriental despotism—on which he depicted the tortures inflicted by his orders, the flagrant injustice committed by his authority, the pollution that ensued in consequence of his sanction—when he painted agonizing nature vibrating in horrid suspense between life and destruction—when he described, in the climax of crimes, "death introduced into the very sources of life," the bosoms of his auditors became convulsed with passion, and those of more delicate organs and weaker frame actually swooned away. Nay, after the storm of eloquence had spent its force, and the captivated ears no longer listened to his voice, his features still spoke the purpose of his heart, his hand still seemed to threaten punishment, and his brow to meditate vengeance.

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"The qualities of his heart (says one of his biographers) were not less amiable and estimable than his talents were astonishing:—benevolent, just, temperate, magnanimous. He loved his country, loved its constitution, because he believed it the best adapted for its happiness: at different times, from the same principle, he supported different members of it, when he thought the one or the other likely to be overbalanced. During the prevalence of the Bute plans, dreading the influence of the crown, he supported the people; and for the same reason, during the American war.

"After the overthrow of the French monarchy, the aristocracy, and the dissemination in Great Britain of the principles that had destroyed these powers, apprehending similar effects, if not vigorously opposed in England, he strenuously supported the monarchy and aristocracy. Thus discriminately patriotic in public life, in his private relations his conduct was highly meritorious. A fond and attentive husband, an affectionate and judiciously indulgent father, a sincere friend, at once fervid and active, a liberal and kind master, an agreeable neighbour, a zealous and bountiful patron, he diffused light and happiness. His principles were as strict, and habits as virtuous, as his dispositions were kind." (*Annual Necrology*).

BURKITT, William, a celebrated commentator on the New Testament, was born at Hitcham in Northamptonshire, July 25. 1650, and educated at Pembroke-hall, Cambridge. He entered young upon the ministry, being ordained by Bishop Reynolds: and the first employment which he had was at Milden in Suffolk, where he continued 21 years a constant preacher, first as a curate, and afterwards as rector of that church. In the year 1692, he had a call to the vicarage of Dedham in Essex, where he continued to the time of his death, which happened in the latter end of October 1703. He was a pious and charitable man. He made great collections for the French Protestants in the years 1687, &c. and by his great care, pains, and charges, procured a worthy minister to go and settle in Carolina. Among other charities, by his last will and testament, he bequeathed the house wherein he lived, with the lands thereunto belonging, to be a habitation for the lecturer that should be chosen from time to time to read the lecture at Dedham. Besides his commentary upon the New Testament, written in the same plain, practical, and affectionate manner in which he preached, he wrote a volume, entitled *The poor man's help, and the rich man's guide*.

BURLAW. See *By-Law*.

BURLEIGH. See Cecil.

BURLESQUE, a species of composition, which, though a great engine of ridicule, is not confined to that subject; for it is clearly distinguishable into burlesque that excites laughter merely, and burlesque that excites derision or ridicule. A grave subject, in which there is no impropriety, may be brought down by a certain colouring so as to be risible, as in Virgil travestie; the author first laughs at every turn in order to make his readers laugh. The Lutrin is a burlesque poem of the other sort, laying hold of a low and trifling incident to expose the luxury, indolence, and contentious spirit, of a set of monks. Boileau, the author, turns the subject into ridicule, by dressing it in the heroic style, and affecting to consider it as of the utmost dignity and importance. Though ridicule is the poet's aim, he always carries a grave face, and never once betrays a smile. The opposition between the subject and the manner of handling it, is what produces the ridicule; and therefore, in a composition of this kind, no image professedly ludicrous ought to have quarter, because such images destroy the contrast.

Though the burlesque that aims at ridicule produces its effects by elevating the style far above the subject, yet the poet ought to confine himself to such images as are lively, and readily apprehended. A strained elevation, soaring above the ordinary reach of fancy, makes not a pleasant impression. The mind is soon disgusted by being kept long on the stretch. Machinery may be employed in a burlesque poem, such as the Lutrin, Dispensary, or Hudibras, with more success and propriety than in any other species of poetry. For burlesque poems, though they assume the air of history, give entertainment chiefly by their pleasant and ludicrous pictures: It is not the aim of such a poem to raise sympathy; and, for that reason, a strict imitation of nature is not necessary. And hence, the more extravagant the machinery in a ludicrous poem, the more entertainment it affords.

BURLINGTON, a sea-port town in the east riding of Yorkshire, situated on the German ocean, about 37 miles north-east of York. E. Long. 0. 10. and N. Lat. 54. 15. It gave the title of earl to a branch of the noble family of Boyle, but the earldom is now extinct. Population 3741 in 1811.

New Burlington, the capital of New Jersey, in North America; situated in an island of Delaware river, about 20 miles north of Philadelphia. W. Long. 74. 0. N. Lat. 40. 40.

BURMAN, Francis, a Protestant minister, and learned professor of divinity at Utrecht, was born at Leyden in 1628; and died on the 10th of November 1679, after having published a course of divinity, and several other works.

He is not to be confounded with *Francis Burman*, his son; or with *Peter Burman*, a laborious commentator on Phædrus, Lucan, Petronius, and other profane authors, who died in 1741.

BURN, in *Medicine* and *Surgery*, an injury received in any part of the body by fire. See Surgery.

BURNET, Gilbert, bishop of Salisbury in the latter end of the 17th century, was born at Edinburgh, in 1643, of an ancient family in the shire of Aberdeen. His father being bred to the law, was, at the restoration of King Charles II. appointed one of the lords of session, with the title of *Lord Crimond*, in reward for his constant attachment to the royal party during the troubles of Great Britain. Our author, the youngest son of his father, was instructed by him in the Latin tongue; at ten years of age he was sent to continue his studies at Aberdeen, and was admitted M. A. before he was 14. His own inclination led him to the study of the civil and feudal law; and he used to say, that it was from this study he had received more just notions concerning the foundations of civil society and government, than those which some divines maintain. About the year after, he changed his mind, and began to apply to divinity, to the great satisfaction

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satisfaction of his father. He was admitted preacher before he was 18; and Sir Alexander Burnet, his cousin-german, offered him a benefice; but he refused to accept of it.

In 1663, about two years after the death of his father, he came into England; and after six months stay at Oxford and Cambridge, returned to Scotland; which he soon left again to make a tour for some months, in 1664, in Holland and France. At Amsterdam, by the help of a Jewish rabbi, he perfected himself in the Hebrew language; and likewise became acquainted with the leading men of the different persuasions tolerated in that country; as Calvinists, Arminians, Lutherans, Anabaptists, Brownists, Papists, and Unitarians; amongst each of which he used frequently to declare, he met with men of such unfeigned piety and virtue, that he became fixed in a strong principle of universal charity, and an invincible abhorrence of all severities on account of religious dissensions.

Upon his return from his travels, he was admitted minister of Salton: in which station he served five years in the most exemplary manner. He drew up a memorial, in which he took notice of the principal errors in the conduct of the Scots bishops, which he observed not to be conformable to the primitive institution; and sent a copy of it to several of them. This exposed him to their resentments: but, to show he was not actuated with a spirit of ambition, he led a retired course of life for two years; which so endangered his health, that he was obliged to abate his excessive application to study. In 1669, he published his "Modest and free conference between a conformist and nonconformist." He became acquainted with the duchess of Hamilton, who communicated to him all the papers belonging to her father and her uncle; upon which he drew up the "Memoirs of the dukes of Hamilton." The duke of Lauderdale, hearing he was about this work, invited him to London, and introduced him to King Charles II. He returned to Scotland, and married the lady Margaret Kennedy, daughter of the earl of Cassilis; a lady of great piety and knowledge, highly esteemed by the Presbyterians, to whose sentiments she was strongly inclined. As there was some disparity in their ages, that it might remain past dispute that this match was wholly owing to inclination, and not to avarice or ambition, the day before their marriage our author delivered the lady a deed, whereby he renounced all pretensions to her fortune, which was very considerable, and must otherwise have fallen into his hand, she herself having no intention to secure it. The same year he published his "Vindication of the authority, constitution, and laws of the church and state of Scotland;" which at that juncture was looked upon as so great a service, that he was again offered a bishopric, and a promise of the next vacant archbishopric; but did not accept of it, because he could not approve of the measures of the court, the grand view of which he saw to be the advancement of Popery.

Mr Burnet's intimacy with the dukes of Hamilton and Lauderdale occasioned him to be frequently sent for by the king and the duke of York, who had conversations with him in private. But Lauderdale, conceiving a resentment against him on account of the freedom with which he spoke to him, represented at last to the king, that Dr Burnet was engaged in an opposition to his measures. Upon his return to London, he perceived that these suggestions had entirely thrown him out of the king's favour, though the duke of York treated him with greater civility than ever, and dissuaded him from going to Scotland. Upon this, he resigned his professorship at Glasgow, and staid at London. About this time the living at Cripplegate being vacant, the dean and chapter of St Paul's (in whose gift it was), hearing of his circumstances, and the hardships he had undergone, sent him an offer of the benefice; but, as he had been informed of their first intention of conferring it on Dr Fowler, he generously declined it. In 1675, at the recommendation of Lord Hollis, whom he had known in France, ambassador at that court, he was by Sir Herbottle Grimstone, master of the rolls, appointed preacher of the chapel there, notwithstanding the opposition of the court. He was soon after chosen a lecturer of St Clement's, and became one of the preachers that were most followed in town. In 1697, he published his *History of the Reformation*, for which he had the thanks of both houses of parliament. The first part of it was published in 1679, and the second in 1681. Next year, he published an abridgement of these two parts.

Mr Burnet about this time happened to be sent for to a woman in sickness, who had been engaged in an amour with the earl of Rochester. The manner in which he treated her during her illness, gave that lord a great curiosity for being acquainted with him. Whereupon, for a whole winter, he spent one evening in a week with Dr Burnet, who discoursed with him upon all those topics upon which sceptics and men of loose morals attack the Christian religon. The happy effects of these conferences occasioned the publication of his account of the life and death of that earl. In 1682, when the administration was changed in favour of the duke of York, being much resorted to by persons of all ranks and parties, in order to avoid returning visits, he built a laboratory, and went for above a year through a course of chemical experiments. Not long after, he refused a living of 300l. a-year offered him by the earl of Essex, on the terms of his not residing there, but in London. When the inquiry concerning the popish plot was on foot, he was frequently sent for and consulted by King Charles with relation to the state of the nation. His majesty offered him the bishopric of Chichester, then vacant, if he would engage in his interests; but he refused to accept it on these terms. He preached at the Rolls till 1684, when he was dismissed by order of the court. About this time he published several pieces.

On King James's accession to the throne, having obtained leave to go out of the kingdom, he first went to Paris, and lived in great retirement; till, contracting an acquaintance with Brigadier Stouppe, a Protestant gentleman in the French service, he made a tour with him into Italy. He met with an agreeable reception at Rome. Pope Innocent XI. hearing of our author's arrival, sent the captain of the Swiss guards to acquaint him he would give him a private audience in bed, to avoid the ceremony of kissing his holiness's slipper. But Dr Burnet excused himself as well as he could. Some disputes which our author had here concerning religion,

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Burnet. religion, beginning to be taken notice of, made it proper for him to quit the city, which, upon an intimation given him by Prince Borghese, he accordingly did.

He pursued his travels through Switzerland and Germany. In 1688, he came to Utrecht, with an intention to settle in some of the seven provinces. There he received an invitation from the prince and princess of Orange (to whom their party in England had recommended him) to come to the Hague, which he accepted. He was soon made acquainted with the secret of their councils, and advised the fitting out of a fleet in Holland sufficient to support their designs and encourage their friends. This, and the Account of his Travels, in which he endeavoured to blend Popery and tyranny together, and represent them as unseparable, with some papers reflecting on the proceedings of England, that came out in single sheets, and were dispersed in several parts of England, most of which Mr Burnet owned himself the author of, alarmed King James, and were the occasion of his writing twice against him to the princess of Orange, and insisting, by his ambassador, on his being forbid the court; which, after much importunity, was done, though he continued to be trusted and employed as before, the Dutch minister consulting him daily. To put an end to these frequent conferences with the ministers, a prosecution for high treason was set on foot against him both in England and Scotland. But Burnet receiving the news thereof before it arrived at the States, he avoided the storm, by petitioning for, and obtaining without any difficulty, a bill of naturalization, in order to his intended marriage with Mary Scott, a Dutch lady of considerable fortune, who, with the advantage of birth, had those of a fine person and understanding.

After his marriage with this lady, being legally under the protection of Holland, when Mr Burnet found King James plainly subverting the constitution, he omitted no method to support and promote the design the prince of Orange had formed of delivering Great Britain, and came over with him in quality of chaplain. He was soon advanced to the see of Salisbury. He declared for moderate measures with regard to the clergy who scrupled to take the oaths, and many were displeased with him for declaring for the toleration of nonconformists. His pastoral letter concerning the oaths of allegiance and supremacy to King William and Queen Mary, 1689, happening to touch upon the right of conquest, gave such offence to both houses of parliament, that it was ordered to be burnt by the hands of the common executioner. In 1698 he lost his wife by the smallpox; and as he was almost immediately after appointed preceptor to the duke of Gloucester, in whose education he took great care, this employment, and the tender age of his children, induced him the same year to supply her loss by a marriage with Mrs Berkely, eldest daughter of Sir Richard Blake, knight. In 1669 he published his Exposition of the 39 Articles; which occasioned a representation against him in the lower house of convocation in the year 1701; but he was vindicated in the upper house. His speech in the house of lords in 1704 against the bill to prevent occasional conformity was severely attacked. He died in 1715, and was interred in the church of St James, Clerkenwell, where he has a monument erected to him. He formed a scheme for augmenting the poor livings; which he pressed forward with such success, that it ended in an act of parliament passed in the second year of Queen Anne, "for the augmentation of the livings of the poor clergy." Burnet.

Burnet, *Thomas*, a polite and learned writer in the end of the 17th century, was born in Scotland, but educated in Cambridge, under the tuition of Mr John Tillotson, afterwards archbishop of Canterbury. In the beginning of 1685, he was made master of Sutton's hospital in London, after which he entered into holy orders. During the reign of King James, he made a noble stand in his post as master of the Charter-house against the encroachments of that monarch, who would have imposed one Andrew Popham, a Papist, as a pensioner upon the foundation of that house. In 1680 he published his *Telluris theoria sacra*, so universally admired for the purity of the style and beauty of the sentiments, that King Charles gave encouragement to a translation of it into English. This theory was, however, attacked by several writers. In 1692 he published his *Archæologia philosophica*, deditated to King William, to whom he was clerk of the closet. He did in 1715. Since his death, hath been published his book *De statu mortuorum et resurgentium*, and his treatise *De fide et officiis Christianorum*.

Burnet, the *Honourable James, Lord Monboddo*, a senator of the college of justice in Scotland, was born about the year 1714. He was the son of Mr Burnet of Monboddo in Kincardineshire. After passing through the usual course of school education, he prosecuted his studies at the universities of Aberdeen, Edinburgh, and Leyden, with distinguished reputation. He was admitted an advocate in 1737, and on the 12th of February 1767, he was raised to the bench by the title of Lord Monboddo, in the room of Lord Milton, appointed a judge the 4th of June 1742, and who had succeeded Sir John Lauder of Fountainhall, admitted November 1689; being the third on the bench in succession since the Revolution.

He married Miss Farquharson, a very amiable woman, by whom he had a son and two daughters.

His private life was spent in the practice of all the social virtues, and in the enjoyment of much domestic felicity. Although rigidly temperate in his habits of life, he, however, delighted much in the convivial society of his friends, and among these he could number almost all the most eminent of those who were distinguished in Scotland for virtue, literature, or genuine elegance of conversation and manners. One of those who esteemed him the most was the late Lord Gardenstone, a man who possessed no mean portion of the same overflowing benignity of disposition, the same unimpeachable integrity as a judge, the same partial fondness for literature and the fine arts. His son, a very promising boy, in whose education he took great delight, was, indeed, snatched away from his affections by a premature death. But, when it was too late for sorrow and anxiety to avail, the afflicted father stifled the emotions of nature in his breast, and wound up the energies of his soul to the firmest tune of stoical fortitude. He was, in like manner, bereaved of his excellent lady, the object of his dearest tenderness; and he endured the loss with a similar firmness, fitted to do honour

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Burnet. honour either to philosophy or to religion. In addition to his office as a judge in the court of session, an offer was made to him of a seat in the court of justiciary. But, though the emoluments of this would have made a convenient addition to his income, he refused to accept it, lest its business should too much detach him from the pursuit of his favourite studies. To these studies he continued through the whole of a long life to be greatly devoted. His admiration of the manners, literature, and philosophy of the ancients, was unbounded. Thus strongly prepossessed, it is not to be wondered at, that the comparison which he made between the ancients and moderns was little favourable to the latter. For among the former he supposed that he saw all that was elegant, manly, and virtuous, all that was praiseworthy and excellent; while the degenerate race of the moderns exhibited nothing but effeminacy and corruption.

The vacation of the court of session afforded him sufficient leisure to retire every year, in spring and in autumn, to the country; and he used then to dress in a style of simplicity, as if he had been only a plain farmer; and to live among the people upon his estate, with all the kind familiarity and attention of an aged father among his grown-up children. Although his estate, from the old leases, afforded comparatively but a moderate income, he would never raise the rents or displace an old tenant to make room for a new one who offered a higher rent. In imitation of the rural economy of some of the ancients, whom he chiefly admired, he accounted population the true wealth of an estate, and was desirous of no improvement so much as of increasing the number of souls upon his lands, so as to make it greater, in proportion to the extent, than that of those upon the estate of any neighbouring landholder. It was there he had the pleasure of receiving Dr Samuel Johnson, with his friend James Boswell, at the time when these two gentlemen were upon their well-known tour through the Highlands of Scotland. Johnson admired nothing in literature so much as the display of a keen discrimination of human character, a just apprehension of the principles of moral action, and that vigorous common sense which is the most happily applicable to the ordinary conduct of life. Monboddo delighted in the refinements, the subtleties, the abstractions, the affectations of literature; and in comparison with these, despised the grossness of modern taste and of common affairs. Johnson thought learning and science to be little valuable, except so far as they could be made subservient to the purposes of living usefully and happily with the world, upon his own terms. Monboddo's favourite science taught him to look down with contempt upon all sublunary, and especially upon all modern things; and to fit life to literature and philosophy, not literature and philosophy to life. James Boswell, therefore, in carrying Johnson to visit Monboddo, probably thought of pitting them one against another, as two game cocks, and promised himself much sport from the colloquial contest which he expected to ensue between them. But Monboddo was too hospitable and courteous to enter into keen contention with a stranger in his own house. There was much talk between them, but no angry controversy, no exasperation of that dislike for each other's well-known peculiarities with which they had met. Johnson it is true, still continued to think Lord Monboddo what he called *a prig* in literature. Burnet.

Lord Monboddo used frequently to visit London, to which he was allured by the opportunity that great metropolis affords of enjoying the conversation of a vast number of men of profound erudition. A journey to the capital became a favourite amusement of his periods of vacation from the business of the court to which he belonged; and, for a time, he made this journey once a year. A carriage, a vehicle that was not in common use among the ancients, he considered as an engine of effeminacy and sloth, which it was disgraceful for a man to make use of in travelling. To be dragged at the tail of a horse, instead of mounting upon his back, seemed, in his eyes, to be a truly ludicrous degradation of the genuine dignity of human nature. In all his journeys, therefore, between Edinburgh and London, he was wont to ride on horseback, with a single servant attending him. He continued this practice, without finding it too fatiguing for his strength, till he was upwards of eighty years of age. Within these few years, on his return from a last visit, which he made on purpose to take leave, before his death, of all his old friends in London, he became exceedingly ill upon the road, and was unable to proceed; and had he not been overtaken by a Scotch friend, who prevailed upon him to travel the remainder of the way in a carriage, he might, perhaps, have actually perished by the way side, or breathed his last in some dirty inn. Since that time, he did not again attempt an equestrian journey to London.

In London, his visits were exceedingly acceptable to all his friends, whether of the literary or fashionable world. He delighted to shew himself at court; and the king is said to have taken a pleasure in conversing with the old man, with a distinguishing notice that could not but be very flattering to him.

A constitution of body, naturally framed to wear well and last long, was strengthened to Lord Monboddo by exercise, guarded by temperance, and by a tenor of mind too firm to be deeply broken in upon by those passions which consume the principles of life. In the country he always used much the exercises of walking in the open air, and of riding. The cold bath was a means of preserving the health, to which he had recourse in all seasons, amidst every severity of the weather, under every inconvenience of indisposition or business, with a perseverance invincible. He was accustomed, alike in winter and in summer, to rise at a very early hour in the morning, and, without loss of time, to betake himself to study or wholesome exercise. It is said, that he even found the use of what he called the air bath, or the practice of occasionally walking about, for some minutes, naked, in a room filled with fresh and cool air, to be highly salutary.

Lord Monboddo is well known to the world as a man of letters. His first publication was "a Dissertation on the Origin and Progress of Language," in 2 vols. 8vo. 1773; which were followed by four more vols. the last published not long before his death. In this work, intended chiefly to vindicate the honours of *Grecian literature*, he ascribes the origin of alphabetical writing to the Egyptians; and strenuously maintains, that the ouran-outang is a class of the human species, and that his want of speech is merely accidental. He al-

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Burnet. so endeavours to establish the reality of the existence of mermaids, and other fictitious animals. He was induced to undertake another work, for the purpose of defending the cause of Grecian philosophy; and published, in five vols. 4to. a work entitled, "Ancient Metaphysics," which, like the other, is remarkable for a surprising mixture of erudition and genius, with the most absurd whim and conceit.

As a judge, his decisions were sound, upright, and learned, and marked with acute discrimination; and free from those paradoxes and partialities which appear in his writings. He attended his judicial duty with indefatigable diligence till within a few days of his death, which happened at his house in Edinburgh, May 26. 1799, at the advanced age of 85.

His eldest daughter married some years before his death. His second daughter, in personal loveliness one of the finest women of the age, was beheld in every public place with general admiration, and was sought in marriage by many suitors. Her mind was endowed with all her father's benevolence of temper, and with all his taste for elegant literature, without any portion of his whim and caprice. It was her chief delight to be the nurse and the companion of his declining age. Her presence contributed to draw around him, in his house, and at his table, all that was truly respectable among the youth of his country. She mingled in the world of fashion, without sharing its follies; and heard those flatteries which are addressed to youth and beauty, without being betrayed to that light and selfish vanity which is often the only sentiment that fills the heart of the high-praised beauty. She delighted in reading, in literary conversation, in poetry, and in the fine arts, without contracting from this taste, any of that pedantic self-conceit and affectation which usually characterize literary ladies, and whose presence often frightens away the domestic virtues, the graces, the delicacies, and all the more interesting charms of the sex. When Burns, the well-known Scotish poet, first arrived from the plough in Ayrshire to publish his poems in Edinburgh, there was none by whom he was more zealously patronized than by Lord Monboddo and his lovely daughter. No man's feelings were ever more powerfully or exquisitely alive than those of the rustic bard, to the emotions of gratitude, or to the admiration of the good and fair. In a poem which he at that time wrote, as a panegyrical address to Edinburgh, he took occasion to celebrate the beauty and excellence of Miss Burnet, in perhaps the finest stanza of the whole:

"Thy daughters bright thy walks adorn,
"Gay as the gilded summer sky,
"Sweet as the dewy milk-white thorn,
"Dear as the raptur'd thrill of joy!
"Fair Burnet strikes th' adoring eye:
"Heav'n's beauties on my fancy shine,
"I see the *Sire of Love* on high,
"And own his work, indeed, divine."

She was the ornament of the elegant society of the city in which she resided, her father's pride, and the comfort of his domestic life in his declining years. Every amiable and noble sentiment was familiar to her heart, every female virtue was exemplified in her life. Yet, this woman, thus lovely, thus elegant, thus wise and virtuous, was cut off in the flower of her age, and left her father bereft of the last tender tie which bound him to society and to life. She died about six years before him, of a consumption; a disease that, in Scotland, proves too often fatal to the loveliest and most promising among the fair and the young. Neither his philosophy, nor the necessary torpor of the feelings of extreme old age, were capable of preventing Lord Monboddo from being very deeply affected by so grievous a loss; and from that time he began to droop exceedingly in his health and spirits. *Edin. Mag.*

Burnet ‖ Burning.

BURNET. See POTERIUM and SANGUISORBA, BOTANY *Index*.

BURNHAM, a market town of Norfolk in England, situated in E. Long. 0. 50. N. Lat. 53. 0.

BURNING, the action of fire on some pabulum or fuel, by which the minute parts thereof are put into a violent motion, and some of them assuming the nature of fire themselves, fly off *in orbem*, while the rest are dissipated in form of vapour, or reduced to ashes. See IGNITION.

Extraordinary Cases of BURNING. We have instances of persons burnt by fire kindled within their own bodies. A woman at Paris, who used to drink brandy to excess, was one night reduced to ashes by a fire from within, all but her head and the ends of her fingers. Signora Corn. Zangari, or, as others call her, *Corn. Bandi*, an aged lady, of an unblemished life, near Cesana in Romagna, underwent the same fate in March 1731. She had retired in the evening to her chamber somewhat indisposed; and in the morning was found in the middle of the room reduced to ashes, all except her face, legs, skull, and three fingers. The stockings and shoes she had on were not burnt in the least. The ashes were light; and, on pressing between the fingers, vanished, leaving behind a gross stinking moisture with which the floor was smeared; the walls and furniture of the room being covered with a moist cineritious soot, which had not only stained the linen in the chests, but had penetrated into the closet, as well as into the room overhead, the walls of which were moistened with the same viscous humour.—We have various other relations of persons burnt to death in this unaccountable manner.

Sig. Mondini, Bianchini, and Maffei, have written treatises express to account for the cause of so extraordinary an event: common fire it could not be, since this would likewise have burnt the bed and the room; besides that it would have required many hours, and a vast quantity of fuel, to reduce a human body to ashes; and, after all, a considerable part of the bones would have remained entire, as they were anciently found after the fiercest funeral fires. Some attribute the effect to a mine of sulphur under the house; others to a miracle; while others suspect that art or villany had a hand in it. A philosopher of Verona maintains, that such a conflagration might have arisen from the inflammable matters wherewith the human body naturally abounds. Sig. Bianchini accounts for the conflagration of the lady above mentioned, from her using a bath or lotion of camphorated spirit of wine when she found herself out of order. Maffei supposes it owing to lightning, but to lightning generated in her own body, agreeable to his doctrine, which is, That lightning does not proceed from the clouds, but is always produced in the place where it is seen and its effects perceived. We have

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Burning.

have had a late attempt to establish the opinion, that these destroying internal fires are caused in the entrails of the body by inflamed effluvia of the blood; by juices and fermentation in the stomach; by the many combustible matters which abound in living bodies for the purposes of life; and, finally, by the fiery evaporations which exhale from the settlings of spirit of wine, brandies, and other hot liquors, in the tunica villosa of the stomach and other adipose or fat membranes; within which those spirits engender a kind of camphor, which in the night time, in sleep, by a full respiration, are put in a stronger motion, and are more apt to be set on fire. Others ascribe the cause of such persons being set on fire to lightning; and their burning so entirely, to the greater quantity of phosphorus and other combustible matters they contained.—For our own part, we can by no means pretend to explain the cause of such a phenomenon: but for the interests of humanity, we wish it could be derived from something external to the human body; for if, to the calamities of human life already known, we superadd a suspicion that we may unexpectedly, and without the least warning, be consumed by an *internal* fire, the thought is too dreadful to be borne.

BURNING, or *Brenning*, in our old customs, denotes an infectious disease, got in the stews by conversing with lewd women, and supposed to be the same with what we now call the *venereal disease*.

In a manuscript of the vocation of John Bale to the bishopric of Ossory, written by himself, he speaks of Dr Hugh Weston, who was dean of Windsor in 1556, but deprived by Cardinal Pole for adultery, thus: "At this day is leacherous Weston, who is more practised in the arts of breech-burning, than all the whores of the stews. He not long ago brent a beggar of St Botolph's parish. See STEWS.

BURNING, in antiquity, a way of disposing of the dead, much practised by the ancient Greeks and Romans, and still retained by several nations in the East and West Indies. The antiquity of this custom rises as high as the Theban war, where we are told of the great solemnity accompanying this ceremony at the pyre of Menœacus and Archemorus, who were cotemporary with Jair, the eighth judge of Israel. Homer abounds with funeral obsequies of this nature. In the inward regions of Asia, the practice was of very ancient date, and the continuance long: for we are told, that in the reign of Julian, the king of Chionia burnt his son's body, and deposited the ashes in a silver urn. Coeval almost with the first instances of this kind in the east, was the practice in the western parts of the world. The Herulians, the Getes, and the Thracians, had all along observed it; and its antiquity was as great with the Celtæ, Sarmatians, and other neighbouring nations. The origin of this custom seems to have been out of friendship to the deceased: their ashes were preserved, as we preserve a lock of hair, a ring, or a seal, which had been the property of a deceased friend.

Kings were burnt in cloth made of the asbestos stone, that their ashes might be preserved pure from any mixture with the fuel and other matters thrown on the funeral pile. The same method is still observed with the princes of Tartary. Among the Greeks, the body was placed on the top of a pile, on which were thrown divers animals, and even slaves and captives, besides unguents and perfumes. In the funeral of Patroclus we find a number of sheep and oxen thrown in, then four horses, followed by two dogs, and lastly by 12 Trojan prisoners. The like is mentioned by Virgil in the funerals of his Trojans; where, besides oxen, swine, and all manner of cattle, we find eight youths condemned to the flames. The first thing was the fat of the beasts, wherewith the body was covered, that it might consume the sooner: it being reckoned great felicity to be quickly reduced to ashes. For the like reason, where numbers were to be burnt at the same time, care was taken to mix with the rest some of humid constitutions, and therefore more easily to be inflamed. Thus we are assured by Plutarch and Macrobius, that for every ten men it was customary to put in one woman. Soldiers usually had their arms burnt with them. The garments worn by the living were also thrown on the pile, with other ornaments and presents; a piece of extravagance which the Athenians carried to so great a height, that some of their lawgivers were forced to restrain them, by severe penalties, from defrauding the living by their liberality to the dead.—In some cases, burning was expressly forbidden among the Romans, and even looked upon as the highest impiety. Thus infants, who died before the breeding of teeth, were entombed unburnt in the ground, in a particular place set apart for this purpose, called *suggrundarium*. The like was practised with regard to those who had been struck dead with lightning, who were never to be burnt again. Some say that burning was denied to suicides.—The manner of burning among the Romans was not unlike that of the Greeks; the corpse, being brought out without the city, was carried directly to the place appointed for burning it; which, if it joined to the sepulchre, was called *bustum*; if separate from it, *ustrina*; and there laid on the *rogus* or *pyra*, a pile of wood prepared on which to burn it, built in shape of an altar, but of different height, according to the quality of the deceased. The wood used was commonly from such trees as contain most pitch or rosin; and if any other were used, they split it, for the more easy catching fire: round the pile they set cypress trees, probably to hinder the noisome smell of the corpse. The body was not placed on the bare pile, but on the couch or bed whereon it lay. This done, the next of blood performed the ceremony of lighting the pile; which they did with a torch, turning their faces all the while the other way, as if it were done with reluctance. During the ceremony, decursions and games were celebrated; after which came the *ossilegium*, or gathering of the bones and ashes; also washing and anointing them, and repositing them in urns.

BURNING, among surgeons, denotes the application of an actual cautery, that is, a red hot iron instrument to the part affected; otherwise denominated *cauterization*. The whole art of physic among the Japanese lies in the choice of places proper to be burnt: which are varied according to the disease. In the country of the Mogul, the colic is cured by an iron ring applied red hot about the patient's navel. Certain it is, that some very extraordinary cures have been performed accidentally by burning. The following case is recorded in the Memoirs of the Academy of Sciences by M. Homberg. A woman of about 35 became subject to a head-

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 ach; which at times was so violent that it drove her out of her senses, making her sometimes stupid and foolish, at other times raving and furious. The seat of the pain was in the forehead, and over the eyes, which were inflamed, and looked violently red and sparkling; and the most violent fits of it were attended with nauseas and vomitings. In the times of the fits, she could take no food; but out of them, had a very good stomach. Mr Homberg had in vain attempted her cure for three years with all kinds of medicines; only opium succeeded; and that but little, all its effect being only the taking off the pain for a few hours. The redness of her eyes was always the sign of an approaching fit. One night, feeling a fit coming on, she went to lie down upon the bed; but first walked up to the glass with the candle in her hand, to see how her eyes looked: in observing this, the candle set fire to her cap: and as she was alone, her head was terribly burnt before the fire could be extinguished. Mr Homberg was sent for, and ordered bleeding and proper dressings: but it was perceived, that the expected fit this night never came on; the pain of the burning wore off by degrees; and the patient found herself from that hour cured of the headach, which had never returned in four years after, which was the time when the account was communicated. Another case, not less remarkable than the former, was communicated to Mr Homberg by a physician at Bruges. A woman, who for several years had her legs and thighs swelled in an extraordinary manner, found some relief from rubbing them before the fire with brandy every morning and evening. One evening the fire chanced to catch the brandy she had rubbed herself with, and slightly burnt her. She applied some brandy to her burn; and in the night all the water her legs and thighs were swelled with was entirely discharged by urine, and the swelling did not again return.

Burning-Bush. See Bush.

Burning-Glass, a convex glass, commonly spherical, which being exposed directly to the sun, collects all the rays falling thereon into a very small space called the *focus;* where wood or any other combustible matter being put, will be set on fire. The term *burning-glass* is also used to denote those concave mirrors, whether composed of glass quicksilvered, or of metalline matters, which burn by reflection, condensing the sun's rays into a focus similar to the former.

The use of burning-glasses appears to have been very ancient. Diodorus Siculus, Lucian, Dion, Zonaras, Galen, Anthemius, Eustathius, Tzetzes, and others, attest, that by means of them Archimedes set fire to the Roman fleet at the siege of Syracuse. Tzetzes is so particular in his account of this matter, that his description suggested to Kircher the method by which it was probably accomplished. That author says, that "Archimedes set fire to Marcellus's navy, by means of a burning-glass composed of small square mirrors moving every way upon hinges; which, when placed in the sun's rays, directed them upon the Roman fleet, so as to reduce it to ashes at the distance of a bow shot." A very particular testimony we have also from Anthemius of Lydia, who takes pains to prove the possibility of setting fire to a fleet, or any other combustible body, at such a distance.

That the ancients were also acquainted with the use of catoptric or refracting burning-glasses, appears from a passage in Aristophanes's comedy of The Clouds, which clearly treats of their effects. The author introduces Socrates as examining Strepsiades about the method he had discovered of getting clear of his debts. He replies, that "he thought of making use of a burning-glass which he had hitherto used in kindling his fire:" "for (says he) should they bring a writ against me, I'll immediately place my glass in the sun at some little distance from it, and set it on fire." Pliny and Lactantius have also spoken of glasses that burn by refraction. The former calls them *balls* or *globes of glass* or *crystal*, which, exposed to the sun, transmit a heat sufficient to set fire to cloth, or corrode the dead flesh of those patients who stand in need of caustics; and the latter, after Clemens Alexandrinus, takes notice that fire may be kindled by interposing glasses filled with water between the sun and the object, so as to transmit the rays to it.

It seems difficult to conceive how they should know such glasses would burn without knowing they would magnify, which it is granted they did not, till towards the close of the 13th century, when spectacles were first thought on. For as to those passages in Plautus which seem to intimate the knowledge of spectacles, M. de la Hire observes, they do not prove any such thing; and he solves this, by observing, that their burning-glasses being spheres, either solid or full of water, their foci would be one-fourth of their diameter distant from them. If then their diameter were supposed half a foot, which is the most we can allow, an object must be at an inch and a half distance to perceive it magnified; those at greater distances do not appear greater, but only more confused through the glass than out of it. It is no wonder, therefore, the magnifying property of convex glasses was unknown, and the burning one known. It is more wonderful there should be 300 years between the invention of spectacles and telescopes.

Among the ancients, the burning mirrors of Archimedes and Proclus are famous: the former we have already taken notice of; by the other, the navy of Vitellius besieging Byzantium, according to Zonaras, was burnt to ashes.

Among the moderns, the most remarkable burning mirrors are those of Settala, of Villette, of Tschirnhausen, of Buffon, of Trudaine, and of Parker.

Settala, canon of Padua, made a parabolic mirror, which, according to Shottus, burnt pieces of wood at the distance of 15 or 16 paces. The following things are noted of it in the *Acta Eruditorum*. 1. Green wood takes fire instantaneously, so as a strong wind cannot extinguish it. 2. Water boils immediately; and eggs in it are presently edible. 3. A mixture of tin and lead, three inches thick, drops presently, and iron and steel plate becomes red hot presently, and a little after burns into holes. 4. Things not capable of melting, as stones, bricks, &c. become soon red hot, like iron. 5. Slate becomes first white, then a black glass. 6. Tiles are converted into a yellow glass, and shells into a blackish yellow one. 7. A pumice stone, emitted from a volcano, melts into white glass; and, 8. A piece of crucible also vitrifies in eight minutes. 9. Bones are soon turned into an opaque glass, and earth into a black one. The breadth of this mirror is near three Leipsic ells, its focus two ells from it; it is made of copper, and

and its substance is not above double the thickness of the back of a knife.

Villette, a French artist of Lyons, made a large mirror, which was bought by Tavernier, and presented to the king of Persia; a second, bought by the king of Denmark; a third, presented by the French king to the Royal Academy; a fourth has been in England, where it was publicly exposed. The effects hereof, as found by Dr Harris, and Dr Desaguliers, are, that a silver sixpence is melted in $7\frac{1}{2}''$, a King George's halfpenny in 16", and runs with a hole in 34". Tin melts in 3", cast iron in 16", slate in 3"; a fossil shell calcines in 7"; a piece of Pompey's pillar at Alexandria vitrifies, the black part in 50", the white in 54"; copper ore in 8"; bone calcines in 4", vitrifies in 33". An emerald melts into a substance like a turquois stone; a diamond weighing four grains loses seven-eighths of its weight: the asbestos vitrifies; as all other bodies will do, if kept long enough in the focus; but when once vitrified, the mirror can go no farther with them. This mirror is 47 inches wide, and is ground to a sphere of 76 inches radius; so that its focus is about 38 inches from the vertex. Its substance is a composition of tin, copper, and tin-glass.

Every lens, whether convex, plano-convex, or convexo-convex, collects the sun's rays, dispersed over its convexity, into a point by refraction; and is therefore a burning-glass. The most considerable of this kind is that made by M. de Tschirnhausen: the diameters of his lenses are three and four feet, the focus at the distance of 12 feet, and its diameter an inch and a half. To make the focus the more vivid, it is collected a second time by a second lens parallel to the first, and placed in that point where the diameter of the cone of rays formed by the first lens is equal to the diameter of the second; so that it receives them all: and the focus, from an inch and a half, is contracted into the space of eight lines, and its force increased proportionably.

This glass vitrifies tiles, slate, pumice-stones, &c. in a moment. It melts sulphur, pitch, and all rosins, under water; the ashes of vegetables, woods, and other matters, are transmuted into glass; and every thing applied to its focus is either melted, turned into a calx, or into smoke. Tschirnhausen observes, that it succeeds best when the matter applied is laid on a hard charcoal well burnt.

Sir Isaac Newton presented a burning-glass to the Royal Society, consisting of seven concave glasses, so placed as that all their foci join in one physical point. Each glass is about 11 inches and a half in diameter: six of them are placed round the seventh, to which they are all contiguous; and they form a kind of segment of a sphere, whose subtense is about 34 inches and a half, and the central glass lies about an inch farther in than the rest. The common focus is about 22 inches and a half distant, and about an inch in diameter. This glass vitrifies brick or tile in 1", and melts gold in 30".

It would appear, however, that glass quicksilvered is a more proper material for burning-glasses than metals; for the effects of that speculum wherewith Mr Macquer melted the platina seem to have been superior to those above mentioned, though the mirror itself was much smaller. The diameter of this glass was only 22 inches, and its focal distance 28. Black flint, when exposed to the focus, being powdered to prevent its crackling and flying about, and secured in a large piece of charcoal, bubbled up and ran into transparent glass in less than half a minute. Hessian crucibles, and glass-house pots, vitrified completely in three or four seconds. Forged iron smoked, boiled, and changed into a vitrescent scoria as soon as it was exposed to the focus. The gypsum of Montmartre, when the flat sides of the plates or leaves of which it is composed were presented to the glass, did not show the least disposition to melt; but, on presenting a transverse section of it, or the edges of the plates, it melted in an instant, with a hissing noise, into a brownish yellow matter. Calcareous stones did not completely melt: but there was detached from them a circle more compact than the rest of the mass, and of the size of the focus; the separation of which seemed to be occasioned by the shrinking of the matter which had begun to enter into fusion. The white calx of antimony, commonly called *diaphoretic antimony*, melted better than the calcareous stones, and changed into an opaque pretty glossy substance like white enamel. It was observed, that the whiteness of the calcareous stones and the antimonial calx was of great disadvantage to their fusion, by reason of their reflecting great part of the sun's rays; so that the subject could not undergo the full activity of the heat thrown upon it by the burning-glass. The case was the same with metallic bodies; which melted so much the more difficultly as they were more white and polished; and this difference was so remarkable, that in the focus of this mirror, so fusible a metal as silver, when its surface was polished, did not melt at all.

Plate CXXXI. fig. 1. represents M. Buffon's burning mirror, which he with great reason supposes to be of the same nature with that of Archimedes. It consists of a number of small mirrors of glass quicksilvered, all of which are held together by an iron frame. Each of these small mirrors is also moveable by a contrivance on the back part of the frame, that so their reflections may all coincide in one point. By this means they are capable of being accommodated to various heights of the sun, and to different distances. The adjusting them in this manner takes up a considerable time; but after they are so adjusted, the focus will continue unaltered for an hour or more.

Fig. 2. represents a contrivance of M. Buffon's for diminishing the thickness of very large refracting lenses. He observes, that in the large lenses of this kind, and which are most convenient for many purposes, the thickness of the glass in the middle is so great as very much to diminish their force. For this reason he proposes to form a burning-glass of concentric circular pieces of glass, each resting upon the other, as represented in the figure. His method is to divide the convex arch of the lens into three equal parts. Thus, suppose the diameter to be 26 inches, and the thickness in the middle to be three inches: By dividing the lens into three concentric circles, and laying the one over the other, the thickness of the middle piece needs be only one inch; at the same time that the lens will have the same convexity, and almost the same focal distance, as

Burning. as in the other case; while the effects of it must be much greater, on account of the greater thinness of the glass.

M. Trudaine, a French gentleman, constructed a burning lens on a new principle. It was composed of two circular segments of glass spheres, each four feet in diameter, applied with their concave sides towards each other. The cavity was filled with spirit of wine, of which it contained 40 pints. It was presented by the maker to the Royal Academy of Sciences, but was, not long after, broken by accident. The expence of constructing it amounted to about 1000l. sterling. After all, it does not appear that the effects of this lens were very great. Mr Magellan informs us, that it could only coagulate the particles of platina in 20 minutes, while Mr Parker's lens entirely melted them in less than two.

A large burning lens, indeed, for the purpose of fusing and vitrifying such substances as resist the fires of ordinary furnaces, and especially for the application of heat in vacuo, and in other circumstances in which heat cannot be applied by any other means, has long been a desideratum among persons concerned in philosophical experiments: And it appears now to be in a great degree accomplished by Mr Parker. His lens is three feet in diameter, made of flint-glass, and which, when fixed in its frame, exposes a surface two feet eight inches and a half in the clear.

In the *Elevation* represented on Plate CXXXII, A is the lens of the diameter mentioned: thickness in the centre, three inches and one-fourth: weight, 212 pounds: length of the focus, six feet eight inches; diameter of ditto, one inch. B, a second lens, whose diameter in the frame is 16 inches, and shows in the clear 13 inches: thickness in the centre, one inch five-eighths: weight 21 pounds: length of focus 29 inches: diameter of ditto, three-eighths of an inch. When the two above lenses are compounded together, the length of the focus is five feet three inches: diameter of ditto, half an inch. C, a truncated cone, composed of 21 ribs of wood: at the larger end is fixed the great lens A; at the smaller extremity the lesser lens B: near the smaller end is also fixed a rack D, passing through the pillar L, moveable by a pinion turning in the said pillar, by means of the handle E, and thus giving a vertical motion to the machine. F, a bar of wood, fixed between the two lower ribs of the cone at G; having, within a chased mortice in which it moves, an apparatus H, with the iron plate, I, fixed thereto; and this part turning on a ball and socket, K, a method is thereby obtained of placing the matter under experiment, so as to be acted upon by the focal rays in the most direct and powerful manner. LL, a strong mahogany frame, moving on casters, MM. Immediately under the table N are three friction wheels, by which the machine moves horizontally. O, a strong iron bow, in which the lens and the cone hang.

Section.—a, The great lens marked A in the elevation. b, The frame which contains the lens. c, The small lens marked B. d, The frame which contains the small lens. e, The truncated cone, marked C. f, The bar on which the apparatus marked F moves. g, The iron plate marked I. h, The cone of rays formed by the refraction of the great lens a, and falling on the lens c. i, The cone of rays formed by the refraction of the lens c. *Front-view.*—k, The great lens. l, The frame containing it. m, The strong iron bow in which it hangs.

From a great number of experiments made with this lens, in the presence of many scientific persons, the following are selected as specimens of its powers.

Substances fused, with their weight and time of fusion.	Weight in Grains.	Time in Seconds.
Gold, pure, - - -	20	3
Silver, do. - - -	20	4
Copper, do. - - -	33	20
Platina, do. - - -	10	3
Nickel, - - - -	16	3
Bar iron, a cube, - -	10	12
Cast iron, a cube, - -	10	3
Steel, a cube, - - -	10	12
Scoria of wrought iron, - -	12	2
Terra ponderosa, or barytes, -	10	7
A topaz, or chrysolite, - -	3	45
An oriental emerald, - -	2	25
Crystal pebble, - - -	7	6
White agate, - - -	10	30
Flint, oriental, - - -	10	30
Rough cornelian, - - -	10	75
Jasper, - - -	10	25
Onyx, - - - -	10	20
Garnet, - - - -	10	17
White rhomboidal spar, - -	10	60
Zeolites, - - -	10	23
Rotten-stone, - - -	10	80
Common slate, - - -	10	2
Asbestos, - - -	10	10
Common lime-stone, - -	10	55
Pumice-stone, - - -	10	24
Lava, - - - -	10	7
Volcanic clay, - - -	10	60
Cornish moor-stone, - -	10	60

Burning Mountains. See Ætna, Hecla, Vesuvius, and Volcano, with the plates accompanying them.

Burning Springs. Of these there are many in different parts of the world; particularly one in Dauphiny near Grenoble; another near Hermanstadt in Transylvania; a third at Chermay, a village near Switzerland; a fourth in the canton of Friburg; and a fifth not far from the city of Cracow in Poland. There also is, or was, a famous spring of the same kind at Wigan in Lancashire, which, upon the approach of a lighted candle, would take fire and burn like spirit of wine for a whole day. But the most remarkable one of this kind, or at least that of which we have the most particular description, was discovered in 1711 at Brosely in Shropshire. The following account of this remarkable spring was given by the reverend Mr Mason, Woodwardian professor at Cambridge, dated February 18. 1746. "The well for four or five feet deep is six or seven feet wide; within that is another less hole of like depth dug in the clay, in the bottom whereof is placed a cylindric earthen vessel, of about four or five inches diameter at the mouth, having the bottom taken off, and the sides well fixed in the clay rammed

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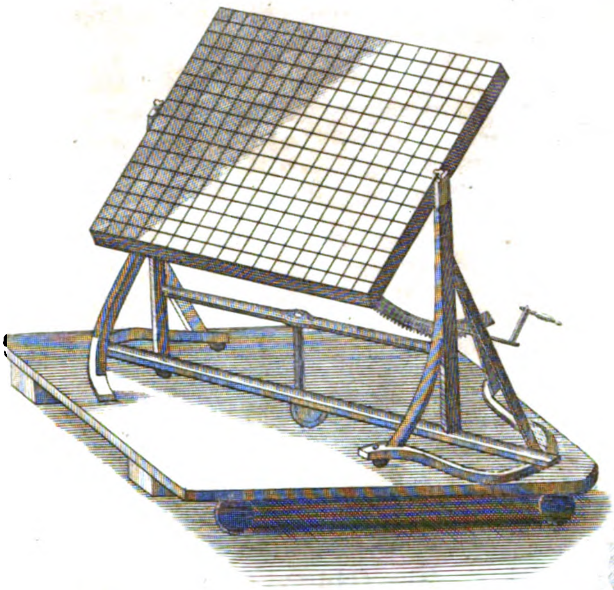
Burning Mirror of Archimedes.

Fig. 1.



Burning Mirror with elevations.

Fig. 2.

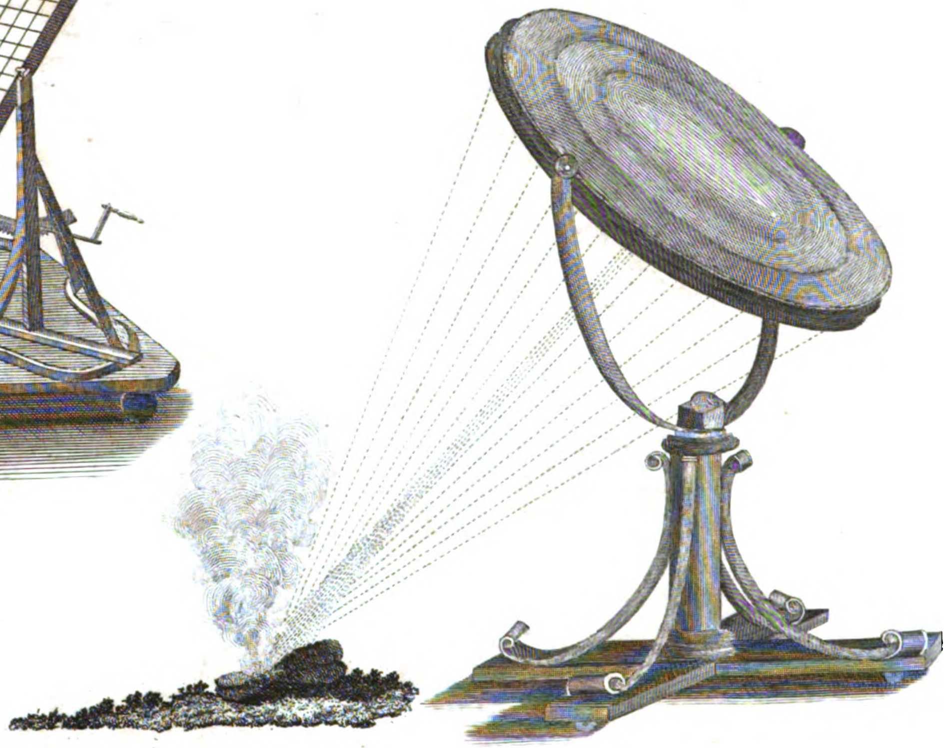


Fig. 3.

Burroughs Machine for polishing Glass.

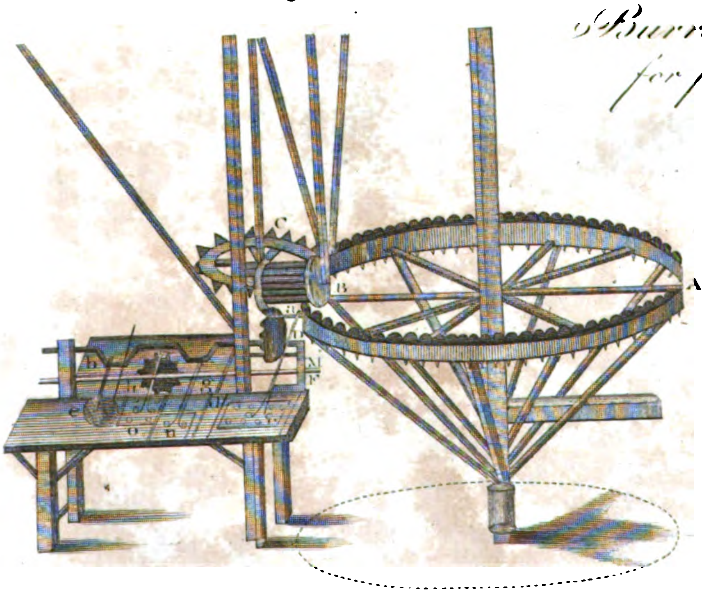
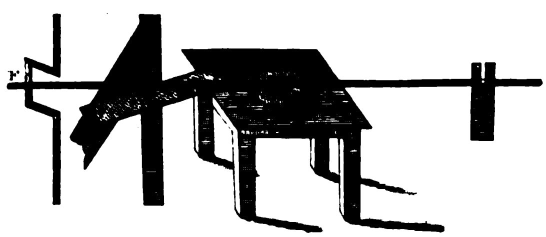


Fig. 4.



W. Archibald Sculp t

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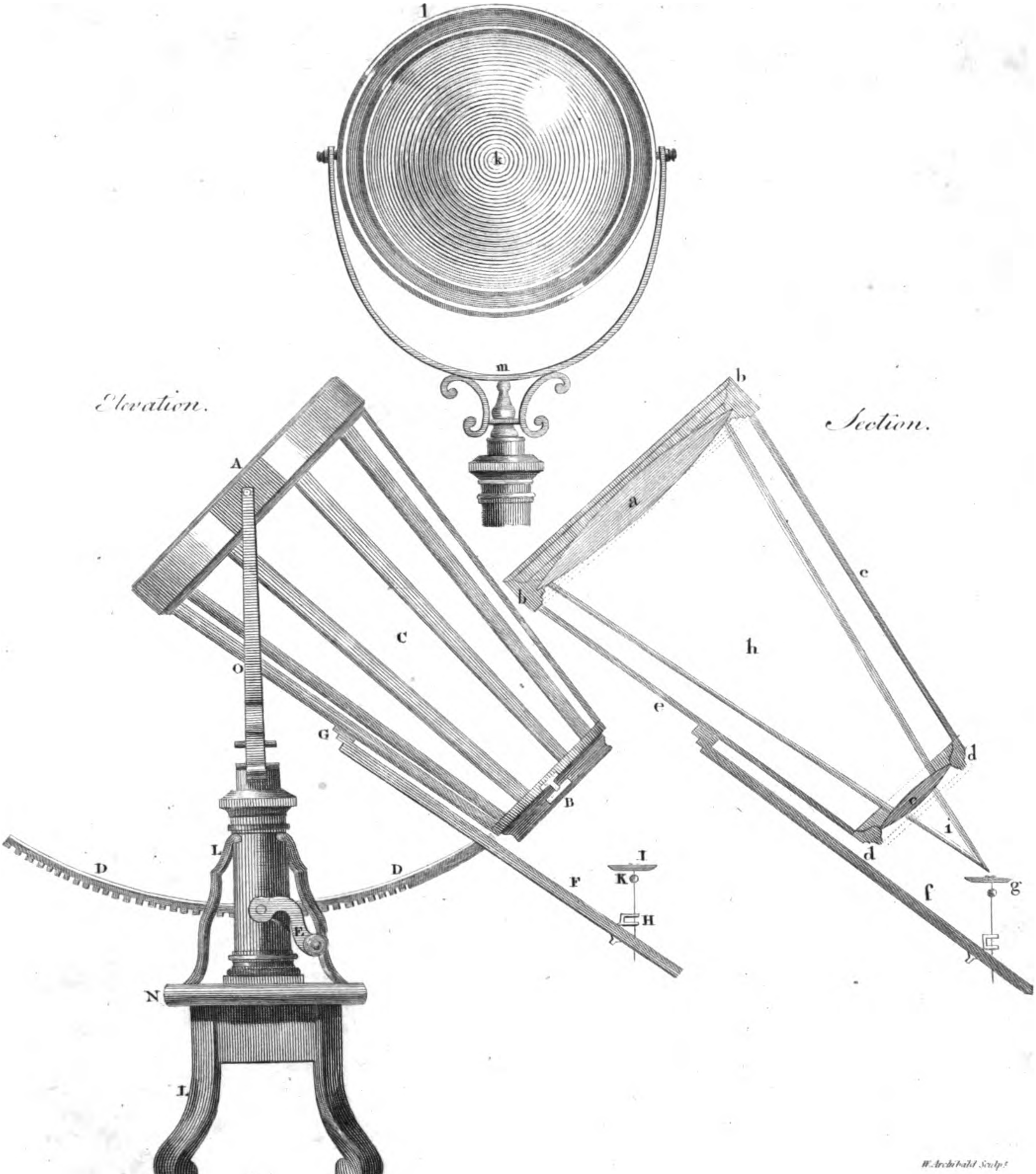
BURNING LENS. PLATE CXXXII.

Parker's.



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rammed close about it. Within the pot is a brown water, thick as puddle, continually forced up with a violent motion beyond that of boiling water, and a rumbling hollow noise, rising or falling by fits five or six inches; but there was no appearance of any vapour rising, which perhaps might have been visible, had not the sun shone so bright. Upon putting a candle down at the end of a stick, at about a quarter of a yard distance, it took fire, darting and flashing after a very violent manner for about half a yard high, much in the manner of spirits in a lamp, but with great agitation. It was said that a tea-kettle had been made to boil in about nine minutes time, and that it had been left burning for 48 hours without any sensible diminution. It was extinguished by putting a wet mop upon it; which must be kept there for a little time, otherwise it would not go out. Upon the removal of the mop there arises a sulphureous smoke lasting about a minute, and yet the water is very cold to the touch." In 1755, this well totally disappeared by the sinking of a coal-pit in its neighbourhood.

The cause of the inflammable property of such waters is, with great probability, supposed to be their mixture with petroleum, which is a very inflammable substance, and has the property of burning on the surface of water.

Burning of Colours, among painters. There are several colours that require burning; as,

First, Lamp black, which is a colour of so greasy a nature, that, except it is burnt, it will require a long time to dry. The method of burning, or rather drying, lamp black, is as follows: Put it into a crucible over a clear fire, letting it remain till it be red hot, or so near it that no manner of smoke arises from it.

Secondly, Umber, which, if it be intended for colour for a horse, or to be a shadow for gold, then burning fits it for both these purposes. In order to burn umber, you must put it into the naked fire, in large lumps, and not take it out till it is thoroughly red hot; if you have a mind to be more curious, put it into a crucible, and keep it over the fire till it be red hot.

Ivory also must be burnt to make black, thus: Fill two crucibles with shavings of ivory, then clap their two mouths together, and bind them fast with an iron wire, and lute the joints close with clay, salt, and horse-dung, well beaten together; then set it over the fire, covering it all over with coals: let it remain in the fire till you are sure that the matter enclosed is thoroughly red hot: then take it out of the fire; but do not open the crucibles till they are perfectly cold; for were they opened while hot, the matter would turn to ashes; and so it will be, if the joints are not luted close.

BURNISHER, a round polished piece of steel, serving to smooth and give a lustre to metals.

Of these there are different kinds, of different figures, straight, crooked, &c. Half burnishers are used to solder silver, as well as to give a lustre.

Burnishers for gold and silver are commonly made of a dog's or wolf's tooth, set in the end of an iron or wooden handle. Of late, agates and pebbles have been introduced, which many prefer to the dog's tooth.

The burnishers used by engravers in copper, usually serve with one end to burnish, and with the other to scrape.

BURNISHING, the art of smoothing or polishing a metalline body, by a brisk rubbing of it with a burnisher.

Book-binders burnish the edges of their books, by rubbing them with a dog's tooth.

BURNLEY, a town of Lancashire in England, situated in W. Long. 2. 5. N. Lat. 51. 38.

BURNS, Robert, was a native of Ayrshire, one of the western counties of Scotland. He was the son of humble parents; and his father passed through life in the condition of a hired labourer, or of a small farmer. Even in this situation, however, it was not hard for him to send his children to the parish school, to receive the ordinary instruction in reading, writing, arithmetic, and the principles of religion. By this course of education young Robert profited to a degree that might have encouraged his friends to destine him to one of the liberal professions, had not his father's poverty made it necessary to remove him from school, as soon as he had grown up, to earn for himself the means of support as a hired ploughboy or shepherd.

The expence of education in the parish-schools of Scotland is so small, that hardly any parents who are able to labour want the means of giving to their children at least such education as young Burns received. From the spring labours of a ploughboy, from the summer employment of a shepherd, the peasant-youth often returns for a few months, eagerly to pursue his education at the parish-school.

It was so with Burns; he returned from labour to learning, and from learning went again to labour, till his mind began to open to the charms of taste and knowledge; till he began to feel a passion for books, and for the subjects of books, which was to give a colour to the whole thread of his future life. On nature he soon began to gaze with new discernment and with new enthusiasm: his mind's eye opened to perceive affecting beauty and sublimity, where, by the mere gross peasant, there was nought to be seen but water, earth, and sky—but animals, plants, and soil.

What might perhaps first contribute to dispose his mind to poetical efforts, is one particular in the devotional piety of the Scotish peasantry. It is still common for them to make their children get by heart the Psalms of David, in the version of homely rhymes which is used in their churches. In the morning and in the evening of every day, or at least on the evening of every Saturday and Sunday, these Psalms are sung in solemn family devotion, a chapter of the Bible is read, and extemporary prayer is fervently uttered. The whole books of the sacred Scriptures are thus continually in the hands of almost every peasant. And it is impossible that there should not be occasionally some souls among them, awakened to the divine emotions of genius by that rich assemblage which those books present, of almost all that is interesting in incidents, or picturesque in imagery, or affectingly sublime or tender in sentiments and character. It is impossible that those rude rhymes, and the simple artless music with which they are accompanied, should not occasionally excite some ear to a fond perception of the melody of verse. That Burns had felt these impulses, will appear undeniably certain to whoever shall carefully peruse his *Cottar's*

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Burns.

tar's Saturday's Night; or shall remark, with nice observation, the various fragments of Scripture sentiment, of Scripture imagery, of Scripture language, which are scattered throughout his works.

Still more interesting to the young peasantry are those ancient ballads of love and war, of which a great number are, in the south of Scotland, yet popularly known, and often sung by the rustic maid or matron at her spinning-wheel. They are listened to with ravished ears by old and young. Their rude melody; that mingled curiosity and awe which are naturally excited by the very idea of their antiquity; the exquisitely tender and natural complaints sometimes poured forth in them; the gallant deeds of knightly heroism, which they sometimes celebrate; their wild tales of demons, ghosts, and fairies, in whose existence superstition alone has believed; the manners which they represent; the obsolete, yet picturesque and expressive, language in which they are often clothed—give them wonderful power to transport every imagination, and to agitate every heart. To the soul of Burns they were like a happy breeze touching the wires of an Æolian harp, and calling forth the most ravishing melody.

Beside all this, the Gentle Shepherd, and the other poems of Allan Ramsay, have long been highly popular in Scotland. They fell early into the hands of Burns; and while the fond applause which they received drew his emulation, they presented to him likewise treasures of phraseology and models of versification. He got acquainted at the same time with the poetry of Robert Ferguson, written chiefly in the Scotish dialect, and exhibiting many specimens of uncommon poetical excellence. The Seasons of Thomson, too, the Grave of Blair, the far-famed Elegy of Gray, the Paradise Lost of Milton, perhaps the Minstrel of Beattie, were so commonly read, even among those with whom Burns would naturally associate, that poetical curiosity, although even less ardent than his, could in such circumstances have little difficulty in procuring them.

With such means to give his imagination a poetical bias, and to favour the culture of his taste and genius, Burns gradually became a poet. He was not, however, one of those forward children who, from a mistaken impulse, begin prematurely to write and to rhyme, and hence never attain to excellence. Conversing familiarly for a long while with the works of those poets who were known to him; contemplating the aspect of nature in a district which exhibits an uncommon assemblage of the beautiful and the ruggedly grand, of the cultivated and the wild; looking upon human life with an eye quick and keen, to remark as well the stronger and leading, as the nicer and subordinate, features of character; to discriminate the generous, the honourable, the manly in conduct, from the ridiculous, the base, and the mean—he was distinguished among his fellows for extraordinary intelligence, good sense, and penetration, long before others, or perhaps even himself, suspected him to be capable of writing verses. His mind was mature, and well stored with such knowledge as lay within his search: he had made himself master of powers of language, superior to those of almost any former writer in the Scotish dialect, before he conceived the idea of surpassing Ramsay and Ferguson.

Hitherto he had conversed intimately only with peasants on his own level; but having got admission into the fraternity of free-masons, he had the fortune, whether good or bad, to attract in the lodges the notice of gentlemen better qualified than his more youthful companions to call forth the powers of his mind, and to show him that he was indeed a poet. A masonic song, a satirical epigram, a rhyming epistle to a friend, attempted with success, taught him to know his own powers, and gave him confidence to try tasks more arduous, and which should command still higher bursts of applause.

The annual celebration of the sacrament of the Lord's Supper, in the rural parishes of Scotland, has much in it of those old Popish festivals, in which superstition, traffic, and amusement, used to be strangely intermingled. Burns saw, and seized in it one of the happiest of all subjects, to afford scope for the display of that strong and piercing sagacity by which he could almost intuitively distinguish the reasonable from the absurd, and the becoming from the ridiculous; of that picturesque power of fancy, which enabled him to represent scenes, and persons, and groups, and looks, attitudes, and gestures, in a manner almost as lively and impressive, even in words, as if all the artifices and energies of the pencil had been employed; of that knowledge which he had necessarily acquired of the manners, passions, and prejudices of the rustics around him, of whatever was ridiculous, no less than of whatever was affectingly beautiful, in rural life.

A thousand prejudices of Popish, and perhaps too of ruder Pagan superstition, have from time immemorial been connected in the minds of the Scotish peasantry, with the annual recurrence of the Eve of the Festival of all the Saints, or Hallowe'en. These were all intimately known to Burns, and had made a powerful impression upon his imagination and feelings. He chose them for the subject of a poem, and produced a piece which is almost to frenzy the delight of those who are best acquainted with its subject; and which will not fail to preserve the memory of the prejudices and usages which it describes, when they shall perhaps have ceased to give one merry evening in the year to the cottage fire-side.

The simple joys, the honest love, the sincere friendship, the ardent devotion of the cottage; whatever in the more solemn part of the rustic's life is humble and artless, without being mean or unseemly—or tender and dignified, without aspiring to stilted grandeur, or to unnatural buskined pathos, had deeply impressed the imagination of the rising poet: had, in some sort, wrought itself into the very texture of the fibres of his soul. He tried to express in verse what he most tenderly felt, what he most enthusiastically imagined; and produced the *Cottar's Saturday's Night*.

These pieces, the true effusion of genius, informed by reading and observation, and prompted by its own native ardour, as well as by friendly applause, were soon handed about amongst the most discerning of Burns's acquaintance; and were by every new reader perused and reperused, with an eagerness of delight and approbation which would not suffer their author long to withhold them from the press. A subscription was proposed; was earnestly promoted by some gentlemen, who were glad to interest themselves in behalf of such signal poetical merit; was soon crowded with the names of a considerable number of the inhabitants of

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Burns. of Ayrshire, who in the proffered purchase sought not less to gratify their own passion for Scotish poetry, than to encourage the wonderful ploughman. At Kilmarnock were the poems of Burns for the first time printed. The whole edition was quickly distributed over the country.

It is hardly possible to express with what eager admiration and delight they were everywhere received.—They eminently possessed all those qualities which the most invariably contribute to render any literary work quickly and permanently popular. They were written in a phraseology, of which all the powers were universally felt; and which being at once antique, familiar, and now rarely written, was hence fitted to serve all the dignified and picturesque uses of poetry, without making it unintelligible. The imagery, the sentiments, were at once faithfully natural, and irresistibly impressive and interesting. Those topics of satire and scandal in which the rustic delights; that humorous imitation of character, and that witty association of ideas familiar and striking, yet not naturally allied to one another, which has force to shake his sides with laughter; those fancies of superstition, at which he still wonders and trembles; those affecting sentiments and images of true religion, which are at once dear and awful to his heart, were all represented by Burns with all a poet's magic power. Old and young, high and low, grave and gay, learned or ignorant, all were alike delighted, agitated, transported.

In the mean time, some few copies of these fascinating poems found their way to Edinburgh; and having been read to Dr Blacklock, they obtained his warmest approbation. In the beginning of the winter 1786-7 Burns went to Edinburgh, where he was received by Dr Blacklock with the most flattering kindness, and introduced to every man of generosity and taste among that good man's friends. Multitudes now vied with each other in patronising the rustic poet. Those who possessed at once true taste and ardent philanthropy were soon earnestly united in his praise: they who were disposed to favour any good thing belonging to Scotland, purely because it was Scotch, gladly joined the cry; those who had hearts and understanding to be charmed, without knowing why, when they saw their native customs, manners, and language, made the subjects and the materials of poesy, could not suppress that voice of feeling which struggled to declare itself for Burns: for the dissipated, the licentious, the malignant wits, and the freethinkers, he was so unfortunate as to have satire and obscenity, and ridicule of things sacred, sufficient to captivate their fancies; even for the pious he had passages in which the inspired language of devotion might seem to come mended from his pen.

Thus did Burns, ere he had been many weeks in Edinburgh, find himself the object of universal curiosity, favour, admiration, and fondness. He was sought after, courted with attentions the most respectful and assiduous, feasted, flattered, caressed, treated by all ranks as the first boast of his country, whom it was scarcely possible to honour and reward to a degree equal to his merits. In comparison with the general favour which now promised to more than crown his most sanguine hopes, it could hardly be called praise at all which he had obtained in Ayrshire.

In this posture of our poet's affairs a new edition of his poems was earnestly called for. He sold the copy-right for 100l.; but his friends at the same time suggested, and actively promoted, a subscription for an edition, to be published for the benefit of the author, ere the bookseller's right should commence. Those gentlemen who had formerly entertained the public of Edinburgh with the periodical publication of the papers of the *Mirror*, having again combined their talents in producing the *Lounger*, were at this time about to conclude this last series of papers; yet before the Lounger relinquished his pen, he dedicated a number to a commendatory criticism of the poems of the Ayrshire bard. Burns.

The subscription papers were rapidly filled; and it was supposed that the poet might derive from the subscription and the sale of his copy-right, a clear profit of at least 700l.

The conversation of even the most eminent authors is often found to be so unequal to the fame of their writings, that he who reads with admiration can listen with none but sentiments of the most profound contempt. But the conversation of Burns was, in comparison with the formal and exterior circumstances of his education, perhaps even more wonderful than his poetry. He affected no soft air or graceful motions of politeness, which might have ill accorded with the rustic plainness of his native manners. Conscious superiority of mind taught him to associate with the great, the learned, and the gay, without being overawed into any such bashfulness as might have made him confused in thought, or hesitating in elocution. He possessed withal an extraordinary share of plain common sense or mother-wit, which prevented him from obtruding upon persons, of whatever rank, with whom he was admitted to converse, any of those effusions of vanity, envy, or self-conceit, in which authors are exceedingly apt to indulge, who have lived remote from the general practice of life, and whose minds have been almost exclusively confined to contemplate their own studies and their own works. In conversation he displayed a sort of intuitive quickness and rectitude of judgment upon every subject that arose. The sensibility of his heart, and the vivacity of his fancy, gave a rich colouring to whatever reasoning he was disposed to advance; and his language in conversation was not at all less happy than in his writings. For these reasons, those who had met and conversed with him once, were pleased to meet and to converse with him again and again.

For some time he conversed only with the virtuous, the learned, and the wise; and the purity of his morals remained uncontaminated. But, alas! he fell, as others have fallen in similar circumstances. He suffered himself to be surrounded by a race of miserable beings, who were proud to tell that they had been in company with Burns, and had seen Burns as loose and as foolish as themselves. He was not yet irrecoverably lost to temperance and moderation; but he was already almost too much captivated with their wanton rivals, to be ever more won back to a faithful attachment to their more sober charms. He now also began to contract something of new arrogance in conversation. Accustomed to be among his favourite associates what is vulgarly but expressively called *the cock of the company*, he could scarcely refrain from indulging in similar freedom

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dom and dictatorial decision of talk, even in the presence of persons who could less patiently endure his presumption.

The subscription edition of his poems, in the mean time, appeared; and although not enlarged beyond that which came from the Kilmarnock press by any new pieces of eminent merit, did not fail to give entire satisfaction to the subscribers. He was now to close accounts with his bookseller and his printer, to retire to the country with his profits in his pocket, and to fix upon a plan for his future life. He talked loudly of independence of spirit, and simplicity of manners, and boasted his resolution to return to the plough; yet still he lingered in Edinburgh, week after week, and month after month, perhaps expecting that one or other of his noble patrons might procure him some permanent and competent annual income, which should set him above all necessity of future exertions to earn for himself the means of subsistence; perhaps unconsciously reluctant to quit the pleasures of that voluptuous town life to which he had for some time too willingly accustomed himself. An accidental dislocation or fracture of an arm or leg confining him for some weeks to his apartment, left him, during this time, leisure for serious reflection; and he determined to retire from the town without longer delay. None of all his patrons interposed to divert him from his purpose of returning to the plough, by the offer of any small pension, or any sinecure place of moderate emolument, such as might have given him competence without withdrawing him from his poetical studies. It seemed to be forgotten that a ploughman thus exalted into a man of letters was unfitted for his former toils, without being regularly qualified to enter the career of any new profession; and that it became incumbent upon those patrons who had called him from the plough, not merely to make him their companion in the hour of riot, not simply to fill his purse with gold for a few transient expences, but to secure him, as far as was possible, from being ever overwhelmed in distress in consequence of the favour which they had shewn him, and of the habits of life into which they had seduced him. Perhaps indeed the same delusion of fancy betrayed both Burns and his patrons into the mistaken idea, that, after all which had passed, it was still possible for him to return in cheerful content to the homely joys and simple toils of undissipated rural life.

In this temper of Burns's mind, in this state of his fortune, a farm and the excise were the objects upon which his choice ultimately fixed for future employment and support. By the surgeon who attended him during his illness, he was recommended with effect to the commissioners of excise; and Patrick Miller, Esq. of Dalswinton, deceived, like Burns himself and Burns's other friends, into an idea that the poet and exciseman might yet be respectable and happy as a farmer, generously proposed to establish him in a farm, upon conditions of lease, which prudence and industry might easily render exceedingly advantageous. Burns eagerly accepted the offers of this benevolent patron. Two of the poet's friends from Ayrshire were invited to survey that farm in Dumfries-shire which Mr Miller offered. A lease was granted to the poetical farmer at that annual rent which his own friends declared that the due cultivation of his farm might easily enable him to pay. What yet remained of the profits of his publication was laid out in the purchase of farm stock; and Mr Miller might, for some short time, please himself with the persuasion that he had approved himself the liberal patron of genius; had acquired a good tenant upon his estate; and had placed a deserving man in the very situation in which alone he himself desired to be placed, in order to be happy to his wishes.

Burns, with his Jane, whom he now married, took up their residence upon his farm. The neighbouring farmers and gentlemen, pleased to obtain for an inmate among them the poet by whose works they had been delighted, kindly sought his company, and invited him to their houses. He found an inexpressible charm in sitting down beside his wife, at his own fireside; in wandering over his own grounds; in once more putting his hand to the spade and the plough; in forming his inclosures, and managing his cattle. For some months he felt almost all that felicity which fancy had taught him to expect in his new situation. He had been for a time idle; but his muscles were not yet unbraced for rural toil. He now seemed to find a joy in being the husband of the mistress of his affections, in seeing himself the father of her children, such as might promise to attach him for ever to that modest, humble, and domestic life, in which alone he could hope to be permanently happy. Even his engagements in the service of the excise did not, at the very first, threaten necessarily to debase him by association with the mean, the gross, and the profligate, to contaminate the poet, or to ruin the farmer.

But it could not be: it was not possible for Burns now to assume that soberness of fancy and passions, that sedateness of feeling, those habits of earnest attention to gross and vulgar cares, without which success in his new situation was not to be expected. A thousand difficulties were to be encountered and overcome, much money was to be expended, much weary toil was to be exercised, before his farm could be brought into a state of cultivation, in which its produce might enrich the occupier. This was not a prospect encouraging to a man who had never loved labour, and who was at this time certainly not at all disposed to enter into agriculture with the enthusiasm of a projector. The business of the excise too, as he began to be more and more employed in it, distracted his mind from the care of his farm, led him into gross and vulgar society, and exposed him to many unavoidable temptations to drunken excess, such as he had no longer sufficient fortitude to resist. Amidst the anxieties, distractions, and seducements which thus arose to him, home became insensibly less and less pleasing; even the endearments of his Jane's affection began to lose their hold on his heart; he became every day less and less unwilling to forget in riot those gathering sorrows which he knew not to subdue.

Mr Miller and some others of his friends would gladly have exerted an influence over his mind, which might have preserved him in this situation of his affairs, equally from despondency and from dissipation; but Burns's temper spurned all controul from his superiors in fortune. He resented, as an arrogant encroachment upon his independence, that tenor of conduct by which Mr Miller wished to turn him from dissolute conviviality, to that steady attention to the business of his farm, without which it was impossible to thrive in it. His

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His crosses and disappointments drove him every day more and more into dissipation; and his dissipation tended to enhance whatever was disagreeable and perplexing in the state of his affairs. He sunk, by degrees, into the boon companion of mere excisemen; and almost every drunken fellow, who was willing to spend his money lavishly in the alehouse, could easily command the company of Burns. The care of his farm was thus neglected; waste and losses wholly consumed his little capital: he resigned his lease into the hands of his landlord; and retired, with his family, to the town of Dumfries, determining to depend entirely for the means of future support upon his income as an excise-officer.

Yet during this unfortunate period of his life, which passed between his departure from Edinburgh to settle in Dumfriesshire, and his leaving the country in order to take up his residence in the town of Dumfries, the energy and activity of his intellectual powers appeared not to have been at all impaired. In a collection of Scotish songs, which were published (the words with the music) by Mr Johnson, engraver in Edinburgh, in 4 vols. 8vo, Burns, in many instances, accommodated new verses to the old tunes with admirable felicity and skill. He assisted in the temporary institution of a small subscription library, for the use of a number of the well-disposed peasants in his neighbourhood. He readily aided, and by his knowledge of genuine Scotish phraseology and manners, greatly enlightened, the antiquarian researches of the late ingenious Captain Grose. He still carried on an epistolary correspondence, sometimes gay, sportive, humorous, but always enlivened by bright flashes of genius, with a number of his old friends, and on a very wide diversity of topics. At times, as it should seem from his writings of this period, he reflected, with inexpressible heart-bitterness, on the high hopes from which he had fallen; on the errors of moral conduct into which he had been hurried by the ardour of his soul, and in some measure by the very generosity of his nature; on the disgrace and wretchedness into which he saw himself rapidly sinking; on the sorrow with which his misconduct oppressed the heart of his Jane; on the want and destitute misery in which it seemed probable that he must leave her and their infants; nor amidst these agonizing reflections did he fail to look, with an indignation half invidious, half contemptuous, on those who, with moral habits not more excellent than his, with powers of intellect far inferior, yet basked in the sunshine of fortune, and were loaded with the wealth and honours of the world, while his follies could not obtain pardon, nor his wants an honourable supply. His wit became from this time more gloomily sarcastic; and his conversation and writings began to assume something of a tone of misanthropical malignity, by which they had not been before, in any eminent degree, distinguished. But with all these failings, he was still that exalted mind which had raised itself above the depression of its original condition; with all the energy of the lion, pawing to set free his hinder limbs from the yet encumbering earth, he still appeared *not less than archangel ruined!*

His morals were not mended by his removal from the country. In Dumfries his dissipation became still more deeply habitual; he was here more exposed than in the country to be solicited to share the riot of the dissolute and the idle; foolish young men flocked eagerly about him, and from time to time pressed him to drink with them, that they might enjoy his wicked wit. The Caledonian Club, too, and the Dumfries-shire and Galloway Hunt, had occasional meetings in Dumfries after Burns went to reside there, and the poet was of course invited to share their conviviality, and hesitated not to accept the invitation.

In the intervals between his different fits of intemperance, he suffered still the keenest anguish of remorse, and horribly afflictive foresight. His Jane still behaved with a degree of maternal and conjugal tenderness and prudence, which made him feel more bitterly the evil of his misconduct, although they could not reclaim him. At last crippled, emaciated, having the very power of animation wasted by disease, quite broken-hearted by the sense of his errors, and of the hopeless miseries in which he saw himself and his family depressed; with his soul still tremblingly alive to the sense of shame, and to the love of virtue; yet even in the last feebleness and amid the last agonies of expiring life, yielding readily to any temptation that offered the semblance of intemperate enjoyment, he died at Dumfries, in the summer of 1796, while he was yet three or four years under the age of 40, furnishing a melancholy proof of the danger of *suddenly* elevating even the greatest mind above its original level.

After his death it quickly appeared that his failings had not effaced from the minds of his more respectable acquaintance either the regard which had once been won by his social qualities, or the reverence due to his intellectual talents. The circumstances of want in which he left his family were noticed by the gentlemen of Dumfries with earnest commiseration. His funeral was celebrated by the care of his friends with a decent solemnity, and with a numerous attendance of mourners, sufficiently honourable to his memory. Several copies of verses were inserted in different newspapers upon the occasion of his death. A contribution, by subscription, was proposed, for the purpose of raising a small fund, for the decent support of his widow, and the education of his infant children.

From the preceding detail of the particulars of this poet's life, the reader will naturally and justly infer him to have been an honest, proud, warm-hearted man; of high passions and sound understanding, and a vigorous and excursive imagination. He was never known to descend to any act of deliberate meanness. In Dumfries he retained many respectable friends, even to the last. It may be doubted whether he has not, by his writings, exercised a greater power over the minds of men, and, by consequence, on their conduct, upon their happiness and misery, and upon the general system of life, than has been exercised by any half dozen of the most eminent statesmen of the present age. The power of the statesman is but shadowy, so far as it acts upon externals alone: the power of the writer of genius subdues the heart and the understanding, and having thus made the very spring of action its own, through them moulds almost all life and nature at its pleasure. Burns has not failed to command one remarkable sort of homage, such as is never paid but to great original genius: a crowd of poetasters started up to imitate him, by writing verses as he had done, in in the Scotish dialect; but, *O imitatores! servum pecus!* To persons whom the Scotish dialect, and the customs and manners of rural life in Scotland, have no charm, too much may appear to have been said about Burns; by those who passionately admire him, a great deal more, perhaps, was expected.

A complete edition of his works, in 4 vols 8vo. was published under the superintendence of Dr Currie of Liverpool, who drew up an elaborate and valuable account of the life of the poet, which is prefixed. From the profits of this edition his widow and family have received a handsome sum. The following letter from Burns to the late Dr Moore, gives so interesting an account of the transactions of his early years, and affords so good a specimen of vigour of thought and force of expression in his prose composition, that we hope it will prove acceptable to our readers.

"*Mauchline*, August 2. 1787.—Sir, For some months past I have been rambling up and down the country, but I am now confined with some lingering complaints, originating, as I take it, in the stomach. To divert my spirits a little in this miserable fog of *ennui*, I have taken a whim to give you a history of myself. My name has made some little noise in this country; you have done me the honour to interest yourself very warmly in my behalf; and I think a faithful account of what character of a man I am, and how I came by that character, may perhaps amuse you in an idle moment. I will give you an honest narrative, though I know it will be often at my own expence; for I assure you, Sir, I have, like Solomon, whose character, excepting in the trifling affair of wisdom, I sometimes think I resemble, I have, I say, like him turned my eyes to behold madness and folly, and like him, too, frequently shaken hands with their intoxicating friendship. * * * After you have perused these pages, should you think them trifling and impertinent, I only beg leave to tell you, that the poor author wrote them under some twitching qualms of conscience, arising from a suspicion that he was doing what he ought not to do; a predicament he has more than once been in before.

"I have not the most distant pretensions to assume that character which the pye-coated guardians of escutcheons call, a gentleman. When at Edinburgh last winter, I got acquainted in the heralds office, and looking through that granary of honours, I there found almost every name of the kingdom; but for me,

——My ancient but ignoble blood
Has crept thro' scoundrels ever since the flood.

Gules, purpure, argent, &c. quite disowned me.

"My father was of the north of Scotland, the son of a farmer, and was thrown by early misfortunes on the world at large; where, after many years wanderings and sojournings, he picked up a pretty large quantity of observation and experience, to which I am indebted for most of my little pretensions to wisdom.—I have met with few who understood men, their manners, and their ways, equal to him; but stubborn ungainly integrity, and headlong ungovernable irascibility, are disqualifying circumstances; consequently I was born a very poor man's son. For the first six or seven years of my life, my father was a gardener to a worthy gentleman of a small estate in the neighbourhood of Ayr. Had he continued in that station, I must have marched off to be one of the little underlings about a farm-house; but it was his dearest wish and prayer to have it in his power to keep his children under his own eye, till they could discern between good and evil; so with the assistance of his generous master, my father ventured on a small farm on his estate. At these years I was by no means a favourite with any body. I was a good deal noted for a retentive memory, a stubborn sturdy something in my disposition, and an enthusiastic idiot piety. I say idiot piety, because I was then but a child. Though it cost the schoolmaster some thrashings, I made an excellent English scholar; and by the time I was 10 or 12 years of age, I was a critic in substantives, verbs, and particles. In my infant and boyish days too, I owed much to an old woman who resided in the family, remarkable for her ignorance, credulity, and superstition. She had, I suppose, the largest collection in the country, of tales and songs concerning devils, ghosts, fairies, brownies, witches, warlocks, spunkies, kelpies, elf-candles, dead-lights, wraiths, apparitions, cantraips, giants, enchanted towers, dragons, and other trumpery. This cultivated the latent seeds of poetry; but had so strong an effect on my imagination, that to this hour, in my nocturnal rambles, I sometimes keep a sharp look-out in suspicious places; and though nobody can be more sceptical than I am in such matters, yet it often takes an effort of philosophy to shake off these idle terrors. The earliest composition that I recollect taking pleasure in, was the Vision of Mirza, and a hymn of Addison's, beginning, 'How are thy servants blest, O Lord!' I particularly remember one half-stanza which was music to my boyish ear—

For though on dreadful whirls we hung
High on the broken wave.—

I met with these pieces in Mason's English Collection, one of my school-books. The two first books I ever read in private, and which gave me more pleasure than any two books I ever read since, were, The Life of Hannibal, and The History of Sir William Wallace. Hannibal gave my young ideas such a turn, that I used to strut in raptures up and down after the recruiting drum and bag-pipe, and wish myself tall enough to be a soldier; while the story of Wallace poured a Scotish prejudice into my veins, which will boil along there, till the flood-gates of life shut in eternal rest.

"Polemical divinity about this time was putting the country half mad, and I, ambitious of shining in conversation parties on Sundays between sermons, at funerals, &c. used a few years afterwards to puzzle Calvinism with so much heat and indiscretion, that I raised a hue and cry of heresy against me, which has not ceased to this hour.

"My vicinity to Ayr was of some advantage to me. My social disposition, when not checked by some modifications of spited pride, was, like our catechism definition of infinitude, without bounds or limits. I formed several connexions with other younkers who possessed superior advantages; the youngling actors who were busy in the rehearsal of parts in which they were shortly to appear on the stage of life, where, alas! I was destined to drudge behind the scenes. It is not commonly at this green age that our young gentry

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gentry have a just sense of the immense distance between them and their ragged play-fellows. It takes a few dashes into the world, to give the young great man that proper, decent, unnoticing disregard for the poor, insignificant, stupid devils, the mechanics and peasantry around him, who were perhaps born in the same village. My young superiors never insulted the *clouterly* appearance of my plough-boy carcase, the two extremities of which were often exposed to all the inclemencies of all the seasons. They would give me stray volumes of books; among them, even then, I could pick up some observations, and one, whose heart I am sure not even the Munny Begum scenes have tainted, helped me to a little French. Parting with these my young friends and benefactors, as they occasionally went off for the East or West Indies, was often to me a sore affliction, but I was soon called to more serious evils. My father's generous master died; the farm proved a ruinous bargain; and to clench the misfortune, we fell into the hands of a factor, who sat for the picture I have drawn of one in my tale of Twa Dogs. My father was advanced in life when he married; I was the eldest of seven children, and he, worn out by early hardships, was unfit for labour. My father's spirit was soon irritated, but not easily broken. There was a freedom in his lease in two years more, and to weather these two years, we retrenched our expences. We lived very poorly: I was a dexterous ploughman for my age; and the next oldest to me was a brother (Gilbert) who could drive the plough very well, and help me to thrash the corn. A novel writer might perhaps have viewed these scenes with some satisfaction, but so did not I; my indignation yet boils at the recollection of the s——l factor's insolent threatening letters, which used to set us all in tears.

"This kind of life—the cheerless gloom of a hermit, with the unceasing moil of a galley-slave, brought me to my 16th year; a little before which period I first committed the sin of ryhme. You know our country custom of coupling a man and woman together as partners in the labours of harvest. In my 15th autumn, my partner was a bewitching creature, a year younger than myself. My scarcity of English denies me the power of doing her justice in that language, but you know the Scotish idiom; she was a bonnie, sweet, sonsie lass. In short, she altogether, unwittingly to herself, initiated me in that delicious passion, which, in spite of acid disappointment, gin-horse prudence, and book-worm philosophy, I hold to be the first of human joys, our dearest blessing here below! How she caught the contagion I cannot tell: you medical people talk much of infection from breathing the same air, the touch, &c. but I never expressly said I loved her.—Indeed I did not know myself why I liked so much to loiter behind with her, when returning in the evening from our labours; why the tones of her voice made my heart-strings thrill like an Æolian harp: and particularly why my pulse beat such a furious ratan when I looked and fingered over her little hand to pick out the cruel nettle-stings and thistles. Among her other love-inspiring qualities, she sung sweetly; and it was her favourite reel to which I attempted giving an embodied vehicle in rhyme. I was not so presumptuous as to imagine that I could make verses like printed ones, composed by men who had Greek and Latin; but my girl sung a song which was said to be composed by a small country laird's son, on one of his father's maids, with whom he was in love, and I saw no reason why I might not rhyme as well as he; for excepting that he could smear sheep, and cast peats, his father living in the moorlands, he had no more scholarcraft than myself.

"Thus with me began love and poetry; which at times have been my only, and, till within the last 12 months, have been my highest enjoyment. My father struggled on till he reached the freedom in his lease, when he entered on a larger farm, about ten miles farther in the country. The nature of the bargain he made was such as to throw a little ready money into his hands at the commencement of his lease, otherwise the affair would have been impracticable. For four years we lived comfortably here; but a difference commencing between him and his landlord as to terms, after three years tossing and whirling in the vortex of litigation, my father was just saved from the horrors of a jail, by a consumption, which, after two years promises, kindly stepped in, and carried him away, to 'where the wicked cease from troubling, and where the weary are at rest!'

"It is during the time that we lived on this farm, that my little story is most eventful. I was, at the beginning of this period, perhaps the most ungainly aukward boy in the parish—no solitaire was less acquainted with the ways of the world. What I knew of ancient story was gathered from Salmon's and Guthrie's Geographical Grammars; and the ideas I had formed of modern manners, of literature, and criticism, I got from the Spectator. These, with Pope's Works, some plays of Shakespeare, Tull and Dickson on Agriculture, the Pantheon, Locke's Essay on the Human Understanding, Stackhouse's History of the Bible, Justice's British Gardener's Directory, Bayle's Lectures, Allan Ramsay's Works, Taylor's Scripture Doctrine of Original Sin, a Select Collection of English Songs, and Hervey's Meditations, had formed the whole of my reading. The collection of songs was my *vade mecum*. I pored over them driving my cart, or walking to labour, song by song, verse by verse; carefully noting the true tender, or sublime, from affectation and fustian. I am convinced I owe to this practice much of my critic-craft, such as it is." (*Month Mag. and Currie's Life of Burns*).

BURNTISLAND. See Bruntisland.

BURNTWOOD, a town of Essex in England, situated on a hill, in E. Long. 0. 25. N. Lat. 51. 38.

BURR, the round knob of a horn next a deer's head.

BURRE, Bouree, or *Boree*, a kind of dance composed of three steps joined together in two motions, begun with a crotchet rising. The first couplet contains twice four measures, the second twice eight. It consists of a balance and coupee.

BURR-Pump, or *Bilge-Pump*, differs from the common pump, in having a staff, six, seven, or eight feet long, with a bar of wood, whereto the leather is nailed, and this serves instead of a box. So two men, standing over the pump, thrust down this staff, to the middle whereof is fastened a rope, for six, eight, or ten to hale by, thus pulling it up and down.

BURROCK, a small wier or dam, where weels are laid in a river, for the taking of fish.

BURROUGHS's.

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Burroughs's Machine.

BURROUGHS's MACHINE for grinding and polishing glass, invented by Mr Burroughs of Southwark; and for which he received from the society for the encouragement of arts a premium of 70l.

Plate CXXXI.

This machine consists of a cog-wheel A (fig. 3.), 12 feet in diameter, carrying 72 cogs; which turn a trundle-head B, one foot four inches in diameter, and furnished with eight rounds; and also a horizontal spur-wheel C, of 12 cogs; and one foot eight inches in diameter. The trundle-head B turns a spur-wheel D of 10 cogs, and two feet eight inches in diameter. This spur-wheel has two cranks, *a*, *b*, in its shaft; one of which, *a*, gives motion to a wooden frame, *c*, about 34 inches long and 19 broad. On the under side of this frame are fastened by screws 12 pieces of polished metal, each five inches and a half long, and three broad, covered with leather; and underneath these polishers a glass plate cemented in another frame is placed on the bench *d*, and polished with tripoli by the motion given to the upper frame by the crank *a*. The nuts of the screws which fasten the polishers to the upper frame are not screwed close to the wood, in order to give the frame room to play; by which contrivance the perpendicular rise of the crank is avoided, and the motion of the polishers is always parallel and equal. The under frame may be moved by the hand in any direction without stopping the machine; by which means the plate, when larger than the polishing frame can cover in its motion, will be equally polished in every part.

The other crank *b* gives motion to two other polishers marked *n*, *o*, which have an alternate motion by the bending of the crank; they move upon the same plate, and have an equal number of polishers as that already described.

The same crank also gives motion to a contrivance represented at *e* for polishing spectacle-glasses. It consists of two segments of the same sphere; one concave and the other convex. On the latter the glasses are cemented; and polished by the former, which is moved by the crank *b*. The convex segment may be moved round by the hand without stopping the machine, so that all the glasses on its superficies will be equally polished.

The other spur-wheel C, by means of a crank in its shaft, gives motion to another frame *g*, employed in grinding the glass plates. The rod *h*, extended from the crank *f* to the frame *g*, is fastened to the latter by means of a pivot, in order to admit of a rotatory motion, as well as that given it by the crank in a longitudinal direction. This rotatory motion is effected by means of a rod of iron *i*, called a *trigger*, sharp at the extremity next the frame, where it touches the teeth of a horizontal spur-wheel, or circular piece of wood, fixed on the grinding plate, while the other is extended three feet two inches to the centre of motion.

But this contrivance, in which the merit of the machine principally consists, will be much better conceived from a small delineation of it by itself (fig. 4.), where F is the crank marked *f* in fig. 3. and turned by the spur-wheel C in the same figure. G is the trigger, three feet two inches long. I, a roll fixed on the trigger for the rod to slide on. H, the horizontal spur-wheel, eleven inches in diameter, fixed on the grinding plate; the teeth of which are touched by the trigger; but with a very unequal force, as it will wholly depend upon the grinding-plate's being farther from, or nearer to, the centre of motion of the trigger. By this simple contrivance, the grinding-plate has a very compound motion, never moving exactly in the same track, and therefore must grind the plates equally in every part. Several attempts have been made by others for producing the same effect, but without success; the grinding-plate always follows the same track, and consequently the plates are ground equally.

Burroughs's Machine ‖ Bursars.

BURROW, SIR JAMES, master of the crown office, was elected F. R. S. and F. A. S. 1751. On the death of Mr West in 1772, he was prevailed on to fill the president's chair at the Royal Society till the anniversary election, when he resigned it to Sir John Pringle; and August 10. 1773, when the society presented an address to his majesty, he received the honour of knighthood. He published two volumes of Reports in 1766; two others in 1771 and 1776; and a volume of Decisions of the Court of King's Bench upon settlement cases from 1732 to 1772 (to which was subjoined An Essay of Punctuation), in three parts, 4to, 1768, 1772, 1776. The Essay was also printed separately in 4to, 1773. He published, without his name, "A few Anecdotes and Observations relating to Oliver Cromwell and his family, serving to rectify several errors concerning him," published by Nicol. Comn. Papadopoli, in his *Historia Gymnasii Patavini*, 1763, 4to. He died in 1782.

BURROWS, holes in a warren, serving as a covert for rabbits, &c. A coney's coming out of her burrow is called *bolting*. To catch coneys, they sometimes lay purse-nets over the burrows, then put in a terrier close muzzled, which making the creature bolt, she is caught in the net.

BURSA, or PRUSA, in *Geography*, the capital of Bithynia in Asia Minor, situated in a fine fruitful plain, at the foot of Mount Olympus, about 100 miles south of Constantinople. It is still a large town. E. Long. 29. 0. N. Lat. 40. 30.

Bursa-Pastoris, in *Botany*. See THLASPI.

BURSA, *Burse*, originally signifies a purse. In middle-age writers it is more particularly used for a little college or hall in a university, for the residence of students, called *bursales* or *bursarii*. In the French universities it still denotes a foundation for the maintenance of poor scholars in their studies. The nomination to burses is in the hands of the patrons and founders thereof. The burses of colleges are not benefices, but mere places assigned to certain countries and persons. A burse becomes vacant by the burser's being promoted to a cure.

BURSÆ MUCOSÆ. See ANATOMY *Index*.

BURSAR, or BURSER, (*Bursarius*), is used in middle-age writers for a treasurer or cash-keeper. In this sense we meet with bursars of colleges. Conventual bursars were officers in monasteries, who were to deliver up their account yearly on the day after Michaelmas. The word is formed from the Latin *bursa*, whence also the English word *purse*; hence also the officer, who in a college is called *bursar*, in a ship is called *purser*.

BURSARS, or *Bursors*, (*Bursarii*), also denote those to whom stipends are paid out of a burse or fund appointed for that purpose.

BURSARIA,

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BURSARIA, the bursary, or exchequer of collegiate and conventual bodies; or the place of receiving, paying, and accounting by the bursarii or bursers.

BURSE, in matters of commerce, denotes a public edifice in certain cities, for the meeting of merchants to negotiate bills, and confer on other matters relating to money and trade. In this sense, burse amounts to the same with what we otherwise call an *exchange*.

The first place of this kind to which the name *Burse* was given, Guicchardin assures us was at Bruges; and it took its denomination from a hotel adjoining to it, built by a lord of the family de la Bourse, whose arms, which are three purses, are still found on the crowning over the portal of the house. Catel's account is somewhat different, viz. that the merchants of Bruges bought a house or apartment to meet in, at which was the sign of the purse. From this city the name was afterwards transferred to the like places in others, as in Antwerp, Amsterdam, Bergen in Norway, and London. This last, anciently known by the name of the *common burse of merchants*, had the denomination since given it by Queen Elizabeth, of the *royal exchange*. The most considerable burse is that of Amsterdam, which is a large building, 230 feet long and 130 broad, round which runs a peristyle 20 feet wide. The columns of the peristyle, which are 46, are numbered, for the conveniency of finding people. It will hold 4500 persons.

In the times of the Romans there were public places for the meeting of merchants in most of the trading cities in the empire; that built at Rome, in the 259th year after its foundation, under the consulate of Appius Claudius and Publius Servilius, was denominated the *college of merchants*; some remains of it are still to be seen, and are known by the modern Romans under the name *loggia*. The Hans Towns, after the example of the Romans, gave the name of *colleges* to their burses.

BURSERA. See Botany *Index*.

BURSTEN, denotes a person who has a rupture. See Rupture

BURTHEN *of a* Ship. See Burden.

BURTON *upon* Trent, a town of Staffordshire, in England. It had formerly a large abbey; and over the river Trent it has now a famous bridge of free stone, about a quarter of a mile in length, supported by 37 arches. It consists chiefly of one long street, which runs from the place where the abbey stood to the bridge, and contained 3979 inhabitants in 1811. Burton ale is reckoned the best of any brought to London. W. Long. 1. 36. N. Lat. 52. 48.

Burton, a town of Lincolnshire in England, seated on a hill near the river Trent. It is but a small place, and is situated in W. Long. 0. 30. N. Lat. 53. 40.

Burton, a town of Westmoreland in England, seated in a valley near a large hill called *Farleton-knot-hill*. It is pretty well built, and lies on the great road from Lancaster to Carlisle. W. Long. 2. 35. N. Lat. 54. 10.

Burton, *Robert*, known to the learned by the name of *Democritus junior*, was younger brother to William Burton, who wrote "The Antiquities of Leicestershire," and born of an ancient family at Lindley, in that county, upon the 8th of February 1576. He was educated in grammatical learning in the free school of Sutton Colefield in Warwickshire; in the year 1593 was sent to Brazen-nose college in Oxford; and in 1599 was elected student of Christ-church. In 1616, he had the vicarage of St Thomas, in the west suburb of Oxford, conferred upon him by the dean and canons of Christ-church, to the parishioners of which, it is said, that he always gave the sacrament in wafers; and this, with the rectory of Segrave in Leicestershire, given him some time after by George Lord Berkeley, he held to the day of his death, which happened in January 1639.

He was a man of general learning; a great philosopher; an exact mathematician; and (what makes the peculiarity of his character) a very curious calculator of nativities. He was extremely studious, and of a melancholy turn; yet an agreeable companion, and very humorous. *The anatomy of melancholy*, by *Democritus junior*, as he calls himself, shows, that these different qualities were mixed together in his composition. This book was printed first in 4to, afterwards in folio, in 1624, 1632, 1638, and 1652, to the great emolument of the bookseller, who, as Mr Wood tells us, got an estate by it. Some circumstances attending his death occasioned strange suspicions. He died in his chamber at or very near the time which, it seems, he had some years before predicted from the calculation of his nativity; and this exactness made it whispered about that for the glory of astrology, and rather than his calculation should fail, he became indeed a *felo de se*. This, however, was generally discredited; he was buried with due solemnity in the cathedral of Christ-church, and had a fair monument erected to his memory. He left behind him a very choice collection of books. He bequeathed many to the Bodleian library; and 100l. to Christ-church, the interest of which was to be laid out yearly in books for their library.

Burton, *John*, D. D. a learned divine, was born in 1696, at Wembworth, in Devonshire, of which parish his father was rector. He was educated at Corpus Christi college, Oxford. In 1725, being then proproctor and master of the schools, he spoke a Latin oration before the determining bachelor, which is entitled "*Heli*; or, An Instance of a Magistrate's erring through unseasonable Lenity;" written and published with a view to encourage the salutary exercise of academical discipline; and afterwards treated the same subject still more fully in four Latin sermons before the university, and published them with appendixes. He also introduced into the schools, Locke, and other eminent modern philosophers, as suitable companions to Aristotle: and printed a double series of philosophical questions, for the use of the younger students; from which Mr Johnson of Magdalene college, Cambridge, took the hint of his larger work of the same kind, which has gone through several editions.

When the settling of Georgia was in agitation, Dr Bray, justly revered for his institution of parochial libraries, Dr Stephen Hales, Dr Berriman, and other learned divines, intreated Mr Burton's pious assistance in that undertaking. This he readily gave, by preaching before the society in 1732, and publishing his sermon, with an appendix on the state of that colony; and he

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he afterwards published an account of the designs of the associates of the late Dr Bray, with an account of their proceedings.

About the same time, on the death of Dr Edward Littleton, he was presented by Eton college to the vicarage of Maple-Derham, in Oxfordshire. Here a melancholy scene, which too often appears in the mansion of the clergy, presented itself to his view; a widow, with three infant daughters, without a home, without a fortune; from his compassion arose love, the consequence of which was marriage; for Mrs. Littleton was handsome, elegant, accomplished, ingenious, and had great sweetness of temper. In 1760, he exchanged his vicarage of Maple-Derham for the rectory of Worplesdon in Surrey. In his advanced age, finding his eyes begin to fail him, he collected and published, in one volume, all his scattered pieces, under the title of *Opuscula miscellanea;* and soon after died, February 11th, 1771.

Burton, in the sea-language, a small tackle consisting of two single blocks, and may be made fast any where at pleasure, for hoisting small things in and out.

BURY, is sometimes used to denote the hole or den of some animal under ground. In this sense we say the *bury* of a mole, a tortoise, or the like. The grillotalpa, or mole-cricket, digs itself a bury with its forefeet, which are made broad and strong for that purpose. Naturalists speak of a kind of urchins in the island of Maraguan, which have two entries to their buries, one towards the north, the other to the south, which they open and shut alternately, as the wind happens to lie.

Bury, in *Geography*, a market town of Lancashire, about 80 miles south-east of Lancaster. It is a barony in the family of Albemarle. W. Long. 2. 20. N. Lat. 53. 36.

Bury *St Edmond's*, or *St Edmond's Bury*, the county town of Suffolk, about 12 miles east of Newmarket, and 70 north-east of London. Population 7986. E. Long. 0. 45. N. Lat. 52. 20.

BURYING, the same with interment or Burial.

Burying Alive was the punishment of a vestal who had violated her vow of virginity. The unhappy priestess was let down into a deep pit, with bread, water, milk, oil, a lamp burning, and a bed to lie on. But this was only for show; for the moment she was let down, they began to cast in the earth upon her till the pit was filled up.† Some middle-age writers seem to make burying alive (*defossio*) the punishment of a woman thief. Lord Bacon gives instances of the resurrection of persons who have been buried alive. The famous Duns Scotus is of the number; who, having been seized with a catalepsis, was thought dead, and laid to sleep among his fathers, but raised again by his servant, in whose absence he had been buried. Bartholin gives an account of a woman, who, on recovering from an apoplexy, could not be convinced but that she was dead, and solicited so long and so earnestly to be buried, that they were forced to comply; and performed the ceremonies, at least in appearance. The famous Emperor Charles V. after his abdication, took it into his head to have his burial celebrated in his lifetime, and assisted at it. See Charles V.

† See the article *Vestals*.

Burying-Place. The ancients buried out of cities and towns; an usage which we find equally among Jews, Greeks, and Romans. Among the last, burying within the walls was expressly prohibited by a law of the 12 tables. The usual places of interment were in the suburbs and fields, but especially by the way-sides. We have instances, however, of persons buried in the city; but it was a favour allowed only to a few of singular merit in the commonwealth. Plutarch says, those who had triumphed were indulged in it. Be this as it will, Val. Publicola, and C. Fabricius, are said to have had tombs in the forum: and Cicero adds Tubertus to the number. Lycurgus allowed his Lacedemonians to bury their dead within the city and round their temples, that the youth, being inured to such spectacles, might be the less terrified with the apprehension of death. Two reasons are alleged why the ancients buried out of cities: the first, an opinion that the sight, touch, or even neighbourhood, of a corpse, defiled a man, especially a priest; whence that rule in A. Gellius, that the *flamen dialis* might not on any account enter a place where there was a grave: the second, to prevent the air from being corrupted by the stench of putrified bodies, and the buildings from being endangered by the frequency of funeral fires.

Burying in churches was not allowed for the first 300 years after Christ; and the same was severely prohibited by the Christian emperors for many ages afterwards. The first step towards it appears to have been the practice of erecting churches over the graves of some martyrs in the country, and translating the relics of others into churches in the city; the next was, allowing kings and emperors to be buried in the atrium or church-porch. In the 6th century, the people began to be admitted into the church-yards; and some princes, founders, and bishops, into the church. From that time the matter seems to have been left to the discretion of the bishop.

BUSBEC, Auger Gislen, Lord of, a person illustrious on account of his embassies, was born at Commines in the year 1522; and educated at the most famous universities, at Louvain, at Paris, at Venice, at Bologna, and at Padua. He was engaged in several important employments and negotiations, and particularly was twice sent ambassador by the king of the Romans to the emperor Soliman. He collected inscriptions; bought manuscripts; searched after rare plants; inquired into the nature of animals; and in his second journey to Constantinople, carried with him a painter, that he might be able to communicate to the curious the figures, at least, of the plants and animals that were not well known in the west. He wrote a Discourse of the State of the Ottoman Empire, and a Relation of his two Journeys to Turkey, which are much esteemed. He died in 1592.

BUSBY, Dr Richard, son of a gentleman in Westminster, was born at Lutton in Lincolnshire, in 1606. He passed through the classes in Westminster school, as king's scholar; and completed his studies at Christ-church, Oxford. In 1640 he was appointed master of Westminster school; and by his skill and diligence in the discharge of this important and laborious office, for the space of 55 years, bred up the greatest number of eminent men, in church and state, that ever at one time adorned any age or nation. He was extremely severe in his school; though he applauded wit in in his scholars, even when it reflected on himself. He died in 1695, aged 89, and was buried in Westminster Abbey, where there is a fine monument erected for him, with a Latin inscription. He composed several books for the use of his school.

BUSCHING, A. F. a celebrated German geographer. See SUPPLEMENT.

BUSH, PAUL, the first bishop of Bristol, became a student in the university of Oxford about the year 1513, and in 1518 took the degree of bachelor of arts. He afterwards became a brother of the order called *bonhoms:* of which, after studying some time among the friars of St Austin (now Wadham college), he was elected provincial. In that station he lived many years; till at length King Henry VIII. being informed of his great knowledge in divinity and physic, made him his chaplain, and in 1542 appointed him to the new episcopal see of Bristol; but having in the reign of Edward VI. taken a wife, he was, on the accession of Mary, deprived of his dignity, and spent the remainder of his life in a private station at Bristol, where he died in the year 1558, aged 68, and was buried on the north side of the choir of the cathedral. Wood says, that while he was a student at Oxford, he was numbered among the celebrated poets of that university; and Pitt gives him the character of a faithful Catholic, his want of chastity notwithstanding. He wrote, 1. An Exhortation to Margaret Burgess, wife to John Burgess, clothier, of King's Wood, in the county of Wilts. London, printed in the reign of Edward VI. 8vo. 2. Notes on the Psalms. 3. Treatise in praise of the cross. 4. Answer to certain queries concerning the abuse of the mass. Records, No. 25. 5. Dialogues between Christ and the Virgin Mary. 6. Treatise of slaves and curing remedies. 7. A little treatise called *The Extirpation of Ignorancy.* 8. *Carmina diversa.*

BUSH, a term used for several shrubs of the same kind growing close together: thus we say, a *furze-bush, bramble-bush,* &c.

BUSH is sometimes used, in a more general sense, for any assemblage of thick branches interwoven and mixed together.

BUSH also denotes a coronated frame of wood hung out as a sign of taverns. It takes the denomination from hence, that, anciently, signs where wine was sold were *bushes* chiefly of ivy, cypress, or the like plant, which keeps its verdure long. And hence the English proverb, "Good wine needs no *bush.*"

Burning-BUSH, that bush wherein the Lord appeared to Moses at the foot of Mount Horeb, as he was feeding his father-in-law's flocks.

As to the person that appeared in the bush, the text says, "That the angel of the Lord appeared unto him in a flame of fire, out of the middle of the bush:" but whether it was a created angel, speaking in the person of God, or God himself, or (as the most received opinion is) Christ the son of God, has been matter of some controversy among the learned. Those who suppose it no more than an angel, seem to imply that it would be a diminution of the majesty of God, to appear upon every occasion, especially when he has such a number of celestial ministers, who may do the business as well. But considering that God is present everywhere, the notification of his presence by some outward sign in one determinate place (which is all we mean by his appearance), is in our conception less laborious (if any thing laborious could be conceived of God) than a delegation of angels upon every turn from heaven, and seems in the main to illustrate rather than debase the glory of his nature and existence. But however this be, it is plain that the angel here spoken of was no created being, from the whole context, and especially from his saying, "I am the Lord God, the Jehovah," &c. since this is not the language of angels, who are always known to express themselves in such humble terms as these, "I am sent from God; I am thy fellow servant," &c. It is a vain pretext to say, that an angel, as God's ambassador, may speak in God's name and person; for what ambassador of any prince ever yet said, "I am the king?" Since therefore no angel, without the guilt of blasphemy, could assume these titles; and since neither God the Father nor the Holy Ghost, are ever called by the name of *angel,* i. e. "messenger, or person sent," whereas God the Son is called by the prophet Malachi (chap. iii. 1), "The angel of the covenant:" it hence seems to follow, that this angel of the Lord was God the Son, who might very properly be called an *angel,* because in the fulness of time he was sent into the world in our flesh, as a messenger from God, and might therefore make these his temporary apparitions presages and forerunners, as it were, of his more solemn mission. The emblem of the burning-bush is used as the seal of the church of Scotland, with this motto: *Nec tamen consumebatur;* i. e. "Though burning, is never consumed."

BUSHEL, a measure of capacity for things dry; as grains, pulse, dry fruits, &c. containing four pecks, or eight gallons, or one-eighth of a quarter.

Du Cange derives the word from *bussellus, bustellus,* or *bisellus,* a diminutive of *bus,* or *busa,* used in the corrupt Latin for the same thing; others derive it from *bussulus,* an *urn,* wherein lots were cast; which seems to be a corruption from *buxulus. Bussellus* appears to have been first used for a liquid measure of wine, equal to eight gallons. *Octo libræ faciunt galonem vini, et octo galones vini faciunt* bussellum *London, quæ est octava pars quarterii.* It was soon after transferred to the dry measure of corn of the same quantity.—*Pondus octo librorum frumenti facit* bussellum, *de quibus octo consistit quarterium.*

By 12 Henry VII. c. 5. a bushel is to contain 8 gallons of wheat; the gallon 8 pounds of wheat troy weight; the pound 12 ounces troy-weight; the ounce 20 shillings; and the sterling 32 grains or corns of wheat, growing in the midst of the ear. This standard bushel is kept in the Exchequer; when being filled with common spring-water, and the water measured before the house of commons in 1696, in a regular parallelopiped, it was found to contain 2145,6 solid inches; and the said water being weighed, amounted to 1131 ounces and 14 penny-weights troy. Besides the standard or legal bushel, we have several local bushels, of different dimensions in different places. At Abington and Andover, a bushel contains nine gallons; at Appleby and Penrith, a bushel of pease, rye, and wheat, contains 16 gallons; of barley, big, malt, mixt malt, and oats, 20 gallons. A bushel contains, at Carlisle, 24 gallons; at Chester, a bushel of wheat, rye, &c. contains 32 gallons, and of oats 40; at Dorchester, a bushel of malt and oats contains

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tains 10 gallons; at Falmouth, the bushel of stricken coals is 16 gallons, of other things 20, and usually 21 gallons; at Kingston upon Thames, the bushel contains $8\frac{1}{2}$; at Newbury, 9; at Wycomb and Reading, $8\frac{1}{2}$; at Stamford, 15 gallons. *Houghton. Collect.* tom. i. n. 46. p. 42.

At Paris, the bushel is divided into 2 half-bushels; the half-bushel into 2 quarts; the quart into 2 half-quarts; the half-quart into 2 litrons; and the litron into 2 half-litrons. By a sentence of the provost of the merchants of Paris, the bushel is to be 8 inches $2\frac{1}{2}$ lines high, and 10 inches in diameter; the quart 4 inches 9 lines high, and 6 inches 9 lines wide; the half-quart 4 inches 3 lines high, and 5 inches diameter: the litron $3\frac{1}{2}$ inches high, and 3 inches 10 lines in diameter. Three bushels make a minot, 6 a mine, 12 a septier, and 144 a muid. In other parts of France the bushel varies: $14\frac{1}{2}$ bushels of Amboise and Tours make the Paris septier. Twenty bushels of Avignon make 3 Paris septiers. Twenty bushels of Blois make 1 Paris septier. Two bushels of Bourdeaux make 1 Paris septier. Thirty-two bushels of Rochel make 19 Paris septiers. Oats are measured in a double proportion to other grains; so that 24 bushels of oats make a septier, and 248 a muid. The bushel of oats is divided into 5 picotins, the picotin into 2 half-quarts, or 4 litrons. For salt, 4 bushels make a minot, and 6 a septier. For coals, 8 bushels make a minot, 16 a mine, and 320 a muid. For lime, 3 bushels make a minot, and 48 minots a muid. Such were the measures by bushel before the revolution: for the changes that have since taken place, see MEASURE and WEIGHT.

BUSIRIS, in *Ancient Geography*, a city of the Lower Egypt, to the south of Leontopolis, on that branch of the Nile called Busiriticus; built by Busiris, noted for his cruelty, and slain by Hercules, (Ovid, Virgil, Diodorus Siculus). Strabo denies such a tyrant ever existed; Isocrates has written his panegyric. In this city there stood a grand temple of Isis, which gave it the appellation of the city of Isis. It was destroyed on a revolt by Dioclesian.

BUSIRITICUS FLUVIUS, in *Ancient Geography*, that branch of the Nile which empties itself at the mouth called Ostium Pathmeticum, or Phatniticum, (Ptolemy); also a part according to an ancient map at the Ostium Mindesium; this river, or branch, dividing itself at Diospolis into two branches; called Busiriticus, from the city of Busiris, which stood on its left or west branch. It is the second branch of the Nile, reckoning from the east.

BUSIRITICUS Nomos, in *Ancient Geography*, a prefecture, or division of the Lower Egypt; so called from the city Busiris, (Herodotus, Pliny, Ptolemy).

BUSITIS, in *Ancient Geography*, a district of Arabia Deserta; so called from Bus, or Buz, Nahor's second son; the country of Elihu, the fourth interlocutor in Job; called *Buzetes*, by the Septuagint.

BUSKIN, a kind of shoe, somewhat in manner of a boot, and adapted to either foot, and worn by either sex. This part of dress, covering both the foot and mid-leg, was tied underneath the knee; it was very rich and fine, and principally used on the stage by actors in tragedy. It was of a quadrangular form; and the sole was so thick, as that, by means thereof, men of the ordinary stature might be raised to the pitch and elevation of the heroes they personated. The colour was generally purple on the stage; herein it was distinguished from the sock worn in comedy, that being only a low common shoe. The buskin seems to have been worn not only by actors but by girls, to raise their height; travellers and hunters also made use of it, to defend themselves from the mire. In classic authors, we frequently find the buskin used to signify tragedy itself, in regard it was a mark of tragedy on the stage. It was also to be understood for a lofty strain or high style.

BUSS, in maritime affairs, a small sea vessel, used by us and the Dutch in the herring-fishery, commonly from 48 to 60 tons burden, and sometimes more: a buss has two small sheds or cabins, one at the prow and the other at the stern; that at the prow serves for a kitchen. Every buss has a master, an assistant, a mate, and seamen in proportion to the vessel's size; the master commands in chief, and without his express orders the nets cannot be cast or taken up; the assistant has the command after him; and the mate next, whose business is to see the seamen manage their rigging in a proper manner, to mind those who draw in their nets, and those who kill, gut, and cure the herrings as they are taken out of the sea: the seamen generally engage for a whole voyage in the lump. The provisions which they take on board the busses, consist commonly in biscuit, oatmeal, and dried or salt fish: the crew being content for the rest with what fresh fish they catch. See FISHERIES.

BUST, or BUSTO, in *Sculpture*, denotes the figure or portrait of a person in relievo, showing only the head, shoulders, and stomach, the arms being lopped off: ordinarily placed on a pedestal or console.

In speaking of an antique, we say the head is marble, and the bust porphyry, or bronze, that is, the stomach and shoulders. Felibien observes, that though in painting, one may say a figure appears in busto, yet it is not properly called a *bust*, that word being confined to things in relievo.

The bust is the same with what the Latins called *Herma*, from the Greek Hermes, Mercury, the image of that god being frequently represented in this manner amongst the Athenians.

BUST is also used, especially by the Italians, for the trunk of a human body, from the neck to the hips.

BUSTA Gallica, was a place in ancient Rome, wherein the bones of the Gauls, who first took the city, and were slain by Camillus, were deposited. It differed from

BUSTA Gallorum, a place on the Apennines, thus called by reason of many thousands of Gauls killed there by Fabius.

BUSTARD. See OTIS, ORNITHOLOGY *Index*.

BUSTUARIÆ MOECHÆ, according to some, women that were hired to accompany the funeral and lament the loss of the deceased; but others are of opinion, that they were rather the more common prostitutes, that stood among the tombs, graves, and other such lonely places.

BUSTUARII, in Roman antiquity, gladiators who fought about the bustum or funeral pile of a person of distinction, that the blood which was spilt might serve as a sacrifice to the infernal gods, and render them more propitious to the manes of the deceased. This custom was introduced in the room of the more inhuman

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man one of sacrificing captives at the bustum, or on the tombs of warriors.

BUSTUM, in antiquity, denotes a pyramid or pile of wood, whereon were anciently placed the bodies of the deceased, in order to be burnt.

The Romans borrowed the custom of burning their dead from the Greeks. The deceased, crowned with flowers, and dressed in his richest habits, was laid on the bustum. Some authors say, it was only called *bustum* after the burning, *quasi bene ustum*: before the burning it was more properly called *pyra*; during it *rogus*; and afterwards *bustum*. When the body was only burnt there, and buried elsewhere, the place was not properly called *bustum*, but *ustrina*, or *ustrinum*.

Bustum, in the Campus Martius, was a structure whereon the emperor Augustus first, and after him the bodies of his successors, were burnt. It was built of white stone, surrounded with an iron pallisade, and planted withinside with alder trees.

Bustum was also figuratively applied to denote any tomb. Whence those phrases, *facere bustum*, *violare bustum*, &c.

Bustum of an Altar, was the hearth or place where the fire was kindled.

BUTCHER, a person who slaughters cattle for the use of the table, or who cuts up and retails the same.

Among the ancient Romans, there were three kinds of established butchers, whose office it was to furnish the city with the necessary cattle, and to take care of preparing and vending their flesh. The suarii provided hogs; the pecuarii or boarii, other cattle, especially oxen; and under these was a subordinate class, whose office was to kill, called *lanii* and *carnifices*.

To exercise the office of butcher among the Jews with dexterity, was of more reputation than to understand the liberal arts and sciences. They have a book concerning shamble-constitution; and in case of any difficulty, they apply to some learned rabbi for advice: nor was any allowed to practise this art, without a licence in form; which gave the man, upon evidence of his abilities, a power to kill meat, and others to eat what he killed; provided he carefully read every week for one year, and every month the next year, and once a quarter during his life, the constitution above mentioned.

We have some very good laws for the better regulation and preventing the abuses committed by butchers. A butcher that sells swine's flesh measled, or dead of the murrain, for the first offence shall be amerced; for the second, have the pillory: for the third, be imprisoned, and make fine; and for the fourth, abjure the town. Butchers not selling meat at reasonable prices shall forfeit double the value, leviable by warrant of two justices of the peace. No butcher shall kill any flesh in his scalding-house, or within the walls of London, on pain to forfeit for every ox so killed 12d., and for every other beast 8d., to be divided betwixt the king and the prosecutor.

Butcher-Bird. See Lanius, Ornithology *Index*.

Butcher-Broom. See Ruscus, Botany *Index*.

Butcher-Island, in the East Indies, a small island about two miles long and scarce one broad. It has its name from cattle being kept there for the use of Bombay, from which it is about three miles distant. It has a small fort, but of very little consequence.

BUTE, an island lying to the west of Scotland, being separated from Cowal, a district of Argyleshire, only by a narrow channel. In length it is about 18 miles; the broadest part from east to west is about five. Part of it is rocky and barren; but from the middle southwards, the ground is cultivated, and produces pease, oats, and barley. Here is a quarry of red stone, which the natives have used in building a fort and chapel in the neighbourhood of Rothsay, which is a very ancient royal borough, head town of the shire of Bute and Arran; but very thinly peopled, and maintained chiefly by the herring fishery, with the profits of which all the rents of this island are chiefly paid. On the north side of Rothsay, are the ruins of an ancient fort, with its drawbridge, chapel, and barracks. Here are likewise the remains of some Danish towers. The natives are healthy and industrious, speak the Erse and the dialect of the Lowlands indifferently, and profess the Protestant religion. The island is divided into two parishes, accommodated with four churches; and belongs chiefly to the earl of Bute, who possesses an elegant seat on the east side of the island. The name of this isle has by several authors, and in different periods, been very differently written, as *Bote*, *Both*, *Bothe*, *Boot*, but now generally *Bute*. Our ancient writers suppose that it derived its name from a cell erected therein by St Brendan, an Irish abbot who flourished in the 6th century, because in his language such a cell was called *Both*. It is however, probable, that this name was of great antiquity, since we find it denominated *Botis* by the anonymous geographer of Ravenna. It was from very early times part of the patrimony of the Stuarts: large possessions in it were granted to Sir John Stuart, son of Robert II. by his beloved mistress Elizabeth More; and it has continued in that line to the present time.

BUTESHIRE, comprehends the islands of Bute, Arran, the greater and lesser Cumbray, and *Inch-marnoc*. This shire and that of Caithness send a member to parliament alternately. The earl of Bute is admiral of the county, by commission from his majesty; but no way dependent on the lord high admiral of Scotland: so that if any maritime case occurs within this jurisdiction, (even crimes of as high a nature as murder or piracy), his lordship, by virtue of his powers as admiral, is sufficient judge, or he may delegate his authority to any deputies.

The following is a view of the population of this county at two different periods, taken from the Statistical history of Scotland.

	Parishes.	Population in 1795.	Population in 1790—1798.
Bute.	Rothsay,	2222	4032
	Kingarth,	998	727
Arran.	Kilbride,	1369	2545
	Kilmorie,	2127	3259
	Total,	6716	10,563
	Population in 1811,	12,033	

See Buteshire, Supplement.

BUTEO,

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BUTEO, the trivial name of a species of FALCO. See ORNITHOLOGY Index.

BUTLER, CHARLES, a native of Wycomb in the county of Bucks, and a master of arts in Magdalen college, Oxford, published a book with this title: "The principles of music in singing and setting; with the twofold use thereof, ecclesiastical and civil." Quarto, London 1636. The author of this book was a person of singular learning and ingenuity, which he manifested in sundry other works enumerated by Wood in the *Athen. Oxon.* Among the rest is an English Grammar, published in 1633, in which he proposes a scheme of regular orthography, and makes use of characters, some borrowed from the Saxon, and others of his own invention, so singular, that we want types to exhibit them: and of this imagined improvement he appears to have been so fond, that all his tracts are printed in like manner with his grammar; the consequence whereof has been an almost general disgust to all that he has written. His Principles of Music is, however, a very learned, curious, and entertaining book; and, by the help of the advertisement from the printer to the reader, prefixed to it, explaining the powers of the several characters made use of by him, may be read to great advantage, and may be considered a judicious supplement to Morley's introduction.

BUTLER, *Samuel*, a celebrated poet, was the son of a reputable Worcestershire farmer, and was born in 1612. He passed some time at Cambridge, but was never matriculated in that university. Returning to his native country, he lived some years as clerk to a justice of peace; where he found sufficient time to apply himself to history, poetry, and painting. Being recommended to Elizabeth countess of Kent, he enjoyed in her house, not only the use of all kinds of books, but the conversation of the great Mr Selden, who often employed Butler to write letters, and translate for him. He lived also some time with Sir Samuel Luke, a gentleman of an ancient family in Bedfordshire, and a famous commander under Oliver Cromwell: and he is supposed at this time to have wrote, or at least to have planned, his celebrated *Hudibras*; and under that character to have ridiculed the knight. The poem itself furnishes this key; where, in the first canto, Hudibras says,

"'Tis sung, there is a valiant Mamaluke
"In foreign land yclep'd — —
"To whom we oft have been compar'd
"For person, parts, address, and beard."

After the Restoration, Mr Butler was made secretary to the earl of Carbury, lord president of Wales, who appointed him steward of Ludlow castle, when the court was revived there. No one was a more generous friend to him than the earl of Dorset and Middlesex, to whom it was owing that the court tasted his *Hudibras*. He had promises of a good place from the earl of Clarendon, but they were never accomplished; though the king was so much pleased with the poem, as often to quote it pleasantly in conversation. It is indeed said, that Charles ordered him the sum of 3000l.: but the sum being expressed in figures, somebody through whose hands the order passed, by cutting off a cypher reduced it to 300l. which, though it passed the offices without fees, proved not sufficient to pay what he then owed; so that Butler was not a shilling the better for the king's bounty. He died in 1680: and though he met with many disappointments, was never reduced to any thing like want, nor did he die in debt. Mr Granger observes, that Butler "stands without rival in burlesque poetry. His Hudibras (says he) is in its kind almost as great an effort of genius as the Paradise Lost itself. It abounds with uncommon learning, new rhymes, and original thoughts. Its images are truly and naturally ridiculous. There are many strokes of temporary satire, and some characters and allusions which cannot be discovered at this distance of time."

BUTLER, *Joseph*, late bishop of Durham, a prelate distinguished by his piety and learning, was the youngest son of Mr Thomas Butler, a reputable shopkeeper at Wantage in Berkshire, where he was born in the year 1692. His father, who was a Presbyterian, observing that he had a strong inclination to learning, after his being at a grammar-school, sent him to an academy in Gloucestershire, in order to qualify him for a dissenting minister; and while there, he wrote some remarks on Dr Clarke's first sermon at Boyle's lecture. Afterwards, resolving to conform to the established church, he studied at Oriel college, where he contracted an intimate friendship with Mr Edward Talbot, son of the bishop of Durham, and brother to the lord chancellor, who laid the foundation of his subsequent advancement. He was first appointed preacher at the Rolls, and rector of Haughton and Stanhope, two rich benefices in the bishopric of Durham. He quitted the Rolls in 1726; and published in 8vo, a volume of sermons, preached at the chapel. After this he constantly resided at Stanhope, in the regular discharge of all the duties of his office, till the year 1733, when he was called to attend the Lord Chancellor Talbot as his chaplain, who gave him a prebend in the church of Rochester. In the year 1736, he was appointed clerk of the closet to Queen Caroline, whom he attended every day, by her majesty's special command, from seven to nine in the evening. In 1738 he was appointed to the bishopric of Bristol; and not long afterwards to the deanery of St Paul's, London. He now resigned his living of Stanhope. In the year 1746, he was made clerk of the closet to the king; and in 1750, was translated to Durham. This rich preferment he enjoyed but a short time: for he died at Bath, June 16. 1752. His corpse was interred in the cathedral at Bristol; where there is a monument, with an inscription, erected to his memory. He died a bachelor. His deep learning and comprehensive mind appear sufficiently in his writings, particularly in that excellent treatise entitled, *The Analogy of Religion, natural and revealed, to the Constitution and Course of Nature*, published in 8vo, 1736.

BUTLER, the name anciently given to an officer in the court of France, being the same as the grand echanson, or great cupbearer of the present times.

BUTLER, in the common acceptation of the word, is an officer in the houses of princes and great men, whose principal business is to look after the wine, plate, &c.

BUTLERAGE of wine, is a duty of 2s. for every ton of wine imported by merchant strangers; being a composition in lieu of the liberties and freedoms granted

Butlerage ‖ Butter.

ed to them by King John and Edward I. by a charter called *charta mercatoria*.

Butlerage was originally the only custom that was payable upon the importation of wines, and was taken and received by virtue of the regal prerogative, for the proper use of the crown. But for many years past, there having been granted by parliament subsidies to the kings of England, and the duty of butlerage not repealed, but confirmed, they have been pleased to grant the same way to some noblemen, who, by virtue of such grant, are to enjoy the full benefit and advantage thereof, and may cause the same to be collected in the same manner that the kings themselves were formerly wont to do.

BUTMENT. Butments of arches are the same with buttresses. They answer to what the Romans call *sublicas*, the French *culees* and *butees*.

BUTMENTS, or *Abutments*, of a bridge, denote the two massives at the end of a bridge, whereby the two extreme arches are sustained and joined with the shore on either side.

BUTOMUS, the FLOWERING-RUSH, or *Water-gladiole*. See BOTANY *Index*.

BUTRINTO, a port-town of Epirus, or Canina, in Turkey in Europe, situated opposite to the island of Corfu, at the entrance of the gulf of Venice. E. Long. 20. 40. N. Lat. 39. 45.

BUTT is used for a vessel, or measure of wine, containing two hogsheads, or 126 gallons; otherwise called *pipe*. A butt of currants is from 1500 to 2200 pounds weight.

BUTTS, or *Butt-ends*, in the sea-language, are the fore ends of all planks under water, as they rise, and are joined one end to another.—Butt-ends in great ships are most carefully bolted; for if any one of them should spring or give way, the leak would be very dangerous and difficult to stop.

BUTTS, the place where archers meet with their bows and arrows to shoot at a mark, which is called shooting at the *butts*: (See ARCHERY.)—Also *butts* are the short pieces of land in arable ridges and furrows.

BUTTER, a fat unctuous substance, prepared from milk by beating or churning.

It was late ere the Greeks appear to have had any notion of butter; their poets make no mention of it, and are yet frequently speaking of milk and cheese.

The Romans used butter no otherwise than as a medicine, never as a food.

According to Beckman, the invention of butter belongs neither to the Greeks nor the Romans. The former, he thinks, derived their knowledge of butter from the Scythians, the Thracians, and Phrygians; and the latter from the people of Germany.

The ancient Christians of Egypt burnt butter in their lamps instead of oil; and in the Roman churches, it was anciently allowed, during Christmas time, to burn butter instead of oil, on account of the great consumption of it otherwise.

Butter is the fat, oily, and inflammable part of the milk. This kind of oil is naturally distributed through all the substance of the milk in very small particles, which are interposed betwixt the caseous and serous parts, amongst which it is suspended by a slight adhesion, but without being dissolved. It is in the same state in which oil is in emulsions: hence the same whiteness of milk and emulsions; and hence, by rest, the oily parts separate from both these liquors to the surface, and form a cream. See EMULSION.

When butter is in the state of cream, its proper oily parts are not yet sufficiently united together to form a homogeneous mass. They are still half separated by the interposition of a pretty large quantity of serous and caseous particles. The butter is completely formed by pressing out these heterogeneous parts by means of continued percussion. It then becomes an uniform soft mass.

Fresh butter which has undergone no change has scarce any smell; its taste is mild and agreeable; it melts with a weak heat, and none of its principles are disengaged by the heat of boiling water. These properties prove, that the oily part of butter is of the nature of the fat, fixed, and mild oils, obtained from many vegetable substances by expression. See OILS.—The half fluid consistence of butter, as of most other concrete oily matters, is thought to be owing to a considerable quantity of acid united with the oily part; which acid is so well combined, that it is not perceptible while the butter is fresh and has undergone no change; but when it grows old, and undergoes some kind of fermentation, then the acid is disengaged more and more; and this is the cause that butter, like oils of the same kind, becomes rancid by age.

Butter is constantly used in food, from its agreeable taste: but to be wholesome, it must be very fresh and free from rancidity, and also not fried or burnt; otherwise its acrid and even caustic acid, being disengaged, disorders digestion, renders it difficult and painful, excites acrid empyreumatic belchings, and introduces much acrimony into the blood. Some persons have stomachs so delicate, that they are even affected with these inconveniences by fresh butter and milk. This observation is also applicable to oil, fat, chocolate, and in general to all oleaginous matters.

For the making of butter, see AGRICULTURE *Index*.

The trade in butter is very considerable. Some compute 50,000 tons annually consumed in London. It is chiefly made within 40 miles round the city, Fifty thousand firkins are said to be sent yearly from Cambridge and Suffolk alone: each firkin containing 56lbs. Utoxeter, in Staffordshire, is a market famous for good butter, insomuch that the London merchants have established a factory there for that article. It is bought by the pot, of a long cylindrical form, weighing 14lb.

Shower of BUTTER. Naturalists speak of showers and dews of a butyraceous substance. In 1695, there fell in Ireland, during the winter and ensuing spring, a thick yellow dew, which had the medicinal properties of butter.

BUTTER, among chemists, a name given to several preparations, on account of their consistence resembling that of butter; as butter of antimony, &c. See CHEMISTRY *Index*.

BUTTER-Bur. See TUSSILAGO, BOTANY *Index*.

BUTTER-Milk, the milk which remains after the butter is produced by churning. Butter-milk is esteemed an excellent food, in the spring especially, and is particularly

Butter-milk ‖ Buttons.

larly recommended in hectic fevers. Some make curds of butter-milk, by pouring into it a quantity of new milk hot.

Butter-Wort. See Pinguicula, Botany *Index.*

BUTTERFLY, the English name of a numerous genus of insects. See Papilio, Entomology *Index.*

Butterfly-Shell. See Voluta, Conchology *Index.*

Method of preserving Butterflies. See Insects.

Edwards's Hist. of Birds, vol. ii. p. 122.

Method of making Pictures of Butterflies. "Take butterflies or field moths, either those catched abroad, or such as are taken in caterpillars and nursed in the house till they be flies; clip off their wings very close to their bodies, and lay them on clean paper, in the form of a butterfly when flying; then have ready prepared gum arabic that hath been some time dissolved in water, and is pretty thick; if you put a drop of oxgall into a spoonful of this, it will be better for the use; temper them well with your finger, and spread a little of it on a piece of thin white paper, big enough to take both sides of your fly; when it begins to be clammy under your finger, the paper is in proper order to take the feathers from the wings of the fly; then lay the gummed side on the wings, and it will take them up: then double your paper so as to have all the wings between the paper; then lay it on a table, pressing it close with your fingers; and you may rub it gently with some smooth hard thing; then open the paper and take out the wings, which will come forth transparent: the down of the upper and under side of the wings, sticking to the gummed paper, form a just likeness of both sides of the wing in their natural shapes and colours. The nicety of taking off flies depends on a just degree of moisture of the gummed paper: for if it be too wet, all will be blotted and confused; and if too dry, your paper will stick so fast together, that it will be torn in separation. When you have opened your gummed papers, and they are dry, you must draw the bodies from the natural ones, and paint them in water colours: you must take paper that will bear ink very well for this use; for sinking paper will separate with the rest, and spoil all."

BUTTERIS, in the manege, an instrument of steel, fitted to a wooden handle, wherewith they pare the foot, or cut off the hoof of a horse.

BUTTOCK *of a Ship*, is that part of her which is her breadth right astern, from the tack upwards; and a ship is said to have a broad or a narrow buttock, according as she is built broad or narrow at the transom.

BUTTON, an article in dress, whose form and use are too well known to need description. They are made of various materials, as mohair, silk, horse hair, metal, &c.

Method of making common Buttons. Common buttons are generally made of mohair; some indeed are made of silk, and others of thread; but the latter are of a very inferior sort. In order to make a button, the mohair must be previously wound on a bobbin; and the mould fixed to a board by means of a bodkin thrust through the hole in the middle of it. This being done, the workman wraps the mohair round the mould in three, four, or six columns, according to the button.

Horse-hair Buttons. The moulds of these buttons are covered with a kind of stuff composed of silk and hair; the warp being belladine silk, and the shoot horse hair. This stuff is wove with two selvages, in the same manner and in the same loom as ribbands. It is then cut into square pieces proportional to the size of the button, wrapped round the moulds, and the selvages stitched together, which form the under part of the button.

Buttons

Cleansing of Buttons. A button is not finished when it comes from the maker's hands; the superfluous hair and hubs of silk must be taken off, and the button rendered glossy and beautiful before it can be sold. This is done in the following manner: A quantity of buttons are put into a kind of iron sieve, called by workmen a *singeing box.* Then a little spirit of wine being poured into a kind of shallow iron dish, and set on fire, the workman moves and shakes the singeing box, containing the buttons, briskly over the flame of the spirit, by which the superfluous hairs, hubs of silk, &c. are burnt off, without damaging the buttons. Great care, however, must be taken that the buttons in the singeing box be kept continually in motion; for if they are suffered to rest over the flame, they will immediately burn. When all these loose hairs, &c. are burnt off by the flame of the spirit, the buttons are taken out of the singeing box, and put, with a proper quantity of the crumbs of bread, into a leather bag, about three feet long, and of a conical shape; the mouth or smaller end of which being tied up, the workman takes one of the ends in one hand and the other in the other, and shakes the hand briskly with a particular jerk. This operation cleanses the buttons, renders them very glossy, and fit for sale.

Gold-twist Buttons. The mould of these buttons is first covered in the same manner with that of common buttons. This being done, the whole is covered with a thin plate of gold or silver, and then wrought over of different forms, with purple and gimp. The former is a kind of thread composed of silk and gold wire twisted together; and the latter, capillary tubes of gold or silver, about the tenth of an inch long. These are joined together by means of a fine needle, filled with silk, thrust through their apertures, in the same manner as beads or bugles.

The manner of making metal Buttons. The metal with which the moulds are intended to be covered is first cast into small ingots, and then flatted into thin plates or leaves, of the thickness intended, at the flatting mills; after which it is cut into small round pieces proportionable to the size of the mould they are intended to cover, by means of proper punches on a block of wood covered with a thick plate of lead. Each piece of metal thus cut out of the plate is reduced into the form of a button, by beating it successively in several cavities, or concave moulds, of a spherical form, with a convex puncheon of iron, always beginning with the shallowest cavity of the mould, and proceeding to the deeper, till the plate has acquired the intended form: and the better to manage so thin a plate, they form ten, twelve, and sometimes even twenty-four, to the cavities, or concave moulds, at once; often nealing the metal during the operation, to make it more ductile. This plate is generally called by workmen the *cap of the button.*

The form being thus given to the plates or caps, they

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they strike the intended impression on the convex side, by means of a similar iron puncheon, in a kind of mould engraven *en creux*, either by the hammer or the press used in coining. The cavity or mould, wherein the impression is to be made, is of a diameter and depth suitable to the sort of button intended to be struck in it; each kind requiring a particular mould. Between the puncheon and the plate is placed a thin piece of lead, called by workmen a *hob*, which greatly contributes to the taking off all the strokes of the engraving; the lead, by reason of its softness, easily giving way to the parts that have relievo, and as easily insinuating itself into the traces or indentures.

The plate thus prepared makes the cap or shell of the button. The lower part is formed of another plate, in the same manner, but much flatter, and without any impression. To the last or under plate is soldered a small eye made of wire, by which the button is to be fastened.

The two plates being thus finished, they are soldered together with soft solder, and then turned in a lathe. Generally indeed they use a wooden mould, instead of the under plate; and in order to fasten it, they pass a thread or gut across, through the middle of the mould, and fill the cavity between the mould and the cap with cement, in order to render the button firm and solid; for the cement entering all the cavities formed by the relievo of the other side, sustains it, prevents its flattening, and preserves its bosse or design.

BUTTON, in the manege. Button of the reins of a bridle, is a ring of leather, with the reins passed through it, which runs all along the length of the reins. To put a horse under the button, is when a horse is stopped without a rider upon his back, the reins being laid on his neck, and the button lowered so far down that the reins bring in the horse's head, and fix it to the true posture or carriage. It is not only the horses which are managed in the hand that must be put under the button; for the same method must be taken with such horses as are bred between two pillars, before they are backed.

BUTTON-Wood. See CEPHALANTHUS, BOTANY *Index*.

BUTTON's-Bay, the name of the north part of Hudson's bay in North America, by which Sir Thomas Button attempted to find out a north-west passage to the East Indies. It lies between 80° and 100° west longitude, and between 60° and 66° north latitude.

BUTTON-Stone, in *Natural History*, a kind of figured stone, so denominated from its resembling the button of a garment. Dr Hook gives the figure of three sorts of button-stones, which seem to have been nothing else but the filling up of three several sorts of shells. They are all of them very hard flints; and have this in common, that they consist of two bodies, which seem to have been the filling up of two holes or vents in the shell. Dr Plot describes a species finely striated from the top, after the manner of some hair buttons. This name is also given to a peculiar species of slate found in the marquisate of Bareith, in a mountain called *Fichtelberg;* which is extremely different from the common sorts of slate, in that it runs with great ease into glass in five or six hours time, without the addition of any salt or other foreign substance, to promote its vitrification, as other stones require. It contains in itself all the principles of glass, and really has mixed in its substance the things necessary to be added to promote the fusion of other stony bodies. The Swedes and Germans make buttons of the glass produced from it, which is very black and shining, and it has hence its name *button-stone.* They make several other things also of this glass, as the handles of knives and the like, and send a large quantity of it unwrought in round cakes, as it cools from the fusion, into Holland.

BUTTRESS, a kind of butment built archwise, or a mass of stone or brick, serving to prop or support the sides of a building, wall, &c. on the outside, where it is either very high, or has any considerable load to sustain on the other side, as a bank of earth, &c.—Buttresses are used against the angles of steeples and other buildings of stone, &c. on the outside, and along the walls of such buildings as have great and heavy roofs, which would be subject to thrust the walls out, unless very thick, if no buttresses were placed against them. They are also placed for a support and butment against the feet of some arches, that are turned across great halls in old palaces, abbeys, &c.

BUTUS, in *Ancient Geography*, a town of Lower Egypt, on the west side of the branch of the Nile, called *Thermuthiacus;* towards the mouth called *Ostium Sebennyticum:* in this town stood an oracle of Latona, (Strabo, Herodotus). Ptolemy places Butus in the Nomos Phthenotes: it is also called *Buto, -us*, (Herodotus, Stephanus.) It had temples of Apollo and Diana, but the largest was that of Latona, where the oracle stood.

BUTZAW, a town of Lower Saxony, in Germany; it stands upon the river Varnow, on the road from Schwerin to Rostock, lying in E. Long. 13. 12. N. Lat. 54. 50.

BUVETTE, or BEUVETTE, in the French laws, an established place in every court, where the lawyers and counsellors may retire, warm themselves, and take a glass of wine by way of refreshment, at the king's charge. There is one for each court of parliament, but these are only for persons belonging to that body; there are others in the *palais*, whither other persons also resort.

BUXENTUM, (Livy, Velleius, Ptolemy, Mela, Pliny); PYXUS, (Strabo, Pliny); a town of Lucania, first built by the people of Messina, but afterwards deserted, (Strabo). A Roman colony was sent thither, (Livy, Velleius): and when found still thin of inhabitants, a new colony was sent by a decree of the senate. Its name is from *buxus*, the box-tree, growing plentifully there. Strabo says, the name *Pyxus* includes a promontory, port, and river, under one. New *Pulicastro*, in the Hither Principato of Naples. E. Long. 15. 40. N. Lat. 40. 20.

BUXTON, a place in the Peak of Derbyshire, celebrated for its medicinal waters, and lying in W. Long. 0. 20. N. Lat. 53. 20.

It has been always believed by our antiquaries, that the Romans were acquainted with these wells, and had frequented them much, as there is a military way still visible, called the *Bath-gate*, from Burgh to this place. This was verified about 50 years ago, when Sir Thomas Delves, of Cheshire, in memory of a cure he received here, caused an arch to be erected; in digging the foundation for which, they came to the remains of a solid

Buxton. solid and magnificent structure of Roman workmanship; and in other places of the neighbourhood, very capacious leaden vessels, and other utensils of Roman workmanship, have been discovered. These waters have always been reckoned inferior to those in Somersetshire; but seem never to have been totally disused. They are mentioned by Leland, as well known 200 years ago; but it is certain they were brought into greater credit by Dr Jones in 1572, and by George earl of Shrewsbury, who erected a building over the bath, then composed of nine springs. This building was afterwards pulled down, and a more commodious one erected at the expence of the earl of Devonshire. In doing this, however, the ancient register of cures drawn up by the bath-warden, or physician attending the baths, and subscribed by the hands of the patients, was lost.

The warm waters of Buxton are, the bath, consisting of nine springs, as already mentioned, St Ann's well, and St Peter's, or Bingham well. St Ann's well rises at the distance of somewhat more than 32 yards north-east from the bath. It is chiefly supplied from a spring on the north side, out of a rock of black limestone or bastard marble. It formerly rose into a stone bason, shut up within an ancient Roman brick wall, a yard square within, a yard high on three sides, and open on the fourth. But, in 1709, Sir Thomas Delves, as already mentioned, erected an arch over it, which still continues. It is 12 feet long, and as many broad, set round with stone steps on the inside. In the midst of this dome the water now springs up into a stone bason two feet square. St Peter's or Bingham well rises about 20 yards south-east of St Ann's. It is also called *Leigh's well*, from a memorable cure received from it by a gentleman of that name. It rises out of a black limestone, in a very dry ground; and is not so warm as St Ann's well.

From the great resort of company to the waters, this place has grown into a large straggling town, which is daily increasing. The houses are chiefly, or rather solely, built for the reception of invalids; and many of them are not only commodious, but elegant. The duke of Devonshire has lately erected a most magnificent building in the form of a crescent, with piazzas, under which the company walk in wet or cold weather. It is divided into different hotels, shops, &c. with a public coffee-room, and a very elegant room for assemblies and concerts.

The hot water resembles that of Bristol. It has a sweet and pleasant taste. It contains the calcareous earth, together with a small quantity of sea salt, and an inconsiderable portion of a purging salt, but no iron can be discovered in it. This water taken inwardly is esteemed good in the diabetes; in bloody urine; in the bilious cholic; in loss of appetite, and coldness of the stomach; in inward bleedings; in atrophy; in contraction of the vessels and limbs, especially from age; in cramps and convulsions; in the dry asthma without a fever; and also in barrenness. Inwardly and outwardly, it is said to be good in rheumatic and scorbutic complaints; in the gout; in inflammation of the liver and kidneys, and in consumptions of the lungs; also in old strains; in hard callous tumours; in withered and contracted limbs; in the itch, scabs, nodes, chalky swellings, ring worms, and other similar complaints.—Besides the hot water, there is also a cold chalybeate water, with a rough irony taste: It resembles the Tunbridge water in virtues. Buxton.

For the methods of composing artificial Buxton water, or of impregnating the original water with a greater quantity of its own gas or with other gases, see WATERS, *Medicinal*.

Buxton, *Jedediah*, a prodigy with respect to skill in numbers. His father, William Buxton, was schoolmaster of the same parish where he was born in 1704: yet Jedediah's education was so much neglected, that he was never taught to write; and with respect to any other knowledge but that of numbers, seemed always as ignorant as a boy of ten years of age. How he came first to know the relative proportions of numbers, and their progressive denominations, he did not remember; but to this he applied the whole force of his mind, and upon this his attention was constantly fixed, so that he frequently took no cognizance of external objects, and when he did, it was only with respect to their numbers. If any space of time was mentioned, he would soon after say it was so many minutes; and if any distance of way, he would assign the number of hair-breadths, without any question being asked, or any calculation expected by the company. When he once understood a question, he began to work with amazing facility, after his own method, without the use of a pen, pencil, or chalk, or even understanding the common rules of arithmetic as taught in the schools. He would stride over a piece of land or a field, and tell you the contents of it almost as exact as if you had measured it by the chain. In this manner he measured the whole lordship of Elmton, of some thousand acres, belonging to Sir John Rhodes, and brought him the contents, not only in acres, roods, and perches, but even in square inches. After this, for his own amusement, he reduced them into square hair-breadths, computing 48 to each side of the inch. His memory was so great, that while resolving a question he could leave off, and resume the operation again where he left off the next morning, or at a week, a month, or at several months, and proceed regularly till it was completed. His memory would doubtless have been equally retentive with respect to other objects, if he had attended to other objects with equal diligence; but his perpetual application to figures prevented the smallest acquisition of any other knowledge. He was sometimes asked, on his return from church, whether he remembered the text, or any part of the sermon; but it never appeared that he brought away one sentence, his mind, upon a closer examination, being found to have been busied, even during divine service, in his favourite operation, either dividing some time, or some space, into the smallest known parts, or resolving some question that had been given him as a test of his abilities.

This extraordinary person living in laborious poverty, his life was uniform and obscure. Time, with respect to him, changed nothing but his age; nor did the seasons vary his employment, except that in winter he used a flail, and in summer a ling-hook. In the year 1754 he came to London, where he was introduced to the Royal Society, who, in order to prove his abilities, asked him several questions in arithmetic, and he gave them such satisfaction, that they dismissed him with a handsome gratuity. In this visit to the metropolis,

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polis, the only object of his curiosity, except figures, was his desire to see the king and royal family; but they being just removed to Kensington, Jedediah was disappointed. During his residence in London, he was taken to see King Richard III. performed at Drury-lane playhouse; and it was expected, either that the novelty and the splendour of the show would have fixed him in astonishment, or kept his imagination in a continual hurry; or that his passions would, in some degree, have been touched by the power of action, if he had not perfectly understood the dialogue. But Jedediah's mind was employed in the playhouse just as it was employed in every other place. During the dance, he fixed his attention upon the number of steps; he declared, after a fine piece of music, that the innumerable sounds produced by the instruments had perplexed him beyond measure; and he attended even to Mr Garrick, only to count the words that he uttered, in which he said he perfectly succeeded. Jedediah returned to the place of his birth, where, if his enjoyments were few, his wishes did not seem to be more. He applied to his labour, by which he subsisted, with cheerfulness; he regretted nothing that he left behind him in London; and it continued to be his opinion, that a slice of rusty bacon afforded the most delicious repast.

BUXTORF, John, a learned professor of Hebrew at Basil, who, in the 17th century, acquired the highest reputation for his knowledge of the Hebrew and Chaldee languages. He died of the plague at Basil in 1629, aged 65. His principal works are, 1. A small but excellent Hebrew grammar; the best edition of which is that of Leyden in 1701, revised by Leusden. 2. A treasure of the Hebrew grammar. 3. A Hebrew concordance, and several Hebrew lexicons. 4. *Institutio epistolaris Hebraica.* 5. *De abbreviaturis Hebræorum, &c.*

Buxtorf, *John*, the son of the former, and a learned professor of the Oriental languages at Basil, distinguished himself, like his father, by his knowledge of the Hebrew language, and his rabbinical learning. He died in Basil in 1664, aged 65 years. His principal works are, 1. His translation of the *More Nevochim*, and the *Cosri*. 2. A Chaldee and Syriac lexicon. 3. An anticritic against Cappel. 4. A treatise on the Hebrew points and accents, against the same Cappel.

BUXUS, the Box-tree. See Botany *Index*.

BUYING, the act of making a purchase, or of acquiring the property of a thing for a certain price.

Buying stands opposed to selling, and differs from borrowing or hiring, as in the former the property of the thing is alienated for perpetuity, which in the latter it is not. By the civil law persons are allowed to buy hope, *spem precio emere*, that is, to purchase the event or expectation of any thing; e. gr. the fish or birds a person shall catch, or the money he shall win in gaming.

There are different species of buying in use among traders; as, buying on one's own account, opposed to buying on commission: buying for ready money, which is when the purchaser pays in actual specie on the spot; buying on credit, or for a time certain, is when the payment is not to be presently made, but in lieu thereof, an obligation given by the buyer for payment at a time future; buying on delivery, is when the goods purchased are only to be delivered at a certain time future.

Buying the Refusal, is giving money for the right or liberty of purchasing a thing at a fixed price in a certain time to come; chiefly used in dealing for shares in stock. This is sometimes also called by a cant name, *buying the bear*.

Buying the Smallpox, is an appellation given to a method of procuring that disease by an operation similar to inoculation; frequent in South Wales, where it has obtained time out of mind. It is performed either by rubbing some of the *pus* taken out of a pustule of a variolous person on the skin, or by making a puncture in the skin with a pin dipped in such pus.

BUYS, a town of Dauphiny in France, situated on the borders of Provence. E. Long. 5. 20. N. Lat. 44. 25.

BUZANCOIS, a small town of Berry in France, situated on the borders of Touraine, in E. Long. 1. 29. N. Lat. 46. 38.

BUZBACH, a town of Germany, in Westeravia, and the county of Holmes, on the confines of Hanau. E. Long. 10. 51. N. Lat. 50. 22.

BUZET, a small town of France, in Languedoc, seated on the river Torne, in E. Long. 1. 45. N. Lat. 43. 47.

BUZZARD, the name of several species of the hawk kind. See Falco, Ornithology *Index*.

BYBLUS, in *Ancient Geography*, a town of Phœnicia, situated between Berytus and Botrys; it was the royal residence of Cinyras; sacred to Adonis. Pompey delivered it from a tyrant, whom he caused to be beheaded. It stood at no great distance from the sea, on an eminence (Strabo); near it ran the Adonis into the Mediterranean. Now in ruins.

BYCHOW, a small town of Lithuania in Poland, situated on the river Nieper, in E. Long. 30. 2. N. Lat. 53. 57.

BY-laws, are laws made *obiter*, or by the by; such as orders and constitutions of corporations for the governing of their members, of court-leets, and courts baron, commoners, or inhabitants in vills, &c. made by common assent, for the good of these that made them, in particular cases whereunto the public law doth not extend; so that they bind further than the common or statute law; guilds and fraternities of trades, by letters patents of incorporation, may likewise make by-laws for the better regulation of trade among themselves or with others. In Scotland these laws are called laws of *birlaw* or *burlaw*: which are made by neighbours elected by common consent in the *birlaw-courts*, wherein knowledge is taken of complaints betwixt neighbour and neighbour; which men so chosen are judges and arbitrators, and styled *birlaw-men*. And birlaws, according to Skene, are *leges rusticorum*, laws made by husbandmen, or townships, concerning neighbourhood among them. All by-laws are to be reasonable, and for the common benefit, not private advantage of particular persons, and must be agreeable to the public laws in being.

BYNG, George, Lord Viscount Torrington, was the son of John Byng, Esq. and was born in 1663. At the age of 15, he went volunteer to sea with the king's warrant. His early engagement in this course of life gave him little opportunity of acquiring learning

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ing or cultivating the polite arts; but by his abilities and activity as a naval commander, he furnished abundant matter for the pens of others. After being several times advanced, he was in 1702 raised to the command of the Nassau, a third rate, and was at the taking and burning the French fleet at Vigo; and the next year he was made rear-admiral of the red. In 1704 he served in the grand fleet sent to the Mediterranean under Sir Cloudesly Shovel, as rear-admiral of the red; and it was he who commanded the squadron that attacked, cannonaded, and reduced Gibraltar. He was in the battle of Malaga, which followed soon after; and for his behaviour in that action Queen Anne conferred on him the honour of knighthood. In 1705, in about two months time, he took 12 of the enemies largest privateers, with the Thetis, a French man of war of 44 guns; and also several merchant ships, most of them richly laden. The number of men taken on board was 2070, and of guns 334. In 1718 he was made admiral and commander in chief of the fleet, and was sent with a squadron into the Mediterranean for the protection of Italy, according to the obligation England was under by treaty, against the invasion of the Spaniards: who had the year before surprised Sardinia, and had this year landed an army in Sicily. In this expedition he dispatched Captain Walton in the Canterbury with five more ships, in pursuit of six Spanish men of war, with galleys, fire-ships, bomb-vessels, and store-ships, who separated from the main fleet, and stood in for the Sicilian shore. The captain's laconic epistle on this occasion is worthy of notice; which shewed that fighting was his talent as well as his admiral's, and not writing.

"Sir,

"We have taken and destroyed all the Spanish ships and vessels which were upon the coast, as per margin.

Canterbury, off Syracuse, I am, &c.
August 16, 1718. G. Walton."

From the account referred to, it appeared that he had taken four Spanish men of war, with a bomb-vessel and a ship laden with arms: and burned four, with a fire-ship and bomb-vessel. The king made the admiral a handsome present, and sent him plenipotentiary powers to negotiate with the princes and states of Italy as there should be occasion. He procured the emperor's troops free access into the fortresses that still held out in Sicily, sailed afterwards to Malta, and brought out the Sicilian galleys, and a ship belonging to the Turkey company. Soon after he received a gracious letter from the emperor Charles VI. written with his own hand, accompanied with a picture of his imperial majesty, set round with very large diamonds, as a mark of the grateful sense he had of his services. It was entirely owing to his advice and assistance that the Germans retook the city of Messina in 1719, and destroyed the ships that lay in the bason; which completed the ruin of the naval power of Spain. The Spaniards being much distressed, offered to quit Sicily; but the admiral declared, that the troops should never be suffered to quit the island till the king of Spain had acceded to the quadruple alliance. And to his conduct it was entirely owing that Sicily was subdued, and his Catholic majesty forced to accept the terms prescribed him by the quadruple alliance. After performing so many signal services, the king received him with the most gracious expressions of favour and satisfaction; made him rear-admiral of England, and treasurer of the navy, one of his most honourable privy-council, Baron Byng of Southill in the county of Bedford, Viscount Torrington in Devonshire, and one of the knights companions of the Bath upon the revival of that order. In 1727, George II. on his accession to the crown, placed him at the head of his naval affairs, as first lord commissioner of the admiralty; in which high station he died January 15. 1733, in the 70th year of his age, and was buried at Southill in Bedfordshire.

Byng, *the Honourable George*, the unhappy son of the former, was bred to sea, and rose to the rank of admiral of the blue. He gave many proofs of courage; but was at last shot, upon a dubious sentence, for neglect of duty, in 1757. See Britain.

BYRLAW or *Burlaw Laws* in Scotland. See By-Laws.

BYROM, John, an ingenious poet of Manchester, born in 1691. His first poetical essay appeared in the Spectator, No. 603, beginning, "My time, O ye Muses, was happily spent;" which, with two humorous letters on dreams, are to be found in the eighth volume. He was admitted a member of the Royal Society in 1724; and having originally entertained thoughts of practising physic, to which the title of *doctor* is incident, that was the appellation by which he was always known: but reducing himself to narrow circumstances by a precipitate marriage, he supported himself by teaching a new method of writing short-hand, of his own invention; until an estate devolved to him by the death of an elder brother. He was a man of lively wit; of which, whenever a favourable opportunity tempted him to indulge it, he gave many humorous specimens. He died in 1763; and a collection of his miscellaneous poems was printed at Manchester, in 2 vols 8vo. 1773.

BYRRHUS. See Entomology *Index*.

BYSSUS. See Botany *Index*.

Byssus, or *Byssum*, a fine thready matter produced in India, Egypt, and about Elis in Achaia, of which the richest apparel was anciently made, especially that worn by the priests both Jewish and Egyptian. Some interpreters render the Greek Βυσσος, which occurs both in the Old and New Testament, by *fine linen*. But other versions, as Calvin's, and the Spanish printed at Venice in 1556, explain the word by *silk*: and yet byssus must have been different from our silk, as appears from a multitude of ancient writers, and particularly from Jul. Pollux. M. Simon, who renders the word by fine linen, adds a note to explain it; viz. "that there was a fine kind of linen very dear, which the great lords alone wore in this country as well as in Egypt." This account agrees perfectly well with that given by Hesychius, as well as what is observed by Bochart, that the byssus was a finer kind of linen, which was frequently dyed of a purple colour. Some authors will have the byssus to be the same with our cotton; others take it for the *linum asbestinum*; and others for the lock or bunch of silky hair found adhering to the pinna marina, by which it fastens itself to the neighbouring bodies. Authors usually distinguish two sorts of byssus; that of Elis; and that of Judæa, which

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which was the finest. Of this latter were the priestly ornaments made. Bonfrerius notes, that there must have been two sorts of byssus, one finer than ordinary, by reason there are two Hebrew words used in Scripture to denote byssus; one of which is always used in speaking of the habit of the priests, and the other of that of the Levites.

Byssus Asbestinus, a species of asbestus or incombustible flax, composed of fine flexible fibres, parallel to one another. It is found plentifully in Sweden, either white, or of different shades of green. At a copper mine in Westmanland it forms the greatest part of the vein out of which the ore is dug; and by the heat of the furnace which melts the metal is changed into a pure semitransparent slag or glass.

BYZANTIUM, an ancient city of Thrace, situated on the Bosphorus. It was founded, according to Eusebius, about the 30th Olympiad, while Tullus Hostilius reigned in Rome. But, according to Diodorus Siculus, the foundations of this metropolis were laid in the time of the Argonauts, by one Bysas, who then reigned in the neighbouring country, and from whom the city was called *Byzantium*. This Bysas, according to Eustathius, arrived in Thrace a little before the Argonauts came into those seas, and settled there with a colony of Megarenses. Velleius Paterculus ascribes the founding of Byzantium to the Milesians, and Ammianus Marcellinus to the inhabitants of Attica. Some ancient medals of Byzantium, which have reached our times, bear the name and head of Bysas, with the prow of a ship on the reverse. The year after the destruction of Jerusalem by Titus, Byzantium was reduced to the form of a Roman province. In the year 193 this city took part with Niger against Severus. It was strongly garrisoned by Niger, as being a place of the utmost importance. It was soon after invested by Severus; and as he was universally hated on account of his cruelty, the inhabitants defended themselves with the greatest resolution. They had been supplied with a great number of warlike machines, most of them invented and built by Periscus, a native of Nicæa, and the greatest engineer of his age. For a long time they baffled all the attempts of the assailants, killed great numbers of them, crushed such as approached the walls with large stones; and when stones began to fail, they used the statues of their gods and heroes. At last they were obliged to submit, through famine, after having been reduced to the necessity of devouring one another. The conqueror put all the magistrates and soldiers to the sword; but spared the engineer Periscus. Before this siege, Byzantium was the greatest, most populous, and wealthiest city of Thrace. It was surrounded by walls of an extraordinary height and breadth: and defended by a great number of towers, seven of which were built with such art, that the least noise heard in one of them was immediately conveyed to all the rest. Severus, however, no sooner became master of it, than he commanded it to be laid in ashes. The inhabitants were stripped of all their effects, publicly sold for slaves, and the walls levelled with the ground. But by the chronicle of Alexandria we are informed, that soon after this terrible catastrophe, Severus himself caused a great part of the city to be rebuilt, calling it *Antonia*

from his son Caracalla, who assumed the surname of *Antoninus*. In 262, the tyrant Galienus wreaked his fury on the inhabitants of Byzantium. He intended to besiege it; but on his arrival despaired of being able to make himself master of such a strong place. He was admitted the next day, however, into the city; and without any regard to the terms he had agreed to, caused the soldiers and all the inhabitants to be put to the sword. Trebellius Pollio says, that not a single person was left alive. What the reason was for such an extraordinary massacre, we are nowhere informed. In the wars between the emperors Licinius and Maximin the city of Byzantium was obliged to submit to the latter, but was soon after recovered by Licinius. In the year 323, it was taken from Licinius by Constantine the Great, who in 330 enlarged and beautified it, with a design to make it the second, if not the first, city in the Roman empire. He began with extending the walls of the ancient city from sea to sea; and while some of the workmen were busied in rearing them, others were employed in raising within them a great number of stately buildings, and among others a palace no way inferior in magnificence and extent to that of Rome. He built a capitol and amphitheatre, made a circus maximus, several forums, porticoes, and public baths. He divided the whole city into 14 regions, and granted the inhabitants many privileges and immunities. By this means Byzantium became one of the most flourishing and populous cities of the empire. Vast numbers of people flocked thither from Pontus, Thrace, and Asia, Constantine having, by a law, enacted this year (330), decreed, that such as had lands in those countries should not be at liberty to dispose of them, nor even leave them to their proper heirs at their death, unless they had a house in this new city. But however desirous the emperor was that his city should be filled with people, he did not care that it should be inhabited by any but Christians. He therefore caused all the idols to be pulled down, and all their churches consecrated to the true God. He built besides an incredible number of churches, and caused crosses to be erected in all the squares and public places. Most of the buildings being finished, it was solemnly dedicated to the Virgin Mary, according to Cedrenus, but according to Eusebius, to the God of Martyrs. At the same time Byzantium was equalled to Rome. The same rights, immunities, and privileges, were granted to its inhabitants, as to those of the metropolis. He established a senate and other magistrates, with a power and authority equal to those of old Rome. He took up his residence in the new city; and changed its name to Constantinople.

BZOVIUS, Abraham, one of the most celebrated writers in the 17th century, with respect to the astonishing number of pieces composed by him. His chief work is the continuation of Baronius's Annals. He was a native of Poland, and a Dominican friar. Upon his coming to Rome, he was received with open arms by the Pope, and had an apartment assigned him in the Vatican. He merited that reception, for he has imitated Baronius to admiration, in his design of making all things conspire to the despotic power and glory of the Papal see. He died in 1630, aged 70.

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C.

C, Caaba.

C, THE third letter, and second consonant, of the alphabet, is pronounced like *k* before the vowels *a*, *o*, and *u*; and like *s*, before *e*, *i*, and *y*. C is formed, according to Scaliger, from the κ of the Greeks, by retrenching the stem or upright line; though others derive it from the כ of the Hebrews, which has in effect the same form; allowing only for this, that the Hebrews reading backwards, and the Latins, &c. forwards, each have turned the letter their own way. However the C not being the same as to sound with the Hebrew *caph*, and it being certain the Romans did not borrow their letters immediately from the Hebrews or other orientals, but from the Greeks, the derivation from the Greek κ, is the more probable. Add, that F. Montfaucon, in his Palæographia, gives us some forms of the Greek κ, which come very near to that of our C: thus, for instance, ϲ: and Suidas calls the C the Roman kappa. The second sound of C resembles that of the Greek Σ: and many instances occur of ancient inscriptions, in which Σ has the same form with our C. All grammarians agree, that the Romans pronounced their Q like our C, and their C like our K. F. Mabillon adds, that Charles the Great was the first who wrote his name with a C; whereas all his predecessors of the same name wrote it with a K; and the same difference is observed in their coins.

As an abbreviature, C stands for Caius, Carolus, Cæsar, *condemno*, &c. and CC for *consulibus*.

As a numeral, C signifies 100, CC 200, &c.

C, in *Music*, placed after the cleff, intimates that the music is in common time, which is either quick or slow, as it is joined with allegro, or adagio; if alone, it is usually adagio. If the C be crossed or turned, the first requires the air to be played quick, and the last very quick.

CAABA, or CAABAH, properly signifies a square stone building: but is particularly applied by the Mahometans to the temple at Mecca, built, as they pretend, by Abraham and Ishmael his son.

Before the time of Mahomet, this temple was a place of worship for the idolatrous Arabs, and is said to have contained no less than 360 different images, equalling in number the days of the Arabian year. They were all destroyed by Mahomet, who sanctified the Caaba, and appointed it to be the chief place of worship for all true believers. The temple is in length from north to south about 24 cubits; its breadth from east to west is 23, and its height 27. The door, which is on the east side, stands about four cubits from the ground; the floor being level with the bottom of the door. In the corner next this door is the *black stone*, so much celebrated among the Mahometans. On the north side of the Caaba, within a semicircular enclosure 50 cubits long, lies the *white stone*, said to be the sepulchre of Ishmael, which receives the rain water from the Caaba by a spout formerly of wood, but now of gold. The black stone, according to the Mahometans, was brought down from heaven by Gabriel at the creation of the world, and was originally of a white colour; but contracted the blackness that now appears on it from the guilt of those sins committed by the sons of men. It is set in silver, and fixed in the south-east corner of the Caaba, looking towards Basra, about seven spans from the ground. This stone, upon which there is the figure of a human head, is held in the highest estimation among the Arabs; all the pilgrims kissing it with great devotion, and some even calling it the *right hand of God*. Its blackness, which is only superficial, is probably owing to the kisses and touches of so many people. After the Karmatians had taken Mecca, they carried away this precious stone, and could by no means be prevailed upon to restore it; but finding at last that they were unable to prevent the concourse of pilgrims to Mecca, they sent it back of their own accord, after having kept it 22 years.

Caaba.

The double roof of the Caaba is supported within by three octagonal pillars of aloes wood; between which, on a bar of iron, hang some silver lamps. The outside is covered with rich black damask, adorned with an embroidered band of gold, which is changed every year, and was formerly sent by the caliphs, afterwards by the sultans of Egypt, and is now provided by the Turkish emperors. The Caaba, at some distance, is almost surrounded by a circular enclosure of pillars, joined towards the bottom by a low ballustrade, and towards the top by bars of silver. Just without this inner enclosure, on the south, north, and west sides of the Caaba, are three buildings, which are the oratories or places where three of the orthodox sects assemble to perform their devotions. Towards the south-east stands an edifice which covers the well Zemzem, the treasury, and the cupola of Al Abbas. Formerly there was another cupola, that went under the name of the *hemicycle* or *cupola of Judea;* but whether or not any remains of this are now to be seen, is unknown; nor is it easy to obtain information in this respect, all Christians being denied access to this holy place. At a small distance from the Caaba, on the east side, is the *station* or *place* of Abraham; where is another stone much respected by the Mahometans; and where they pretend to shew the footsteps of the patriarch, telling us he stood on it when he built the Caaba. Here the fourth sect of Arabs, viz. that of Al Shafei, assemble for religious purposes.

The square colonnade, or great piazza, which at a considerable distance encloses these buildings, consists, according to Al Jannabi, of 488 pillars, and has no less than 38 gates. Mr Sale compares this piazza to that of the Royal Exchange at London, but allows it to be much larger. It is covered with small domes or cupolas, from the four corners of which rise as many minarets or steeples, with double galleries, and adorned with gilded spires and crescents after the Turkish manner, as are also the cupolas which cover the piazza and other buildings. Between the columns of both enclosures hang a great number of lamps, which are constantly

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constantly lighted at night. The first foundation of this second enclosure was laid by Omar, the second caliph, who built no more than a low wall, to prevent the court of the Caaba from being encroached upon by private buildings; but by the liberality of succeeding princes the whole has been raised to that state of magnificence in which it appears at present.

This temple enjoys the privilege of an asylum for all sorts of criminals: but it is most remarkable for the pilgrimages made to it by the devout Mussulmans, who pay so great a veneration to it, that they believe a single sight of its sacred walls, without any particular act of devotion, is as meritorious in the sight of God, as the most careful discharge of one's duty, for the space of a whole year, in any other temple.

CAAMINI, in *Botany*, a name given by the Spaniards and others to the finest sort of Paraguayan tea. It is the leaf of a shrub which grows on the mountains of Maracaya, and is used in Chili and Peru as the tea is with us. The mountains where this shrub grows naturally are far from the inhabited parts of Paraguay: but the people of the place know so well the value and use of it, that they constantly furnish themselves with great quantities of it from the spot. They used to go out on these expeditions many thousands together; leaving their country, in the mean time, exposed to the insults of their enemies, and many of themselves perishing by fatigue. To avoid these inconveniences, they have of late planted these trees about their habitations; but the leaves of these cultivated ones have not the fine flavour of those that grow wild. The king of Spain has permitted the Indians of Paraguay to bring to the town of Saintfoy 12,000 arobes of the leaves of this tree every year, but they are not able to procure so much of the wild leaves annually: about half the quantity is the utmost they bring of this: the other half is made up of the leaves of the trees in their own plantations; and this sells at a lower price, and is called *pabos*. The arobe is about 25 pounds weight: the general price is four piastres; and the money is always divided equally among the people of the colony.

CAANA, or KAANA, a town in Upper Egypt, seated on the eastern bank of the river Nile, from whence they carry corn and pulse for the supply of Mecca in Arabia. E. Long. 32. 23. N. Lat. 24. 30.

Here are several monuments of antiquity yet remaining, adorned with hieroglyphics.

CAB, a Hebrew dry measure, being the sixth part of a seah or satum, and the 18th part of an ephah. A cab contained $2\frac{5}{6}$ pints of our corn-measure: a quarter cab was the measure of dove's dung, or more properly a sort of chick-pease called by this name, which was sold at Samaria, during the siege of that city, for five shekels.

CABAL, an apt name currently given to the infamous ministry of Charles II. composed of five persons, Clifford, Ashley, Buckingham, Arlington, and Lauderdale; the first letters of whose names, in this order, furnished the appellation by which they were distinguished.

CABALIST, in French commerce, a factor or person who is concerned in managing the trade of another.

CABALLARIA, in middle-age writers, lands held by the tenure of furnishing a horseman with suitable equipage in time of war, or when the lord had occasion for him.

CABALLEROS, or CAVALLEROS, are Spanish wools, of which there is a pretty considerable trade at Bayonne in France.

CABALLINE, denotes something belonging to horses; thus caballine aloes is so called, from its being chiefly used for purging horses; and common brimstone is called *sulphur caballinum*, for a like reason.

CABALLINUM, in *Ancient Geography*, a town of the Ædui in Gallia Celtica; now *Chalons sur Saone*.

CABALLINUS, in *Ancient Geography*, a very clear fountain in Mount Helicon in Bœotia; called *Hippocrene* by the Greeks, because opened by Pegasus on striking the rock with his hoof, and hence called *Pegasius*.

CABALLIO, or CABELLIO, in *Ancient Geography*, a town of the Cavares in Gallia Narbonensis, situated on the Druentia. One of the Latin colonies, in the Notitiæ called *Civitas Cabellicorum*. Now *Cavaillon* in Provence.

CABANIS, P. J. G. a celebrated French medical writer. See SUPPLEMENT.

CABBAGE, in *Botany*. See BRASSICA; and AGRICULTURE *Index*.

CABBAGE-Tree, or *True CABBAGE-Palm*. See ARECA, BOTANY *Index*.

CABBAGE-BARK *Tree*. See GEOFFRÆA, BOTANY *Index*.

CABBALA, according to the Hebrew style, has a very distinct signification from that wherein we understand it in our language. The Hebrew cabbala signifies tradition; and the rabbins, who are called *cabbalists*, study principally the combination of particular words, letters, and numbers, and by this means pretend to discover what is to come, and to see clearly into the sense of many difficult passages of Scripture. There are no sure principles of this knowledge, but it depends upon some particular traditions of the ancients; for which reason it is termed *cabbala*.

The cabbalists have abundance of names which they call *sacred*; these they make use of in invoking of spirits, and imagine they receive great light from them. They tell us, that the secrets of the Cabbala were discovered to Moses on Mount Sinai; and that these have been delivered to them down from father to son, without interruption, and without any use of letters; for to write them down, is what they are by no means permitted to do. This is likewise termed the *oral law*, because it passed from father to son, in order to distinguish it from the written laws.

There is another cabbala, called *artificial*, which consists in searching for abstruse and mysterious significations of a word in Scripture, from whence they borrow certain explanations, by combining the letters which compose it; this cabbala is divided into three kinds, the gematric, the notaricon, and the temura or themura. The first whereof consists in taking the letters of a Hebrew word for ciphers or arithmetical numbers, and explaining every word by the arithmetical value of the letters whereof it is composed. The second sort of cabbala, called *notaricon*, consists in taking every particular letter of a word for an entire diction; and the third, called *themura*, i. e. change, consists in making different transpositions or changes of of letters, placing one for the other, or one before the other.

Among the Christians, likewise, a certain sort of magic is, by mistake, called *cabbala;* which consists in using improperly certain passages of Scripture for magic operations, or in forming magic characters or figures with stars and talismans.

Some visionaries among the Jews believe, that Jesus Christ wrought his miracles by virtue of the mysteries of the cabbala.

CABBALISTS, the Jewish doctors who profess the study of the cabbala.

In the opinion of these men, there is not a word, letter, or accent in the law, without some mystery in it. The Jews are divided into two general sects; the karaites, who refuse to receive either tradition or the talmud, or any thing but the pure texts of Scripture; and the rabbinists, or talmudists, who, besides this, receive the traditions of the ancients, and follow the talmud.

The latter are again divided into two other sects; pure rabbinists, who explain the Scripture in its natural sense, by grammar, history, and tradition; and cabbalists, who, to discover hidden mystical senses, which they suppose God to have couched therein, make use of the cabbala, and the mystical methods above mentioned.

CABECA, or CABESS, a name given to the finest silks in the East Indies, as those from 15 to 20 per cent. inferior to them are called *barina.* The Indian workmen endeavour to pass them off one with the other; for which reason, the more experienced European merchants take care to open the bales, and to examine all the skaines one after another. The Dutch distinguish two sorts of cabecas; namely, the moor cabeca, and the common cabeca. The former is sold at Amsterdam for about 21⅚ schellinghen Flemish, and the other for about 18⅓.

CABECA *de Vide*, a small sea port town of Alentejo, in Portugal, with good walls, and a strong castle. W. Long. 6. 43. N. Lat. 39. 0.

CABENDA, a sea port of Congo, in Africa, situated in E. Long. 12. 2. S. Lat. 4. 5.

CABES, or GABES, a town of Africa in the kingdom of Tunis, seated on a river near the gulf of the same name. E. Long. 10. 35. N. Lat. 33. 40.

CABEZZO, a province of the kingdom of Angola, in Africa; having Oacco on the north, Lubolo on the south, the Coanzo on the north-east, and the Reinba on the south-west. It is populous, and well stored with cattle, &c. and hath a mine of iron on a mountain, from thence called the *iron mountain*, which yields great quantities of that metal; and this the Portuguese have taught the natives to manufacture. This province is watered by a river called *Rio Longo*, and other small rivulets, lakes, &c. The trees here are vastly large; and they have one sort not unlike our apple trees, the bark of which being slashed with a knife, yields an odoriferous resin of the colour and consistency of wax, and very medicinal in its nature, only a little too hot for Europeans, unless qualified by some cooling drug.

CABIDOS, or CAVIDOS, a long measure used at Goa, and other places of the East Indies belonging to the Portuguese, to measure stuffs, linens, &c. and equal to ⁴⁄₇ths of the Paris ell.

CABIN, a room or apartment in a ship where any of the officers usually reside. There are many of these in a large ship; the principal of which is designed for the captain or commander. In ships of the line this chamber is furnished with an open gallery in the ship's stern, as also a little gallery on each quarter. The apartments where the inferior officers or common sailors sleep and mess are usually called BIRTHS; which see.

The bed places built up for the sailors at the ship's side in merchantmen are also called *cabins.*

CABINDA, the chief port of the kingdom of Angoy in Loango in Africa. It is situated at the mouth of a river of the same name, about five leagues north of Cape Palmerino, on the north side of the mouth of the river Zaire. The bay is very commodious for trade, wooding and watering.

CABINET, the most retired place in the finest part of a building, set apart for writing, studying, or preserving any thing that is precious.

A complete apartment consists of a hall, antichamber, chamber, and cabinet, with a gallery on one side. Hence we say, a cabinet of paintings, curiosities, &c.

CABINET also denotes a piece of joiners workmanship, being a kind of press or chest, with several doors and drawers.

There are common cabinets of oak or of chesnut varnished, cabinets of China and Japan, cabinets of inlaid-work, and some of ebony, or the like scarce and precious woods. Formerly the Dutch and German cabinets were much esteemed in France; but are now quite out of date, as well as the cabinets of ebony which came from Venice.

CABINET is also used in speaking of the more select and secret councils of a prince or administration. Thus we say, the secrets, the intrigues of the cabinet. To avoid the inconveniencies of a numerous council, the policy of Italy and practice of France first introduced cabinet councils. King Charles I. is charged with first establishing this usage in England. Besides his privy council, that prince erected a kind of cabinet council, or junto, under the denomination of a council of state; composed of Archbishop Laud, the earl of Strafford, and Lord Collington, with the secretaries of state. Yet some pretend to find the substance of a cabinet council of much greater antiquity, and even allowed by parliament, which anciently settled a quorum of persons most confided in, without whose presence no arduous matter was to be determined: giving them power to act without consulting the rest of the council. As long since as the 28th of Henry III. a charter passed in affirmance of the ancient rights of the kingdom; which provided, that four great men, chosen by common consent, who were to be conservators of the kingdom, among other things, should see to the disposing of moneys given by parliament, and appropriated to particular uses; and parliaments were to be summoned as they should advise. But even of these four, any two made a quorum: and generally the chief justice of England and chancellor were of the number of the conservators. Matth. Par. 28. Henry III. In the first

of

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of Henry VI. the parliament provides, that the quorum for the privy council be six, or four at least; and that in all weighty considerations, the dukes of Bedford and Gloucester, the king's uncles, should be present; which seems to be erecting a cabinet by law.

CABIRI, a term in the theology of the ancient Pagans, signifying great and powerful gods; being a name given to the gods of Samothracia. They were also worshipped in other parts of Greece, as Lemnos and Thebes, where the Cabiria were celebrated in honour of them: these gods are said to be in number four, viz. Axieros, Axiocersa, Axiocersus, and Casmilus.

CABIRIA, festivals in honour of the Cabiri, celebrated in Thebes and Lemnos, but especially in Samothracia, an island consecrated to the Cabiri. All who were initiated into the mysteries of these gods were thought to be secured thereby from storms at sea, and all other dangers. The ceremony of initiation was performed by placing the candidate, crowned with olive branches, and girded about the loins with a purple ribband, on a kind of throne, about which the priests and persons before initiated danced.

CABLE, a thick, large, strong rope, commonly of hemp, which serves to keep a ship at anchor.

There is no merchant ship, however weak, but has at least three cables; namely, the chief cable, or cable of the sheet anchor, a common cable, and a smaller one.

Cable is also said of ropes, which serve to raise heavy loads, by the help of cranes, pulleys, and other engines. The name of *cable* is usually given to such as are, at least, three inches in circumference; those that are less are only called *ropes*, of different names, according to their use.

Every cable, of whatsoever thickness it be, is composed of three strands; every strand of three ropes; and every rope of three twists: the twist is made of more or less threads, according as the cable is to be thicker or thinner.

In the manufacture of cables, after the ropes are made, they use sticks, which they pass first between the ropes of which they make the strands, and afterwards between the strands of which they make the cable, to the end that they may all twist the better, and be more regularly wound together; and also, to prevent them from entwining or entangling, they hang, at the end of each strand and of each rope, a weight of lead or of stone.

The number of threads each cable is composed of is always proportioned to its length and thickness; and it is by this number of threads that its weight and value are ascertained: thus, a cable of three inches circumference, or one inch diameter, ought to consist of 48 ordinary threads, and to weigh 192 pounds; and on this foundation is calculated the following table, very useful for all people engaged in marine commerce, who fit out merchantmen for their own account, or freight them for the account of others.

A table of the number of threads and weight of cables of different circumferences.

Circumf.	Threads.	Weight.
3 inches.	48	192 pounds.
4	77	308
5 inches.	121	484 pounds.
6	174	696
7	238	952
8	311	1244
9	393	1572
10	485	1940
11	598	2392
12	699	2796
13	821	3284
14	952	3808
15	1093	4372
16	1244	4976
17	1404	5616
18	1574	6296
19	1754	7016
20	1943	7772

Sheet-Anchor CABLE, is the greatest cable belonging to a ship.

Stream CABLE, a hawser or rope, something smaller than the bowers, and used to moor the ship in a river or haven, sheltered from the wind and sea, &c.

Serve or *Plate the* CABLE, is to bind it about with ropes, clouts, &c. to keep it from galling in the hawse.

To splice a CABLE, is to make two pieces fast together, by working the several threads of the rope the one into the other.

Pay more CABLE, is to let more out of the ship. *Pay cheap the* CABLE, is to hand it out apace. *Veer more* CABLE, is to let more out, &c.

CABLE'*s Length*, a measure of 120 fathoms, or of the usual length of the cable.

CABLED, in *Heraldry*, a term applied to a cross formed of the two ends of a ship's cable; sometimes also to a cross covered over with rounds of rope; more properly called a *cross carded*.

CABLED *Flute*, in *Architecture*, such flutes as are filled up with pieces in the form of a cable.

CABO DE ISTRIA, the capital town of the province of Istria, in the Austro-Venetian territories; and the see of a bishop. It is seated on a small island in the gulf of Venice, and is joined to the mainland by drawbridges. E. Long. 14. 22. N. Lat. 45. 49.

CABOCHED, in *Heraldry*, is when the heads of beasts are borne without any part of the neck, full faced.

CABOLETTO, in commerce, a coin of the republic of Genoa, worth about 3d. of our money.

CABOT, SEBASTIAN, the first discoverer of the continent of America, was the son of John Cabot, a Venetian. He was born at Bristol in 1477; and was taught by his father, arithmetic, geometry, and cosmography. Before he was 20 years of age he made several voyages. The first of any consequence seems to have been made with his father, who had a commission from Henry VII. for the discovery of a north-west passage to India. They sailed in the spring of 1497; and proceeding to the north-west they discovered land, which for that reason they called *Primavista*, or *Newfoundland*. Another smaller island they called *St John*, from its being discovered on the feast of St John Baptist; after which, they sailed along the coast of America as far as Cape Florida, and then returned to England

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land with a good cargo, and three Indians aboard. Stowe and Speed ascribe these discoveries wholly to Sebastian, without mentioning his father. It is probable that Sebastian, after his father's death, made several voyages to these parts, as a map of his discoveries, drawn by himself, was hung up in the privy garden at Whitehall. However, history gives but little account of his life for near 20 years: when he went to Spain, where he was made pilot-major, and intrusted with reviewing all projects for discoveries, which were then very numerous. His great capacity and approved integrity induced many eminent merchants to treat with him about a voyage by the new found straits of Magellan to the Moluccas. He therefore sailed in 1525, first to the Canaries; then to the Cape de Verd islands; thence to St Augustine and the island of Patos; when some of his people beginning to be mutinous, and refusing to pass through the straits, he laid aside the design of sailing to the Moluccas; left some of the principal mutineers upon a desert island; and, sailing up the rivers of Plate and Paraguay, discovered, and built forts in, a large tract of fine country, that produced gold, silver, and other rich commodities. He thence dispatched messengers to Spain for a supply of provisions, ammunition, goods for trade, and a recruit of men: but his request not being readily complied with, after staying five years in America, he returned home; where he met with a cold reception, the merchants being displeased at his not having pursued his voyage to the Moluccas, while his treatment of the mutineers had given umbrage at court. Hence he returned to England; and being introduced to the duke of Somerset, then lord protector, a new office was erected for him: he was made governor of the mystery and company of the merchant adventurers for the discovery of regions, dominions, islands, and places unknown; a pension was granted him, by letters-patent, of 166l. 13s. 4d. per annum; and he was consulted in all affairs relative to trade. In 1522, by his interest, the court fitted out some ships for the discovery of the northern parts of the world. This produced the first voyage the English made to Russia, and the beginning of that commerce which has ever since been carried on between the two nations. The Russia company was now founded by a charter granted by Philip and Mary; and of this company Sebastian was appointed governor for life. He is said to be the first who took notice of the variation of the needle, and who published a map of the world. The exact time of his death is not known, but he lived to be above 70 years of age.

CABRA, a town of the kingdom of Tombut in Africa. It is a large town, but without walls; and is seated on the river Niger, about 12 miles from Tombut. The houses are built in the shape of bells; and the walls are made with stakes or hurdles, plastered with clay, and covered with reeds after the manner of thatch. This place is very much frequented by negroes who come here by water to trade. The town is very unhealthy, which is probably owing to its low situation. The colour of the inhabitants is black, and their religion a sort of Mahometanism. They have plenty of corn, cattle, milk, and butter; but salt is very scarce. The judge who decides controversies is appointed by the king of Tombut. E. Long. 0. 50. N. Lat. 14. 21.

CABUL, or GABOUL, a city of Asia, and capital of the province of Cabulistan. It lies in E. Long. 68. 15. N. Lat. 33. 30. on the frontiers of Great Bukharia, on the south side of the mountains which divide the territories of Hindostan from that part of Great Tartary. It is one of the finest places in that part of the world; large, rich, and very populous. As it is considered as the key of the whole country on that side, great care is taken to keep its fortifications in repair, and a numerous garrison is maintained for its security. It lies on the road between Samarcand and Lahor: and is much frequented by the Tartars, Persians, and Indians. The Usbec Tartars drive there a great trade in slaves and horses, of which it is said that no fewer are sold than 60,000 annually. The Persians bring black cattle and sheep, which renders provisions very cheap. They have also wine, and plenty of all sorts of eatables. The city stands on a little river which falls into the Indus, and thereby affords a short and speedy passage for all the rich commodities in the country behind it, which when brought to Cabul, are there exchanged for slaves and horses, and then conveyed by merchants of different countries to all parts of the world. The inhabitants are most of them Indian pagans, though the officers of the prince and most of the garrisons are Mahometans.

CABULISTAN, a province of Asia, formerly belonging to the Great Mogul; but ceded in 1739 to Kouli Khan, who at that time governed Persia. It is bounded on the north by Bukharia, on the east by Caschmire, on the west by Zabulistan, and Candahar, and on the south by Moultan. It is 250 miles in length, 240 in breadth, and its chief town is Cabul. This country in general is not very fruitful; but in the vales they have good pasture lands. The roads are much infested with banditti; which obliges the natives to have guards for the security of travellers. The religion of the Cabulistans is pagan; and their extraordinary time of devotion is the full moon in February, and continues for two days. At this time they are clothed in red, make their offerings, dance to the sound of the trumpet, and make visits to their friends in masquerade dresses. They say, their god Crusman killed a giant who was his enemy, and that he appeared like a little child; in memory of which, they cause a child to shoot at the figure of a giant. Those of the same tribe make bonfires, and feast together in a jovial manner. The moral part of their religion consists in charity; for which reason, they dig wells and build houses for the accommodation of travellers. They have plenty of provisions, mines of iron, myrobolans, aromatic woods, and drugs of many kinds. They carry on a great trade with the neighbouring countries; by which means they are very rich, and are supplied with plenty of all things.

CABURNS, on ship board, are small lines made of spun yarn, to bind cables, seize tackles, or the like.

CACALIA. See BOTANY *Index*.

CACAO. See THEOBROMA, BOTANY *Index*.

CACOONS. See FLEVILLEA, BOTANY *Index*.

CACERES, a town of Spain in the province of Estremadura, is seated on the river Saler, and noted for the exceeding fine wool which the sheep bear in the neighbourhood. Between this town and Brocos, there is a wood, where the allies defeated the rear-guard of the

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the duke of Berwick, on the 7th of April 1706. E. Long. 6. 47. N. Lat. 39. 15.

CACHALOT. See PHYSETER, CETOLOGY *Index*.

CACHAN, or CASHAN, a considerable town of Persia, in Irac Agemi, where they carry on an extensive trade in silks, silver, and gold brocades, and fine earthen ware. It is situated in a vast plain, 55 miles from Ispahan. E. Long. 50. 2. N. Lat. 34. 10.

CACHAO, a province in the kingdom of Tonquin in Asia, situated in the heart of the kingdom, and surrounded by the other seven. Its soil is fertile, and in some places mountainous, abounding with a variety of trees, and particularly that of varnish. Most of these provinces carry on some branch of the silk manufacture, but this most of all. It takes its name from the capital, which is also the metropolis of the whole kingdom, though in other respects hardly comparable to a Chinese town of the third rank.

CACHAO, a city of the province of that name, in the kingdom of Tonquin in Asia, situated in E. Long. 105. 31. N. Lat. 22. 10. at about 80 leagues distance from the sea. It is prodigiously crowded with people, insomuch that the streets are hardly passable, especially on market days. These vast crowds, however, come mostly from the neighbouring villages; upon which account these villages have been allowed their halls in particular parts of the city, where they bring and dispose of their wares. The town itself, though the metropolis of the whole Tonquinese kingdom, hath neither walls nor fortifications. The principal streets are wide and airy, but the rest of them narrow and ill paved; and except the palace royal and arsenal, the town has little else worth notice. The houses are low and mean, mostly built of wood and clay, and not above one story high. The magazines and warehouses belonging to foreigners are the only edifices built of brick; and these, though plain, yet, by reason of their height and more elegant structure, make a considerable shew among those rows of wooden huts. From the combustibility of its edifices, this city suffers frequent and dreadful conflagrations. These spread with such surprising velocity, that some thousands of houses are often laid in ashes before the fire can be extinguished. To prevent these sad consequences, every house hath, either in its yard or even in its centre, some low building of brick, in form of an oven, into which the inhabitants, on the first alarm, convey their most valuable goods. Besides this precaution, which every family takes to secure their goods, the government obliges them to keep a cistern, or some other capacious vessel, always full of water, on the top of their house, to be ready on all occasions of this nature; as likewise a long pole and bucket, to throw water from the kennel upon the houses. If these two expedients fail of suppressing the flames, they immediately cut the straps which fasten the thatch to the walls, and let it fall in and waste itself on the ground. The king's palace stands in the centre of the city; and is surrounded with a stout wall, within whose cincture are seen a great number of apartments two stories high, whose fronts and portals have something of the grand taste. Those of the king and his wives are embellished with variety of carvings and gildings after the Indian manner, and all finely varnished. In the outer court are a vast number of sumptuous stables for the king's horses and elephants. The appearance of the inner courts can only be conjectured; for the avenues are not only shut to all strangers, but even to the king's subjects, except those of the privy council, and the chief ministers of state; yet we are told, that there are staircases by which people may mount up to the top of the wall, which are about 18 or 20 feet high; from whence they may have a distant view of the royal apartments, and of the fine parterres and fish ponds that are between the cincture and them. The front wall hath a large gate well ornamented, which is never opened but when the king goes in and out; but at some distance from it on each side there are two posterns, at which the courtiers and servants may go in and out. This cincture, which is of a vast circumference, is faced with brick within and without, and the whole structure is terminated by wide spacious gardens: which, though stored with great variety of proper ornaments, are destitute of the grandeur and elegance observed in the palaces of European princes. Besides this palace, the ruins of one still more magnificent are to be observed, and are called *Libatvia*. The circumference is said to have been betwixt six and seven miles; some arches, porticoes, and other ornaments, are still remaining; from which, and some of its courts paved with marble, it may be concluded to have been as magnificent a structure as any of the eastern parts can show. The arsenal is likewise a large and noble building, well stored with ammunition and artillery. The English factory is situated on the north side of the city, fronting the river *Song-koy*. It is a handsome low-built house, with a spacious dining-room in the centre; and on each side are the apartments of the merchants, factors, and servants. At each end of the building are smaller houses for other uses, as storehouses, kitchen, &c. which form two wings with the square in the middle, and parallel with the river, near the bank of which stands a long flag-staff, on which they commonly display the English colours on Sundays and all remarkable days. Adjoining to it, on the south side, is the Danish factory, which is neither so large nor so handsome. On the same side of the river runs a long dike, whose timber and stones are so firmly fastened together, that no part of it can be stirred without moving the whole. This work was raised on those banks to prevent the river, during the time of their vast rains, from overflowing the city; and it has hitherto answered its end; for, though the town stands high enough to be in no danger from land floods, it might yet have been otherwise frequently damaged, if not totally laid under water, by the overflowing of that river. Some curious observations have been communicated to the Royal Society concerning differences between the tides of those seas and those of Europe, viz. that on the Tonquinese coast ebbs and flows but once in 24 hours; that is, that the tide is rising during the space of 12 hours, and can be easily perceived during two of the moon's quarters, but can hardly be observed during the other two. In the springs tides, which last 14 days, the waters begin to rise at the rising of the moon; whereas, in the low tides, which continue the same number of days, the tide begins not till that planet has got below the horizon. Whilst it is passing through the six northern signs, the tides are observed to vary greatly, to rise sometimes very high, and some-

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times to be very low; but when it once got into the southern part of the zodiac, they are then found to be more even and regular.

CACHECTIC, something partaking of the nature of, or belonging to, a cachexy.

CACHEO, a town of Negroland in Africa, seated on the river St Domingo. It is subject to the Portuguese, who have three forts there, and carry on a great trade in wax and slaves. W. Long. 14. 55. N. Lat. 12. 0.

CACHEXY, in *Medicine*, a vitious state of the humours and whole habit. See MEDICINE *Index*.

CACHRYS. See BOTANY *Index*.

CACHUNDE, the name of a medicine, highly celebrated among the Chinese and Indians, and made of several aromatic ingredients, the perfumes, medicinal earth, and precious stones; they make the whole into a stiff paste, and form out of it several figures according to their fancy, which are dried for use; these are principally used in the East Indies, but are sometimes brought over to Portugal. In China, the principal persons usually carry a small piece in their mouths, which is a continued cordial, and gives their breath a very sweet smell. It is a highly valuable medicine, also, in all nervous complaints; and is esteemed a prolonger of life, and a provocative to venery, the two great intentions of most of the medicines in use in the East.

CACOCHYLIA, or CACOCHYMIA, a vitious state of the vital humours, especially of the mass of blood; arising either from a disorder of the secretions or excretions, or from external contagion. The word is Greek, compounded of κακος *ill*, and χυμος *juice*.

CACOPHONIA, in *Grammar* and *Rhetoric*, the meeting of two letters, or syllables, which yield an uncouth and disagreeable sound. The word is compounded of κακος *evil*, and φωνη *voice*.

CACOPHONIA, in *Medicine*, denotes a vice or depravation of the voice or speech; of which there are two species, *aphonia* and *dysphonia*.

CACTUS. See BOTANY *Index*.

The cacti are plants of a singular structure, but especially the larger kinds of them; which appear like a large, fleshy, green melon, with deep ribs, set all over with strong sharp thorns, and, when the plants are cut through the middle, their inside is a soft, pale-green, fleshy substance, very full of moisture. The fruit of all the species is frequently eaten by the inhabitants of the West Indies. The fruits are about three quarters of an inch in length, of a taper form, drawing to a point at the bottom toward the plant, but blunt at the top where the empalment of the flower was situated. The taste is agreeably acid, which in a hot country must render the fruit more grateful.

The cochineal animals are supported on a species called *cactus cochenillifer*.—The flower of the cactus grandiflora (one of the creeping cereuses) is said to be as grand and beautiful as any in the vegetable system. It begins to open in the evening about seven o'clock, is in perfection about eleven, and fades about four in the morning; so that the same flower only continues in perfection about six hours. The calyx when expanded is about a foot in diameter, of a splendid yellow within, and a dark brown without; the petals are many, and of a pure white; and the great number of recurved stamina, surrounding the style in the centre of the flower, make a grand appearance, to which may be added the fine scent, which perfumes the air to a considerable distance. It flowers in July.

CACUS, in fabulous history, an Italian shepherd upon Mount Aventine. As Hercules was driving home the herd of King Geryon whom he had slain, Cacus robbed him of some of his oxen, which he drew backward into his den lest they should be discovered. Hercules at last finding them out by their lowing, or the robbery being discovered to him, killed Cacus with his club. He was Vulcan's son, of prodigious bulk, and half man half satyr.

CADAN, a town of Bohemia, in the circle of Zats, seated on the northern bank of the river Egra, in E. Long. 13. 34. N. Lat. 50. 20.

CADARI, or KADARI, a sect of Mahometans, who assert free will; attribute the actions of men to men alone, not to any secret power determining the will; and deny all absolute decrees, and predestination. The author of this sect was Mabeb ben Kaled al Giboni, who suffered martyrdom for it. The word comes from the Arabic, קדר, *cadara*, "power." Ben Aun calls the Cadarians the Magi or Manichees of the Mussulmans.

CADE, a cag, cask, or barrel. A cade of herrings is a vessel containing the quantity of 500 red herrings, or 1000 sprats.

CADE Lamb, a young lamb weaned, and brought up by hand, in a house; called, in the North, *pet lamb*.

CADE Oil, in the *Materia Medica*, a name given to an oil much in use in some parts of France and Germany. The physicians call it *oleum cadæ*, or *oleum de cada*. This is supposed by some to be the piseleæum of the ancients, but improperly; it is made of the fruit of the oxycedrus, which is called by the people of these places *cada*.

CADE Worm, in *Zoology*, the maggot or worm of a fly called *phryganea*. It is used as a bait in angling. See PHRYGANEA, ENTOMOLOGY *Index*.

CADEA, or THE LEAGUE OF THE HOUSE OF GOD, is one of those that compose the republic of the Grisons, and the most powerful and extensive of them all. It contains the bishopric of Coire, the great valley of Engadine, and that of Bragail or Pregal. Of the 11 great or 21 small communities, there are but two that speak the German language; that of the rest is called the *Rhetic*, and is a dialect of the Italian. The Protestant religion is most prevalent in this league, which has been allied to the Swiss cantons ever since the year 1498. Coire is the capital town.

CADENAC, a town of France, in the department of Lot, seated on the river Lot, in E. Long. 2. 12. N. Lat. 44. 36.

CADENCE, or REPOSE, in *Music*, (from the Latin *cadere* "to fall or descend"); the termination of an harmonical phrase on a repose, or on a perfect chord. See MUSIC, Art. 73—76, and 132—137.

CADENCE, in *Reading*, is a falling of the voice below the key-note at the close of every period. In reading, whether prose or verse, a certain tone is assumed which is called the *key-note*: and in this tone the bulk of the words are sounded; but this note is generally lowered towards the close of every sentence.

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Cadence, in the manege, an equal measure or proportion, observed by a horse in all his motions; so that his times have an equal regard to one another, the one does not embrace or take in more ground than the other, and the horse observes his ground regularly.

CADENE, one of the sorts of carpets which the Europeans import from the Levant. They are the worst sort of all, and are sold by the piece, from one or two piastres per carpet.

CADENET, a town of France, in the department of Vaucluse, on the river Durance. E. Long. 5. 30. N. Lat. 43. 40.

CADES, or Kadesh, in *Ancient Geography*, a town in the wilderness of Zin, in Arabia Petræa; the first encampment of the Israelites, after their departure from Eziongeber; and from which the wilderness of Zin was called Cades; the burial place of Miriam, with the rock and water of Meribah in it. Another *Cades*, a town of the tribe of Judah, Joshua xv. 23. *Cadesbarnea*, called also *Cades*.

CADESBARNEA, in *Ancient Geography*, a town of the wilderness of Paran, on the confines of Canaan, from which the spies were sent out; sometimes simply called *Cades*, but distinct from the Cades in the wilderness of Zin.

CADET, the younger son of a family, is a term naturalized in our language from the French. At Paris, among the citizens, the cadets have an equal patrimony with the rest. At Caux, in Normandy, the custom, as with us, is to leave all to the eldest, except a small portion to the cadets. In Spain, it is usual for one of the cadets in great families to take the mother's name.

Cadet is also a military term, denoting a young gentleman who chooses to carry arms in a marching regiment as a private man. His views are, to acquire some knowledge in the art of war, and to obtain a commission in the army. Cadet differs from volunteer, as the former takes pay, whereas the latter serves without pay.

CADI, or Cadhi, a judge of civil affairs in the Turkish empire. It is generally taken for the judge of a town; judges of provinces being distinguished by the appellation of *moulas*.

We find numerous complaints of the avarice, iniquity, and extortion, of the Turkish cadis; all justice is here venal; the people bribe the cadis, the cadis bribe the moulas, the moulas the cadileschers, and the cadileschers the mufti. Each cadi has his serjeants, who are to summon persons to appear and answer complaints. If the party summoned fails to appear at the hour appointed, sentence is passed in favour of his adversary. It is usually in vain to appeal from the sentences of the cadi, since the affair is never heard anew, but judgment is passed on the case as stated by the cadi. But the cadis are often cashiered and punished for crying injustice with the bastinado and mulcts; the law, however, does not allow them to be put to death. Constantinople has had cadis ever since the year 1390, when Bajazet I. obliged John Paleologus, emperor of the Greeks, to receive cadis into the city to judge all controversies happening between the Greeks and the Turks settled there. In some countries of Africa, the cadis are also judges of religious matters. Among the Moors cadis is the denomination of their higher order of priests or doctors, answering to the rabbins among the Jews.

CADIACI, the Turkish name of Chalcedon. See Chalcedon.

CADILESCHER, a capital officer of justice among the Turks, answering to a chief justice among us.

It is said, that this authority was originally confined to the soldiery; but that at present it extends itself to the determination of all kinds of law-suits; yet is nevertheless subject to appeals.

There are but three cadileschers in all the grand signior's territories; the first is that of Europe; the second, of Natolia; and the third resides at Grand Cairo. This last is the most considerable: they have their seats in the divan next to the grand vizir.

CADILLAC, a town of France in Guienne, now in the department of Gironde, near the river Garonne, with a handsome castle, situated in W. Long. 0. 15. N. Lat. 44. 37.

CADIZ, a city and port town of Andalusia in Spain, situated on the island of Leon, opposite to Port St Mary on the continent, about 60 miles south-west of Seville, and 40 north-west of Gibraltar. W. Long. 6. 40. N. Lat. 36. 30.

It occupies the whole surface of the western extremity of the island, which is composed of two large circular parts, joined together by a very narrow bank of sand, forming altogether the figure of a chain-shot. At the south-east end, the ancient bridge of Suaco, thrown over a deep channel or river, affords a communication between the island and the continent; a strong line of works defends the city from all approaches along the isthmus; and, to render them still more difficult, all the gardens and little villas on the beach were in 1762 cleared away, and a dreary sandy glacis left in their room, so that now there is scarce a tree on the whole island.

Except the *Calle Ancha*, all the streets are narrow, ill paved, and insufferably stinking. They are all drawn in straight lines, and most of them intersect each other at right angles. The swarms of rats that in the nights run about the streets are innumerable; whole droves of them pass and repass continually, and these in their midnight revels are extremely troublesome to such as walk late. The houses are lofty, with each a vestibule, which being left open till night, serves passengers to retire to; this custom, which prevails throughout Spain, renders these places exceedingly offensive. In the middle of the house is a court like a deep well, under which is generally a cistern, the breeding place of gnats and mosquitoes; the ground floors are warehouses, the first stories compting-house or kitchen, and the principal apartment up two pair of stairs. The roofs are flat, covered with an impenetrable cement, and few are without a *mirador* or turret for the purpose of commanding a view of the sea. Round the parapet-wall at top are placed rows of square pillars, meant either for ornament according to some traditional mode of decoration, or to fix awnings to, that such as sit there for the benefit of the sea breeze may be sheltered from the rays of the sun; but the most common use made of them, is to fasten ropes for drying linen upon. High above all these pinnacles, which give Cadiz a most singular appearance, stands

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the tower of signals. Here flags are hung out on the first sight of a sail, marking the size of the ship, the nation it belongs to, and, if a Spanish Indiaman, the port of the Indies it comes from. The ships are acquainted with the proper signals to be made, and these are repeated by the watchmen of the tower: as painted lists are in every house, persons concerned in commerce soon learn the marks.

The city is divided into 24 quarters, under the inspection of as many commissioners of police; and its population is reckoned at 70,000 inhabitants, of which part are French, and part also Italians. The square of Saint Antonia is large, and tolerably handsome, and there are a few smaller openings of no great note. The public walk, or Alameda, is pleasant in the evening: it is fenced off the coach-road by a marble rail. The sea air prevents the trees from thriving, and destroys all hopes of future shade.

From the Alameda, continuing your walk westwards, you come to the Camposanto, a large esplanade, the only airing place for coaches; it turns round most part of the west and south sides of the island, but the buildings are straggling and ugly: the only edifice of any show is the new orphan house. Opposite to it is the fortress of St Sebastian, built on a neck of land running out into the sea. The round tower at the extremity is supposed to have saved the city, in the great earthquake of 1755, from being swept away by the fury of the waves. The building proved sufficiently solid to withstand the shock, and break the immense volume of water that threatened destruction to the whole island. In the narrow part of the isthmus the surge beat over with amazing impetuosity, and bore down all before it; among the rest, the grandson of the famous tragic poet Racine, who strove in vain to escape, by urging his horse to the utmost of his speed. On St Sebastian's feast, a kind of wake or fair is held in the fort; an astonishing number of people then passing and repassing, on a string of wooden bridges laid from rock to rock, makes a very lively moving picture.

From hence to the wooden circus where they exhibit the bull feasts, you keep turning to the left close above the sea, which on all this side dashes over large ledges of rock: the shore seems here absolutely inaccessible. On this shore stands the cathedral, a work of great expence, but carried on with so little vigour, that it is difficult to guess at the term of years it will require to bring it to perfection. The vaults are executed with great solidity. The arches, that spring from the clustered pilasters to support the roof of the church, are very bold; the minute sculpture bestowed upon them seems superfluous, as all the effect will be lost from their great height, and from the shade that will be thrown upon them by the filling up of the interstices. From the sea, the present top of the church resembles the carcase of some huge monster cast upon its side, rearing its gigantic blanched ribs high above the buildings of the city. The outward casings are to be of white marble, the bars of the windows of bronze.

Next, crossing before the land gate and barracks, a superb edifice for strength, convenience, and cleanliness, you come down to the ramparts that defend the city on the side of the bay. If the prospect to the ocean is solemn, that towards the main land is animated in the highest degree; the men of war ride in the eastern bosom of the bay; lower down the merchantmen are spread far and near; and close to the town an incredible number of barks, of various shapes and sizes, cover the surface of the water, some moored and some in motion, carrying goods to and fro. The opposite shore of Spain is studded with white houses, and enlivened by the town of St Mary's, Port-real, and others, behind which, eastward, on a ridge of hills, stands Medina Sidonia, and further back rise the mountains of Granada. Westward, Rota closes the horizon, near which was anciently the island and city of Tartessus, now covered by the sea, but at low water some part of the ruins are still to be discerned. In a large bastion, jutting out into the bay, they have built the customhouse, the first story of which is level with the walk upon the walls. When it was resolved to erect a building so necessary to this great emporium of trade, the marquis di Squillace gave orders that no expence should be spared, and the most intelligent architects employed, in order to erect a monument, which by its taste and magnificence might excite the admiration of posterity: the result of these precautions proved a piece of vile architecture, composed of the worst of materials.

The stir here is prodigious during the last months of the stay of the flota. The packers possess the art of pressing goods to great perfection; but, as they pay the freight according to the cubic palms of each bale, they are apt to squeeze down the cloths and linens so very close and hard, as sometimes to render them unfit for use. Every commercial nation has a consul resident at Cadiz; those of England and France are the only ones not allowed to have any concern in trade.

In 1596, Cadiz was taken, pillaged, and burnt by the English; but in 1702 it was attempted, in conjunction with the Dutch, without success. It was bombarded by the English in 1800; and was blockaded by the French while the Cortes held its sittings there in 1810, till the blockade was raised after the battle of Salamanca in 1812.

CADIZADELITES, a sect of Mahometans very like the ancient Stoics. They shun feasts and diversions, and affect an extraordinary gravity in all their actions; they are continually talking of God, and some of them make a jumble of Christianity and Mahometanism; they drink wine, even in the fast of the Ramazan; they love and protect the Christians; they believe that Mahomet is the Holy Ghost, practise circumcision, and justify it by the example of Jesus Christ.

CADMEAN Letters, the ancient Greek or Ionic characters, such as they were first brought by Cadmus from Phœnicia: whence Herodotus also calls them *Phœnician letters*. According to some writers, Cadmus was not the inventor, nor even importer of the Greek letters, but only the modeller and reformer thereof; and it was hence they acquired the appellation *Cadmean* or *Phœnician letters;* whereas before that time they had been called *Pelasgian letters*.

CADMIA. See Calamine.

CADMUS, in fabulous history, king of Thebes, the son of Agenor king of Phœnicia, and the brother of Phœnix, Cilix, and Europa. He carried into Greece the 16 simple letters of the Greek alphabet; and there built Thebes, in Bœotia. The poets say, that

that he left his native country in search of his sister Europa, whom Jupiter had carried away in the form of a bull: and that, inquiring of the Delphic oracle for a settlement, he was answered, that he should follow the direction of a cow, and build a city where she lay down. Having arrived among the Phocenses, he was met by a cow, who conducted him through Bœotia to the place where Thebes was afterwards built: but as he was about to sacrifice his guide to Pallas, he sent two of his company to the fountain Dirce for water; when they being devoured by a serpent or dragon, he slew the monster, and afterwards, by the advice of Pallas, sowed his teeth, when there sprung up a number of armed soldiers, who prepared to revenge the death of the serpent; but on his casting a stone among these upstart warriors, they turned their weapons against each other with such animosity, that only five survived the combast, and these assisted Cadmus in founding his new city. Afterwards, to recompense his labours, the gods gave him Harmonia, or Harmione, the daughter of Mars and Venus; and honoured his nuptials with presents and peculiar marks of favour. But at length resigning Thebes to Pentheus, Cadmus and Harmione went to govern the Ecclelleuses: when grown old, they were transformed into serpents; or, as others say, sent to the Elysian fields, in a chariot drawn by serpents. See THEBES.

CADMUS of Miletus, a celebrated Greek historian, was, according to Pliny, the first of the Greeks who wrote history in prose. He flourished about 550 before Christ.

CADORE, or PIEVE DE CADORE, a town of Italy, in the territory of Venice, and capital of a district called *Cadorino;* famous for the birth of Titian the painter. E. Long. 13. 45. N. Lat. 46. 25.

CADORINO, a province of Italy, in the territory of Venice; bounded on the east by Friuli Proper, on the south and west by the Bellunese, and by the bishopric of Brixen on the north. It is a very mountainous country, but pretty populous. The only town is Pieve de Cadore.

CADRITES, a sort of Mahometan friars, who once a-week spend a great part of the night in turning round, holding each others hands, and repeating incessantly the word *hai*, which signifies *living*, and is one of the attributes of God; during which one of them plays on a flute. They never cut their hair, nor cover their heads; and always go bare-footed: they have liberty to quit their convent when they please, and to marry.

CADSAND, an island on the coast of Dutch Flanders, situated at the mouth of the Scheldt, whereby the Dutch command the navigation of that river.

CADUCEUS, in antiquity, Mercury's rod or sceptre, being a wand entwisted by two serpents, borne by that deity as the ensign of his quality and office, given him, according to the fable, by Apollo, for his seven-stringed harp. Wonderful properties are ascribed to this rod by the poets; as laying men asleep, raising the dead, &c.

It was also used by the ancients as a symbol of peace and concord: the Romans sent the Carthaginians a javelin and a caduceus, offering them their choice either of war or peace. Among that people, those who denounced war were called *feciales;* and those who went to demand peace, *caduceatores*, because they bore a caduceus in their hand.

The caduceus found on medals is a common symbol, signifying good conduct, peace, and prosperity. The rod expresses power, the two serpents prudence, and the two wings diligence.

CADUCI, (from *cado*, "to fall"); the name of a class in Linnæus's *calycina*, consisting of plants whose calyx is a simple perianthium, supporting a single flower or fructification, and falling off either before or with the petals. It stands opposed to the *classes persistentes* in the same method, and is exemplified in mustard and ranunculus.

CADURCI, CADURCUM, *Cadurcus*, and *Cadurx*, in *Ancient Geography*, a town of the Caduroi, a people of Aquitania; situated between the rivers Oldus, running from the north, and the Tarnis from the south, and falling into the Garumna: Now *Cahors*, capital of the territory of the Querci, in Guienne. A part of the Cadurci, to the south next the Tarnis, were called *Eleutheri.*

CADUS, in antiquity, a wine vessel of a certain capacity, containing 80 amphoræ or firkins; each of which, according to the best accounts, held nine gallons.

CADUSII, in *Ancient Geography*, a people of Media Atropatene, situated to the west in the mountains, and reaching to the Caspian sea; between whom and the Medes perpetual war and enmity continued down to the time of Cyrus.

CÆCILIA, in *Zoology*, a genus of serpents belonging to the amphibia class. The cæcilia has no scales: it is smooth, and moves by means of lateral rugæ or prickles. The upper lip is prominent, and furnished with two tentacula. It has no tail. There are but two species of this serpent, viz. 1. The tentaculata, has 135 rugæ. It is about a foot long, and an inch in circumference, preserving an uniform cylindrical shape from the one end to the other. The teeth are very small. It has such a resemblance to an eel, that it may easily be mistaken for one; but as it has neither fins nor gills, it cannot be classed with the fishes. It is a native of America, and its bite is not poisonous. 2. The glutinosa, has 340 rugæ or prickles above, and 10 below, the anus. It is of a brownish colour, with a white line on the side, and is a native of the Indies.

CÆCUM, or COECUM, the blind gut. See ANATOMY *Index.*

CÆLIUM, in *Ancient Geography*, an inland town of Peucetia, a division of Apulia; a place four or five miles above Barium or Bari, and which still retains that name.

CÆLIUS MONS, (Itinerary); a town of Vindelicia, on the right or west side of the Ilargus. Now *Kelmuntz*, a small town of Suabia, on the Iller.

CÆLIUS MONS at Rome. See COELIUS.

CÆLIUS, *Aurelianus*, an ancient physician, and the only one of the sect of the Methodists of whom we have any remains. He was of Sicca, a town of Numidia; but in what age he lived, cannot be determined: it is probable, however, that he lived before Galen; since, though he carefully mentions all the physicians before him, he takes no notice of Galen. He had read over very diligently the ancient physicians.

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cians of all sects; and we are indebted to him for the knowledge of many dogmas which are not to be found but in his books *de celeribus et tardis passionibus*. He wrote, as he himself tells us, several other works; but they are all perished.

CAEN, a handsome and considerable town of France, capital of Lower Normandy, and of the department of Calvados. It contains 60 streets, and 12 parishes, and in 1815 had 36,000 inhabitants. It has a castle with four towers, which were built by the English. The town-house is a large building with four great towers. The royal square is the handsomest in all Normandy, and has fine houses on three sides of it; and in the middle is the statue of Louis XIV. in a Roman habit, standing on a marble pedestal, and surrounded with an iron ballustrade. It is seated in a pleasant country on the river Orne, about eight miles from the sea. William the Conqueror was buried here, in the abbey of St Stephen, which he founded. W. Long. 0. 27. N. Lat. 49. 11.

CÆRE, in *Ancient Geography*, a town of Etruria, the royal residence of Mezentius. Its ancient name was *Argyllæ*. In Strabo's time not the least vestige of it remained, except the baths called *cæretana*. From this town the Roman censor's tables were called *cærites tabulæ*. In these were entered the names of such as for some misdemeanour forfeited their right of suffrage, or were degraded from a higher to a less honourable tribe. For the people of Cære hospitably receiving those Romans who, after the taking of Rome by the Gauls, fled with their gods and the sacred fire of Vesta, were, on the Romans recovering themselves from this disaster, honoured with the privilege of the city, but without a right of voting.

CÆRITES TABULÆ. See the preceding article.

CAERFILLY, a town of Glamorganshire in South Wales, seated between the rivers Taaff and Rumney, in a moorish ground among the hills. It is thought the walls, now in ruins, were built by the Romans; there being often Roman coins dug up there. W. Long. 3. 12. N. Lat. 51. 25.

CAERLEON, a town of Monmouthshire in England, and a place of great antiquity. It was a Roman town, as is evident from the many Roman antiquities found here. It is commodiously situated on the river Usk, over which there is a large wooden bridge. The houses are generally built of stone, and there are the ruins of a castle still to be seen. W. Long. 3. 0. N. Lat. 51. 40.

CAERMARTHENSHIRE, a county of Wales, bounded on the north by the Severn sea or St George's channel, Cardiganshire on the south, the shires of Brecknock and Glamorgan on the east, and Pembrokeshire on the west. Its greatest length is between 30 and 40 miles, and its breadth upwards of 20, and it contained 77,217 inhabitants in 1811. The soil is less rocky and mountainous than most other parts of Wales, and consequently is proportionally more fertile both in corn and pasture. It has also plenty of wood, coal, and limestone. The most considerable rivers are the Towey, the Cothy, and the Tave; of which, the first abounds with excellent salmon. The principal towns are Caermarthen the capital, Kidwely, Lanimdovery, &c. This county abounds with ancient forts, camps, and tumuli or barrows. Near to Caermarthen, towards the east, may be seen the ruins of Kastelk Karrey, which was situated on a steep and inaccessible rock; and also several vast caverns, supposed to have been copper mines of the Romans. Near this spot is a fountain which ebbs and flows twice in 24 hours like the sea. See CAERMARTHENSHIRE, SUPPLEMENT.

CAERMARTHEN, a town of Wales, and capital of the county of that name. It is situated on the river Towey, over which it has a fine stone bridge. It is of great antiquity, being the Maridunum of Ptolemy. It is a thriving place, and many of the neighbouring gentry reside there in the winter. It is a corporation and county of itself, with power to make by-laws. Here were held the courts of chancery and exchequer for South Wales, till the whole was united to England in the reign of Henry VIII. Here was born the famous conjuror Merlin; and near the town is a wood called *Merlin's Grove*, where he is said to have often retired for contemplation. Many of his pretended prophecies are still preserved in the country. The town gives the title of *marquis* to the duke of Leeds. It sends one member to parliament, and the county another. Population 7275.

CAERNARVONSHIRE, a county of Wales, bounded on the north and west by the sea, on the south by Merionethshire, and on the east divided from Denbighshire by the river Conway. It is about 40 miles in length, and 20 in breadth; and sends one member to parliament for the shire, and another for the borough of Caernarvon. The air is very piercing; owing partly to the snow, that lies seven or eight months of the year upon some of the mountains, which are so high that they are called the *British Alps*, and partly to the great number of lakes, which are said not to be fewer than 50 or 60. The soil in the valleys on the side next Ireland is pretty fertile, especially in barley; great numbers of black cattle, sheep, and goats, are fed on the mountains. The population in 1811 was 49,336. The highest mountains in the county are those called *Snowdon hills*, and *Pen-maen-mawr*, which last hangs over the sea. There is a road cut out of the rock on the side next the sea, guarded by a wall running along the edge of it on that side; but the traveller is sometimes in danger of being crushed by the fall of pieces of the rock from the precipices above. The river Conway, though its course from the lake out of which it issues to its mouth is only 12 miles, yet is so deep, in consequence of the many brooks it receives, that it is navigable by ships of good burden for eight miles. Pearls are found in large black muscles taken in this river. The principal towns are Bangor, Caernarvon the capital, and Conway. In this county is an ancient road said to have been made by Helena the mother of Constantine the Great: and Matthew of Westminster asserts, that the body of Constantius, father of Constantine, was found at Caernarvon in the year 1283, and interred in the parish church by order of Edward I. See CAERNARVONSHIRE, SUPPLEMENT.

CAERNARVON, a town of Wales, and capital of the county of that name. It was built by Edward I. near the site of the ancient Segontium, after his conquest of the country in 1282, the situation being well adapted to overawe his new subjects. It had natural requisites for strength; being bounded on one side by the arm of the sea called the *Menai*; by the estuary of the

Seiont

Caernarvon ‖ Cæsalpinia.

Sciont on another, exactly where it receives the tide from the former; on a third side, and a part of the fourth, by a cheek of the Menai; and the remainder has the appearance of having the insulation completed by art. Edward undertook this great work immediately after his conquest of the country in 1282, and completed the fortifications and castle before 1284; for his queen, on April 25th in that year, brought forth within its walls Edward, first prince of Wales of the English line. It was built within the space of one year, by the labour of the peasants, and at the cost of the chieftains of the country, on whom the conqueror imposed the hateful task. The external state of the walls and castle, Mr Pennant informs us, are at present exactly as they were in the time of Edward. The walls are defended by numbers of round towers, and have two principal gates: the east, facing the mountains; the west, upon the Menai. The entrance into the castle is very august, beneath a great tower, on the front of which appears the statue of the founder, with a dagger in his hand, as if menacing his new-acquired unwilling subjects. The gate had four portcullises, and every requisite of strength. The towers are very beautiful. The eagle tower is remarkably fine, and has the addition of three slender angular turrets issuing from the top. Edward II. was born in a little dark room in this tower, not twelve feet long nor eight in breadth: so little did, in those days, a royal consort consult either pomp or conveniency. The gate through which the affectionate Eleanor entered, to give the Welsh a prince of their own, who could not speak a word of English, is at the farthest end, at a vast height above the outside ground; so could only be approached by a drawbridge. The quay is a most beautiful walk along the side of the Menai, and commands a most agreeable view.

Caernarvon is destitute of manufactures, but has a brisk trade with London, Bristol, Liverpool, and Ireland, for the several necessaries of life. It is the residence of numbers of genteel families, and contains several very good houses. Edward I. bestowed on this town its first royal charter, and made it a free borough. Among other privileges, none of the burgesses could be convicted of any crime committed between the rivers Conway and Dyfe, unless by a jury of their own townsmen. It is governed by a mayor, who, by patent, is created governor of the castle. It has one alderman, two bailiffs, a town clerk, and two serjeants at mace. The representative of the place is elected by its burgesses, and those of Conway, Pwllheli, Nesyn, and Crickaeth. The right of voting is in the freemen. The town gives title of *earl* and *marquis* to the duke of Chandos, and has a good tide harbour. Population 4595 in 1811.

CAERWIS, a market town of Flintshire, in North Wales, situated in W. Long. 3. 25. N. Lat. 53. 20.

CÆSALPINIA, Brasiletto, or *Brasil wood*. See Botany *Index*. Of this there are three species, the most remarkable of which is the brasiliensis, commonly called *Brasiletto*. It grows naturally in the warmest parts of America, from whence the wood is imported for the dyers, who use it much. The demand has been so great, that none of the large trees are left in any of the British plantations; so that Mr Catesby owns himself ignorant of the dimensions to which they grow. The largest remaining are not above two inches in thickness, and eight or nine feet in height. The branches are slender and full of small prickles; the leaves are pinnated; the lobes growing opposite to one another, broad at their ends, with one notch. The flowers are white, papilionaceous, with many stamina and yellow apices growing in a pyramidal spike, at the end of a long slender stalk: the pods enclose several small round seeds. The colour produced from this wood is greatly improved by solution of tin in aqua regia *. The second sort is a native of the same countries with the first, but is of a larger size. It sends out many weak irregular branches, armed with short, strong, upright thorns. The leaves branch out in the same manner as the first; but the lobes, or small leaves, are oval and entire. The flowers are produced in long spikes like those of the former, but are variegated with red. These plants may be propagated from seeds, which should be sown in small pots filled with light rich earth early in the spring, and plunged in a bed of tanner's bark. Being tender, they require to be always kept in the stove, and to be treated in the same manner as other exotics of that kind.

Cæsalpinia ‖ Cæsar.

* See *Colour-making and Dyeing*.

CÆSALPINUS of Arezzo, professor at Pisa, and afterwards physician to Pope Clement VIII. one of the capital writers in botany. See Supplement.

CÆSAR, Julius, the illustrious Roman general and historian, was of the family of the Julii, who pretended they were descended from Venus by Æneas. The descendants of Ascanius, son of Æneas and Creüsa, and surnamed *Julius*, lived in Alba till that city was ruined by Tullus Hostilius king of Rome, who carried them to Rome, where they flourished. We do not find that they produced more than two branches. The first bore the name of *Tullus*, the other that of *Cæsar*. The most ancient of the Cæsars were those who were in public employments in the 11th year of the first Punic war. After that time we find there was always some of that family who enjoyed public offices in the commonwealth, till the time of Caius Julius Cæsar, the subject of this article. He was born at Rome the 12th of the month Quintilis, year of the city 653, and lost his father An. 669. By his valour and eloquence he soon acquired the highest reputation in the field and in the senate. Beloved and respected by his fellow citizens, he enjoyed successively every magisterial and military honour the public could bestow consistent with its own free constitution. But at length having subdued Pompey, the great rival of his growing power, his boundless ambition effaced the glory of his former actions: for, pursuing his favourite maxim, "that he had rather be the first man in a village than the second in Rome," he procured himself to be chosen perpetual dictator; and, not content with this unconstitutional power, his faction had resolved to raise him to the imperial dignity; when the friends of the civil liberties of the republic rashly assassinated him in the senate-house, where they should only have seized him and brought him to a legal trial for usurpation. By this impolitic measure they defeated their own purpose, involving the city in consternation and terror, which produced general anarchy, and paved the way to the revolution they wanted to prevent: the monarchical government being absolutely founded on the murder of Julius Cæsar. He fell in the 56th year of his age, 43 years before

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Cæsar.

before the Christian era. His commentaries contain a history of his principal voyages, battles, and victories. The London edition in 1712, in folio, is preferred.

The detail of Cæsar's transactions (so far as is consistent with the limits of this work) being given under the article ROME, we shall here only add a portrait of him as drawn by a philosopher *.

"If, after the lapse of 18 centuries, the truth may be published without offence, a philosopher might, in the following terms, censure Cæsar without calumniating him, and applaud him without exciting his blushes.

"Cæsar had one predominant passion: it was the love of glory; and he passed 40 years of his life in seeking opportunities to foster and encourage it. His soul, entirely absorbed in ambition, did not open itself to other impulses. He cultivated letters; but he did not love them with enthusiasm, because he had not leisure to become the first orator of Rome. He corrupted the one half of the Roman ladies, but his heart had no concern in the fiery ardours of his senses. In the arms of Cleopatra, he thought of Pompey; and this singular man, who disdained to have a partner in the empire of the world, would have blushed to have been for one instant the slave of a woman.

"We must not imagine that Cæsar was born a warrior, as Sophocles and Milton were born poets. For, if nature had made him a citizen of Sybaris, he would have been the most voluptuous of men. If in our days he had been born in Pennsylvania, he would have been the most inoffensive of Quakers, and would not have disturbed the tranquillity of the new world.

"The moderation with which he conducted himself after his victories, has been highly extolled; but in this he showed his penetration, not the goodness of his heart. Is it not obvious, that the display of certain virtues is necessary to put in motion the political machine? It was requisite that he should have the appearance of clemency, if he inclined that Rome should forgive him his victories. But what greatness of mind is there in a generosity which follows on the usurpation of the supreme power?

"Nature, while it marked Cæsar with a sublime character, gave him also that spirit of perseverance which renders it useful. He had no sooner begun to reflect, than he admired Sylla; hated him, and yet wished to imitate him. At the age of 15, he formed the project of being dictator. It was thus that the president Montesquieu conceived, in his early youth, the idea of the Spirit of Laws.

"Physical qualities as well as moral causes, contributed to give strength to his character. Nature, which had made him for command, had given him an air of dignity. He had acquired that soft and insinuating eloquence, which is perfectly suited to seduce vulgar minds, and has a powerful influence on the most cultivated. His love of pleasure was a merit with the fair sex; and women, who even in a republic can draw to them the suffrages and attention of men, have the highest importance in degenerate times. The ladies of his age were charmed with the prospect of having a dictator whom they might subdue by their attractions.

"In vain did the genius of Cato watch for some time to sustain the liberty of his country. It was unequal to contend with that of Cæsar. Of what avail were the eloquence, the philosophy, and the virtue of this republican, when opposed by a man who had the address to debauch the wife of every citizen whose interest he meant to engage; who, possessing an enthusiasm for glory, wept, because, at the age of 30, he had not conquered the world like Alexander; and who, with the haughty temper of a despot, was more desirous to be the first man in a village than the second in Rome.

"Cæsar had the good fortune to exist in times of trouble and civil commotions, when the minds of men are put into a ferment; when opportunities of great actions are frequent; when talents are every thing, and those who can only boast of their virtues are nothing. If he had lived an hundred years sooner, he would have been no more than an obscure villain; and, instead of giving laws to the world, would not have been able to produce any confusion in it.

"I will here be bold enough to advance an idea, which may appear paradoxical to those who weakly judge of men from what they achieve, and not from the principle which leads them to act. Nature formed in the same mould Cæsar, Mahomet, Cromwell, and Kouli Khan. They all of them united to genius that profound policy which renders it so powerful. They all of them had an evident superiority over those with whom they were surrounded; they were conscious of this superiority, and they made others conscious of it. They were all of them born subjects, and became fortunate usurpers. Had Cæsar been placed in Persia, he would have made the conquest of India; in Arabia, he would have been the founder of a new religion; in London, he would have stabbed his sovereign, or have procured his assassination under the sanction of the laws. He reigned with glory over men whom he had reduced to be slaves; and, under one aspect, he is to be considered as a hero; under another, as a monster. But it would be unfortunate, indeed, for society, if the possession of superior talents gave individuals a right to trouble its repose. Usurpers accordingly have flatterers, but no friends; strangers respect them; their subjects complain and submit; it is in their own families that humanity finds her avengers. Cæsar was assassinated by his son, Mahomet was poisoned by his wife, Kouli Khan was massacred by his nephew, and Cromwell only died in his bed because his son Richard was a philosopher.

"Cæsar, the tyrant of his country; Cæsar, who destroyed the agents of his crimes, if they failed in address; Cæsar, in fine, the husband of every wife, and the wife of every husband, has been accounted a great man by the mob of writers. But it is only the philosopher who knows how to mark the barrier between celebrity and greatness. The talents of this singular man, and the good fortune which constantly attended him till the moment of his assassination, have concealed the enormity of his actions."

* From the *Melanges Philosophiques* of M. Ophellot.

CÆSAR, in Roman antiquity, a title borne by all the emperors, from Julius Cæsar to the destruction of the empire. It was also used as a title of distinction for the intended or presumptive heir of the empire, as *King of the Romans* is now used for that of the German empire.

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This title took its rise from the surname of the first emperor C. Julius Cæsar, which, by a decree of the senate, all the succeeding emperors were to bear. Under his successor, the appellation of *Augustus* being appropriated to the emperors, in compliment to that prince, the title *Cæsar* was given to the second person in the empire, though still it continued to be given to the first; and hence the difference betwixt Cæsar used simply, and Cæsar with the addition of Imperator Augustus.

The dignity of Cæsar remained to the second of the empire, till Alexius Comnenus having elected Nicephorus Melissenus Cæsar by contract; and it being necessary to confer some higher dignity on his own brother Isaacius, he created him Sebastocrator with the precedency over Melissenus; ordering, that in all acclamations, &c. Isaacius Sebastocrator should be named the second, and Melissenus Cæsar the third.

Cæsar, *Sir Julius*, a learned civilian, was descended by the female line from the duke de Cesarini in Italy; and was born near Tottenham in Middlesex, in the year 1557. He was educated at Oxford, and afterwards studied in the university of Paris, where, in the year 1581, he was created doctor of the civil law, and two years after was admitted to the same degree at Oxford, and also became doctor of the canon law. He was advanced to many honourable employments, and for the last 20 years of his life was master of the rolls. He was remarkable for his extensive bounty and charity to all persons of worth, so that he seemed to be the almoner-general of the nation. He died in 1639, in the 79th year of his age. It is very remarkable that the manuscripts of this lawyer were offered (by the executors of some of his descendants) to a cheesemonger for waste paper; but being timely inspected by Mr Samuel Paterson, this gentleman discovered their worth, and had the satisfaction to find his judgment confirmed by the profession, to whom they were sold in lots for upwards of 500l. in the year 1757.

Cæsar *Augusta*, or *Cæsarea Augusta*, in *Ancient Geography*, a Roman colony situated on the river Iberus in the Hither Spain, before called *Salduba*, in the territories of the Edetani. Now commonly thought to be Saragosa.

CÆSAREA, the name of several ancient cities, particularly one on the coast of Phœnicia. It was very conveniently situated for trade; but had a very dangerous harbour, so that no ships could be safe in it when the wind was at south-west. Herod the Great, king of Judea, remedied this inconveniency at an immense expence and labour, making it one of the most convenient havens on that coast. He also beautified it with many buildings, and bestowed 12 years on the finishing and adorning it.

CÆSAREAN operation. See Midwifery.

CÆSARIANS, *Cæsarienses*, in Roman antiquity, were officers or ministers of the Roman emperors: They kept the account of the revenues of the emperors; and took possession, in their name, of such things as devolved or were confiscated to them.

CÆSARODUNUM, in *Ancient Geography*, a town of the Turones in Celtic Gaul; now *Tours*, the capital of Touraine. See Tours.

CÆSAROMAGUS, in *Ancient Geography*, a town of the Trinobantes in Britain; by some supposed to be *Chelmsford*, by others *Brentford*, and by others *Purfleet*.

CÆSENA, in *Ancient Geography*, a town of Gallia Cispadana, situated on the rivers Isapis and Rubicon; naw Cecena, which see.

CÆSIA sylva, in *Ancient Geography*, a wood in Germany, part of the great Sylva Hercynia, situated partly in the duchy of Cleves, and partly in Westphalia, between Wesel and Kesfield.

CÆSONES, a denomination given to those cut out of their mothers wombs. Pliny ranks this as an auspicious kind of birth; the elder Scipio Africanus, and the first of the family of Cæsars, were brought into the world in this way.

CÆSTUS, in antiquity, a large gauntlet made of raw hide, which the wrestlers made use of when they fought at the public games.—This was a kind of leathern strap, strengthened with lead or plates of iron, which encompassed the hand, the wrist, and a part of the arm, as well to defend these parts as to enforce their blows.

Cæstus, or *Cæstum*, was also a kind of girdle, made of wool, which the husband untied for his spouse the first day of marriage, before they went to bed.

This relates to Venus's girdle, which Juno borrowed of her to entice Jupiter to love her. See Cestus.

CÆSURA, in the ancient poetry, is when, in the scanning of a verse, a word is divided so, as one part seems cut off, and goes to a different foot from the rest: as,

Menti|ri no|li, nun|quam men|dacia| prosunt.

where the syllables *ri*, *li*, *quam*, and *men*, are cæsuras.

Cæsura, in the modern poetry, denotes a rest or pause towards the middle of an Alexandrian verse, by which the voice and pronunciation are aided, and the verse, as it were, divided into two hemistichs. See Pause.

CÆTERIS paribus, a Latin term in frequent use among mathematical and physical writers. The words literally signify, *the rest* (or *other things*) *being alike or equal*. Thus we say the heavier the bullet, *cæteris paribus*, the greater the range; i. e. by how much the bullet is heavier, if the length and diameter of the piece and strength of the powder be the same, by so much will the utmost range or distance of a piece of ordnance be the greater. Thus also, in a physical way, we say, the velocity and quantity circulating in a given time through any section of an artery, will, *cæteris paribus*, be according to its diameter, and nearness to or distance from the heart.

CÆTOBRIX, in *Ancient Geography*, a town of Lusitania, near the mouth of the Tagus, on the east side; now extinct. It had its name from its fishery; and there are still extant fish ponds on the shore done with plaster of Paris, which illustrate the name of the ruined city.

CAFFA, in commerce, painted cotton cloths manufactured in the East Indies, and sold at Bengal.

Caffa, or *Kaffa*, a city and port town of Crim Tartary, situated on the south-east part of that peninsula. E. Long. 37. 0. N. Lat. 44. 55.

It is the most considerable town in the country, and gives

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gives name to the straits of Caffa, which run from the Euxine or Black sea, to the Palus Mæotis, or sea of Asoph.

CAFFILA, a company of merchants or travellers, who join together in order to go with more security through the dominions of the Great Mogul, and through other countries on the continent of the East Indies.

The caffila differs from a caravan, at least in Persia; for the caffila properly belongs to some sovereign, or to some powerful company in Europe; whereas a caravan is a company of particular merchants, each trading upon his own account. The English and Dutch have each of them their caffila at Gambrow. There are also such caffilas, which cross some parts of the deserts of Africa, particularly that called the *sea of sand*, which lies between the kingdom of Morocco and those of Tombut and Giago. This is a journey of 400 leagues; and takes up two months in going, and as many in coming back; the caffila travelling only by night, on account of the excessive heat of that country, The chief merchandise they bring back consists in gold dust, which they call *atibar*, and the Europeans *tibir*.

Caffila, on the coast of Guzerat or Cambaya, signifies a small fleet of merchant ships.

CAFFRARIA, the country of the Caffres or Hottentots, in the most southerly parts of Africa, lying in the form of a crescent about the inland country of Monomotapa, between 35° south latitude and the tropic of Capricorn; and bounded on the east, south, and west, by the Indian and Atlantic oceans. See Hottentots.

Most of the sea coasts of this country are subject to the Dutch, who have built a fort near the most southern promontery called the *Cape of Good Hope*.

CAG, or Keg, a barrel or vessel that contains some four or five gallons.

CAGANUS, or Cacanus, an appellation anciently given by the Huns to their kings. The word appears also to have been formerly applied to the princes of Muscovy, now called *czar*. From the same also, probably, the Tartar title *cham* or *can*, had its origin.

CAGE, an enclosure made of wire, wicker, or the like, interwoven lattice-wise, for the confinement of birds or wild beasts. The word is French, *cage*, formed from the Italian *gaggia*, of the Latin *cavea*, which signifies the same: *à caveis theatralibus in quibus includebantur feræ*.

Beasts were usually brought to Rome shut up in oaken or beechen cages artfully formed, and covered or shaded with boughs, that the creatures, deceived with the appearance of a wood, might fancy themselves in their forest. The fiercer sorts were pent in iron cages, lest wooden prisons might be broke through. In some prisons there are iron cages for the closer confinement of criminals. The French laws distinguish two sorts of birds cages; viz. high or singing cages, and low or dumb cages; those who expose birds to sale are obliged to put the hens in the latter, and the cocks in the former, that persons may not be imposed on by buying a hen for a cock.

Cages (*caveæ*), denote also places in the ancient amphitheatres, wherein wild beasts were kept, ready to be let out for sport. The *caveæ* were a sort of iron cages, different from dens, which were under ground and dark; whereas the *caveæ* being airy and light, the beasts rushed out of them with more alacrity and fierceness than if they had been pent under ground.

Cage, in carpentry, signifies an outer work of timber, inclosing another within it. In this sense we say, *the cage of a wind-mill*, The cage of a staircase denotes the wooden sides or walls which enclose it.

CAGEAN, or Cagayan, a province of the island of Luzon, or Manilla, in the East Indies. It is the largest in the island, being 80 leagues in length and 40 in breadth. The principal city is called *New Segovia*, and 15 leagues eastward from this city lies Cape Bajador. Doubling that cape, and coasting along 20 leagues from north to south, the province of Cagean ends, and that of Illocos begins. The peaceable Cageans who pay tribute are about 9000; but there are a great many not subdued. The whole province is fruitful; the men apply themselves to agriculture, and are of a martial disposition; and the women apply to several works in cotton. The mountains afford food for a vast number of bees; in consequence of which wax is so plenty, that all the poor burn it instead of oil. They make their candles after the following manner; they leave a small hole at each end of a hollow stick for the wick to run through, and then, stopping the bottom, fill it with wax at the top; when cold, they break the mould and take out the candle. On the mountains there is abundance of brasil, ebony, and other valuable woods. In the woods are store of wild beasts, as boars; but not so good as those of Europe. There are also abundance of deer, which they kill for their skins and horns to sell to the Chinese.

CAGLI, an ancient episcopal town of Italy, in the duchy of Urbino, situated at the foot of the Apennine mountains. E. Long. 14. 12. N. Lat. 43. 30.

CAGLIARI, Paolo, called *Paulo Veronese*, an excellent painter, was born at Verona in the year 1532. Gabriel Cagliari his father was a sculptor, and Antonio Badile his uncle was his master in painting. He was not only esteemed the best of all the Lombard painters, but for his extensive talents in the art was peculiarly styled *Il pittor felice*, "the happy painter;" and there is scarcely a church in Venice where some of his performances are not to be seen. De Pile says that "his picture of the marriage at Cana, in the church of St George, is to be distinguished from his other works, as being not only the triumph of Paul Veronese, but also the triumph of painting itself." When the senate sent Grimani, procurator of St Mark, to be their ambassador at Rome, Paul attended him, but did not stay long, having left some pieces at Venice unfinished. Philip II. king of Spain, sent for him to paint the Escurial, and made him great offers; but Paul excused himself from leaving his own country, where his reputation was so well established, that most of the princes of Europe ordered their several ambassadors to procure something of his hand at any rate. He was indeed highly esteemed by all the principal men in his time; and so much admired by the great masters, as well his contemporaries, as those who succeeded him, that Titian himself used to say, he was the ornament of his profession. And Guido Reni being asked which of the masters his predecessors he

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would choose to be, were it in his power, after Raphael and Corregio, named Paul Veronese; whom he always called his Paolino. He died of a fever at Venice in 1588, and had a tomb and a statue of brass erected to his memory in the church of St Sebastian. He left great wealth to his two sons Gabriel and Charles, who lived happily together, and joined in finishing several of their father's imperfect pieces with good success.

CAGLIARI, an ancient, large, and rich town, capital of the island of Sardinia in the Mediterranean. It is seated on the declivity of a hill; is an university, an archbishopric, and the residence of the viceroy. It has an excellent harbour, and a good trade; but is a place of no great strength. It was taken, with the whole island, by the English in 1708, who transferred it to the emperor Charles VI.; but it was retaken by the Spaniards in 1717, and about two years afterwards ceded to the duke of Savoy in lieu of Sicily, and hence he has the title of *King of Sardinia*. E. Long. 9. 14. N. Lat. 39. 12.

CAGUI, in *Zoology*, a synonyme of two species of monkeys, viz the jacchus and œdipus. See SIMIA, MAMMALIA *Index*.

CAHORS, a considerable town of France in Guienne, now in the department of Lot. It is seated on a peninsula made by the river Lot, and built partly on a craggy rock. The principal street is very narrow; and terminates in the market place, in which is the town house. The cathedral is a Gothic structure, and has a large square steeple. The fortifications are regular, and the town contained 10,136 inhabitants in 1815. E. Long. 1. 6. N. Lat. 44. 26.

CAHYS, a dry measure for corn, used in some parts of Spain, particularly at Seville and Cadiz. It is near a bushel of our measure.

CAJANABURG, the capital of the province of Cajania or East Bothnia in Sweden, situated on the north-east part of the lake Cajania, in E. Long. 27. 0. N. Lat. 63. 50.

CAIAPHAS, high priest of the Jews after Simon, condemned Christ to death; and was put out of his place by the emperor Vitellius, for which disgrace he made away with himself.

CAJAZZO, a town of the province of Lavoro in the kingdom of Naples, situated in E. Long. 15. 0. N. Lat. 41. 15.

CAICOS, the name of some American islands to the north of St Domingo, lying from W. Long. 112. 10. to 113. 16. N. Lat. 21. 40.

CAJEPUT, an oil brought from the East Indies, resembling that of cardamoms. See MELALEUCA.

CAIETA, in *Ancient Geography*, a port and town of Latium, so called from Æneas's nurse; now *Gaeta*, which see.

CAJETAN, CARDINAL, was born at Cajeta in the kingdom of Naples in the year 1469. His proper name was *Thomas de Vio*: but he adopted that of *Cajetan* from the place of his nativity. He defended the authority of the pope, which suffered greatly at the council of Nice, in a work entitled *Of the power of the Pope;* and for this work he obtained the bishopric of Cajeta. He was afterwards raised to the archiepiscopal see of Palermo, and in 1517 was made a cardinal by Pope Leo X. The year after, he was sent as legate into Germany, to quiet the commotions raised against indulgences by Martin Luther: but Luther, under protection of Frederic elector of Saxony, set him at defiance; for though he obeyed the cardinal's summons, in repairing to Augsburg, yet he rendered all his proceedings ineffectual. Cajetan was employed in several other negotiations and transactions, being as ready at business as at letters. He died in 1534. He wrote Commentaries upon Aristotle's philosophy, and upon Thomas Aquinas's theology; and made a literal translation of the Old and New Testaments.

CAIFONG, a large, populous, and rich town of Asia, in China, seated in the middle of a large and well cultivated plain. It stands in a bottom; and when besieged by the rebels in 1642, they ordered the dykes of the river Hoang-ho to be cut, which drowned the city and destroyed 300,000 of its inhabitants. E. Long. 113. 27. N. Lat. 35. 0.

CAILLE, NICHOLAS LOUIS DE LA, an eminent mathematician and astronomer, was born at a small town in the diocese of Rheims in 1713. His father had served in the army, which he quitted, and in his retirement studied mathematics; and amused himself with mechanic exercises, wherein he proved the happy author of several inventions of considerable use to the public. Nicholas, almost in his infancy, took a fancy to mechanics, which proved of signal service to him in his maturer years. He was sent young to school at Mantes-sur-Seine, where he discovered early tokens of genius. In 1729, he went to Paris; where he studied the classics, philosophy, and mathematics. Afterwards he went to study divinity at the college de Navarre, proposing to embrace an ecclesiastical life. At the end of three years he was ordained a deacon, and officiated as such in the church of the college de Mazarin several years; but he never entered into priests orders, apprehending that his astronomical studies, to which he became most assiduously devoted, might too much interfere with his religious duties. In 1739, he was conjoined with M. de Thury, son to M. Cassini, in verifying the meridian of the royal observatory through the whole extent of the kingdom of France. In the month of November the same year, whilst he was engaged day and night in the operations which this grand undertaking required, and at a great distance from Paris, he was, without any solicitation, elected into the vacant mathematical chair which the celebrated M. Varignon had so worthily filled. Here he began to teach about the end of 1740; and an observatory was ordered to be erected for his use in the college, and furnished with a suitable apparatus of the best instruments. In May 1741, M. de la Caille was admitted into the Royal Academy of Sciences as an adjoint member for astronomy. Besides the many excellent papers of his dispersed up and down in their Memoirs, he published Elements of Geometry, Mechanics, Optics, and Astronomy. Moreover, he carefully computed all the eclipses of the sun and moon that had happened since the Christian era, which were printed in a book published by two Benedictines, entitled *l' Art de Verifier les Dates*, &c. Paris, 1750, in 4to. Besides these he compiled a volume of astronomical ephemerides for the years 1745 to 1755; another for the years 1755 to 1765; a third for the years 1765 to 1775; an excellent work entitled *Astronomiæ Fundamenta*

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Caille.

menta novissimis solis et stellarum observationibus stabilita: and the most correct solar tables that ever appeared. Having gone through a seven years series of astronomical observations in his own observatory, he formed a project of going to observe the southern stars at the Cape of Good Hope. This was highly approved by the academy, and by the prime minister Comte de Argenson, and very readily agreed to by the states of Holland. Upon this he drew up a plan of the method he proposed to pursue in his southern observations; setting forth, that, besides settling the places of the fixed stars, he proposed to determine the parallax of the moon, Mars, and Venus. But whereas this required correspondent observations to be made in the northern parts of the world, he sent to those of his correspondents who were expert in practical astronomy previous notice in print, what observations he designed to make at such and such times for the said purpose. At length, on the 21st of November 1750, he sailed for the Cape, and arrived there on the 19th of April 1751. He forthwith got his instruments on shore: and, with the assistance of some Dutch artificers, set about building an astronomical observatory, in which his apparatus of instruments was properly disposed of as soon as it was in a fit condition to receive them.

The sky at the Cape is generally pure and serene, unless when a south-east wind blows: But this is often the case, and when it is, it is attended with some strange and terrible effects. The stars look bigger, and seem to caper; the moon has an undulating tremor; and the planets have a sort of beard like comets. Two hundred and twenty-eight nights did our astronomer survey the face of the southern heavens: during which space, which is almost incredible, he observed more than 10,000 stars; and whereas the ancients filled the heavens with monsters and old wives tales, the Abbé de la Caille chose rather to adorn them with the instruments and machines which modern philosophy has made use of for the conquest of nature *. With no less success did he attend to the parallax of the moon, Mars, Venus, and the sun. Having thus executed the purpose of his voyage, and no present opportunity offering for his return, he thought of employing the vacant time in another arduous attempt; no less than that of taking the measure of the earth, as he had already done that of the heavens. This, indeed, had, through the munificence of the French king, been done before by different sets of learned men, both in Europe and America; some determining the quantity of a degree under the equator, and others under the arctic circles; but it had not as yet been decided whether in the southern parallels of latitude the same dimensions obtained as in the northern. His labours were rewarded with the satisfaction he wished for; having determined a distance of 410,814 feet from a place called *Klip Fontyn* to the Cape, by means of a base of 38,802 feet, three times actually measured: whence he discovered a new secret of nature, namely, that the radii of the parallels in south latitude are not the same as those of the corresponding parallels in north latitude. About the 23d degree of south latitude he found a degree on the meridian to contain 342,222 Paris feet. He returned to Paris the 27th of September 1754; having, in his almost four years absence, expended no more than 9144 livres on himself and his companion; and at his coming into port, he refused a bribe of 100,000 livres, offered by one who thirsted less after glory than gain, to be sharer in his immunity from customhouse searches.

* See the Planisphere in his *Cælum australe stelliferum.*

Caille, Caimacan.

After receiving the congratulatory visits of his more intimate friends and the astronomers, he first of all thought fit to draw up a reply to some strictures which Professor Euler had published relative to the meridian, and then he settled the results of the comparison of his own with the observations of other astronomers for the parallaxes. That of the sun he fixed at $9\frac{1}{2}''$; of the moon at 56′ 56″; of Mars in his opposition, 36″; of Venus, 38″. He also settled the laws whereby astronomical refractions are varied by the different density or rarity of the air, by heat or cold, and dryness or moisture. And, lastly, he showed an easy, and by common navigators practicable, method of finding the longitude at sea by means of the moon, which he illustrated by examples selected from his own observations during his voyages. His fame being now established upon so firm a basis, the most celebrated academies of Europe claimed him as their own: and he was unanimously elected a member of the royal society at London; of the institute of Bologna; of the imperial academy at Petersburgh; and of the royal academies at Berlin, Stockholm, and Gottingen. In the year 1760, M. de la Caille was attacked with a severe fit of the gout; which, however, did not interrupt the course of his studies; for he then planned out a new and immense work; no less than the history of astronomy through all ages, with a comparison of the ancient and modern observations, and the construction and use of the instruments employed in making them. In order to pursue the task he had imposed upon himself in a suitable retirement, he obtained a grant of apartments in the royal palace of Vincennes; and whilst his astronomical apparatus was erected there, he began printing his Catalogue of the Southern Stars, and the third volume of his Ephemerides. The state of his health was, towards the end of the year 1763, greatly reduced. His blood grew inflamed; he had pains of the head, obstructions of the kidneys, loss of appetite, with a fulness of the whole habit. His mind remained unaffected, and he resolutely persisted in his studies as usual. In the month of March, medicines were administered to him, which rather aggravated than alleviated his symptoms; and he was now sensible, that the same distemper which in Africa, ten years before, yielded to a few simple remedies, did in his native country bid defiance to the best physicians. This induced him to settle his affairs: his manuscripts he committed to the care and discretion of his esteemed friend M. Maraldi. It was at last determined that a vein should be opened; but this brought on an obstinate lethargy, of which he died, aged 49.

CAIMACAN, or KAIMACAM, in the Turkish affairs, a dignity in the Ottoman empire, answering to lieutenant, or rather deputy, amongst us.

There are usually two caimacans; one residing at Constantinople, as governor thereof; the other attends the grand vizir in quality of his lieutenant, secretary of state, and first minister of his council, and gives audience to ambassadors. Sometimes there is a third caimacan, who attends the sultan; whom he acquaints with any public disturbances, and receives his orders concerning them.

CAIMAN or CAYMAN ISLANDS, certain American islands lying south of Cuba and north-west of Jamaica, between 81° and 86° of west longitude, and in 21° of north latitude. They are most remarkable on account of the fishery of tortoise, which the people of Jamaica catch here and carry home alive, keeping them in pens for food, and killing them as they want them.

CAIN, eldest son of Adam and Eve, killed his brother Abel; for which he was condemned by God to banishment and a vagabond state of life. Cain retired to the land of Nod, on the east of Eden; and built a city, to which he gave the name of his son Enoch.

CAINITES, a sect of heretics in the 2d century, so called on account of their great respect for Cain. They pretended that the virtue which produced Abel was of an order inferior to that which had produced Cain, and that this was the reason why Cain had the victory over Abel and killed him; for they admitted a great number of genii, which they called *virtues*, of different ranks and orders. They made profession of honouring those who carry in Scripture the most visible marks of reprobation; as the inhabitants of Sodom, Esau, Korah, Dathan, and Abiram. They had, in particular, a very great veneration for the traitor Judas, under pretence that the death of Jesus Christ had saved mankind. They had a forged gospel of Judas, to which they paid great respect.

CAIRNS, or CARNES, the vulgar name of those heaps of stones which are to be seen in many places of Britain, particularly Scotland and Wales.—They are composed of stones of all dimensions thrown together in a conical form, a flat stone crowning the apex; (see Plate CXXXV.).

Various causes have been assigned by the learned for these heaps of stones. They have supposed them to have been, in times of inauguration, the places where the chieftain elect stood to show himself to best advantage to the people; or the place from whence judgement was pronounced; or to have been erected on the road-side in honour of Mercury; or to have been formed in memory of some solemn compact, particularly where accompanied by standing pillars of stones; or for the celebration of certain religious ceremonies. Such might have been the reasons, in some instances, where the evidences of stone chests and urns are wanting: but these are so generally found that they seem to determine the most usual purpose of the piles in question to have been for sepulchral monuments. Even this destination might render them suitable to other purposes; particularly religious, to which by their nature they might be supposed to give additional solemnity.—According to Toland, fires were kindled on the tops of flat stones, at certain times of the year, particularly on the eves of the 1st of May and the 1st of November, for the purpose of sacrificing; at which time all the people having extinguished their domestic hearths, rekindled them from the sacred fires of the cairns. In general, therefore, these accumulations appear to have been designed for the sepulchral protection of heroes and great men. The stone chests, the repository of the urns and ashes, are lodged in the earth beneath: sometimes only one, sometimes more, are found thus deposited; and Mr Pennant mentions an instance of 17 being discovered under the same pile.

Cairns are of different sizes, some of them very large. Mr Pennant describes one in the island of Arran, 114 feet over, and of a vast height. They may justly be supposed to have been proportioned in size to the rank of the person, or to his popularity: the people of a whole district assembled to show their respect to the deceased; and, by an active honouring of his memory, soon accumulated heaps equal to those that astonish us at this time. But these honours were not merely those of the day; as long as the memory of the deceased endured, not a passenger went by without adding a stone to the heap: they supposed it would be an honour to the dead, and acceptable to his manes.

Quanquam festinas, non est morà longa: licebit
Injecta ter pulvera, curras.

To this moment there is a proverbial expression among the Highlanders allusive to the old practice; a suppliant will tell his patron, *Curri mi cloch er do charne*, "I will add a stone to your cairn;" meaning, when you are no more, I will do all possible honour to your memory.

Cairns are to be found in all parts of our islands, in Cornwall, Wales, and all parts of North Britain; they were in use among the northern nations; Dahlberg, in his 323d plate, has given the figure of one. In Wales they are called *carneddau*; but the proverb taken from them there, is not of the complimental kind: *Karn ar dy ben*, or, "A cairn on your head," is a token of imprecation.

CAIRO, or GRAND CAIRO, the capital of Egypt, situated in a plain at the foot of a mountain, in E. Long. 32. 0. N. Lat. 30. 0. It was founded by Jawhar, a Magrebian general, in the year of the Hegira 358. He had laid the foundation of it under the horoscope of Mars; and for that reason gave his new city the name of *Al Kahira*, or the *Victorious*, an epithet applied by the Arab astronomers to that planet. In 362 it became the residence of the caliphs of Egypt, and of consequence the capital of that country, and has ever since continued to be so. It is divided into the New and Old cities. Old Cairo is on the eastern side of the river Nile, and is now almost uninhabited. The new, which is properly Cairo, is seated in a sandy plain about two miles and a half from the old city. It stands on the western side of the Nile, from which it is not three quarters of a mile distant. It is extended along the mountain on which the castle is built, for the sake of which it was removed hither, in order, as some pretend, to be under its protection. However, the change is much for the worse, as well with regard to air as water, and the pleasantness of the prospect. Bulack may be called the port of Cairo; for it stands on the bank of the Nile, about a mile and a half from it, and all the corn and other commodities are landed there before they are brought to the city. Some travellers have made Cairo of a most enormous magnitude, by taking in the old city, Bulack, and the new; the real circumference of it, however, is not above ten miles, but it is extremely populous. The first thing that strikes a traveller is the narrowness of the streets,

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Cairo. streets, and the appearance of the houses. These are so daubed with mud on the outside, that you would think they were built with nothing else. Besides, as the streets are unpaved, and always full of people, the walking in them is very inconvenient, especially to strangers. To remedy this, there are a great number of asses, which always stand ready to be hired for a trifle, that is, a penny a mile. The owners drive them along, and give notice to the crowd to make way. And here it may be observed, that the Christians in this, as well as other parts of the Turkish dominions, are not permitted to ride upon horses. The number of the inhabitants can only be guessed at. Volney thinks it may amount to 200,000; but some later travellers estimate it as high as 300,000 or 400,000. The houses are from one to two or three stories high, and flat at the top; where they take the air, and often sleep all night. The better sort of these have a court on the inside like a college. The common run of houses have very little room, and even among great people it is usual for 20 or 30 to lie in a small hall. Some houses will hold 300 persons of both sexes, among whom are 20 or 30 slaves; and those of ordinary rank have generally three or four.

There is a canal, called *khalis*, which runs along the city from one end to the other, with houses on each side, which makes a large straight street. Besides this, there are several lakes, which are called *birks* in the language of the country. The principal of these, which is near the castle, is 500 paces in diameter. The most elegant houses in the city are built on its banks; but what is extraordinary, eight months in the year it contains water, and the other four it appears with a charming verdure. When there is water sufficient, it is always full of gilded boats, barges, and barks, in which people of condition take their pleasure towards night, at which time there are curious fire-works, and variety of music.

New Cairo is surrounded with walls built with stone, on which are handsome battlements, and at the distance of every hundred paces there are very fine towers, which have room for a great number of people. The walls were never very high, and are in many places gone to ruin. The basha lives in the castle, which was built by Saladine 700 years ago. It stands in the middle of the famous mountain Moketan, which terminates in this place, after it had accompanied the Nile from Ethiopia hither. This castle is the only place of defence in Egypt; and yet the Turks take no notice of its falling, insomuch that in process of time it will become a heap of rubbish. The principal part in it is a magnificent hall, environed with 12 columns of granite, of a prodigious height and thickness, which sustain an open dome, under which Saladine distributed justice to his subjects. Round this dome there is an inscription in relievo, which determines the date and by whom it was built. From this place the whole city of Cairo may be seen, and above 30 miles along the Nile, with the fruitful plains that lie near it, as well as the mosques, pyramids, villages, and gardens, with which these fields are covered. These granite pillars were the work of antiquity, for they were got out of the ruins of Alexandria. There are likewise in the mosques and in the principal houses no less than 40,000 more, besides great magazines, where all kinds are to be had at very low rates. A janizary happened to find five in his garden, as large as those in the castle; but could not find any machine of strength sufficient to move them, and therefore had them sawed in pieces to make millstones. It is believed that there have been 30 or 40,000 of these pillars brought from Alexandria, where there are yet many more to be had. The gates of Cairo are three, which are very fine and magnificent.

There are about 300 public mosques in this city, some of which have six minarets. The mosque of Asher hath several buildings adjoining, which were once a famous university, and 14,000 scholars and students were maintained on the foundation; but it has now not above 1400, and those are only taught to read and write. All the mosques are built upon the same plan, and differ only in magnitude. The entrance is through the principal gate into a large square, open on the top, but well paved. Round this are covered galleries, supported by pillars, under which they say their prayers, in the shade. On one side of the square there are particular places with basons of water for the conveniency of performing the ablutions enjoined by the Koran. The most remarkable part of the mosque, besides the minaret, is the dome. This is often bold, well proportioned, and of an astonishing magnitude. The inside stones are carved like lace, flowers, and melons. They are built so firm, and with such art, that they will last 600 or 700 years. About the outward circumference there are large Arabic inscriptions in relievo, which may be read by those who stand below, though they are sometimes of a wonderful height.

The khanes or caravanseras are numerous and large, with a court in the middle, like their houses. Some are several stories high, and are always full of people and merchandise. The Nubians, the Abyssinians, and other African nations, which come to Cairo, have one to themselves, where they always meet with lodging. Here they are secure from insults, and their effects are all safe. Besides these, there is a bazar, or market, where all sorts of goods are to be sold. This is in a long broad street; and yet the crowd is so great, you can hardly pass along. At the end of this street is another short one, but pretty broad, with shops full of the best sort of goods and precious merchandise. At the end of this short street there is a great khane, where all sorts of white slaves are to be sold. Farther than this is another khane, where a great number of blacks, of both sexes, are exposed to sale. Not far from the best market place is a mosque, and an hospital for mad people. They also receive and maintain sick people in this hospital, but they are poorly looked after.

Old Cairo has scarce any thing remarkable but the granaries of Joseph; which are nothing but a high wall, lately built, which includes a square spot of ground where they deposit wheat, barley, and other grain, which is a tribute to the basha, paid by the owners of land. This has no other covering but the heavens, and therefore the birds are always sure to have their share. There is likewise a tolerably handsome church, which is made use of by the Copts, who are Christians, and the original inhabitants of Egypt.

Joseph's

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Joseph's well is in the castle, and was made by King Mohammed about 700 years ago. It is called *Joseph's well*, because they attribute every thing extraordinary to that remarkable person. It is cut in a rock, and is 280 feet in depth. The water is drawn up to the top by means of oxen, placed on platforms, at proper distances, which turn about the machines that raise it. The descent is so sloping, that, though there are no steps, the oxen can descend and ascend with ease.

The river Nile, to which not only Cairo, but all Egypt is so much indebted, is now known to have its rise in Abyssinia. The increase of the Nile generally begins in May, and in June they commonly proclaim about the city how much it is risen. Over against old Cairo the basha has a house, wherein the water enters to a column, which has lines at the distance of every inch, and marks at every two feet as far as 30. When the water rises to 22 feet, it is thought to be of a sufficient height; when it rises much higher, it does a great deal of mischief. There is much pomp and ceremony used in letting the water into the canal above mentioned. See EGYPT.

The inhabitants of Cairo are a mixture of Moors, Turks, Jews, Greeks, and Copts or Coptis. The only difference between the habit of the Moors and Copts is their turbans; those of the Moors being white, and of the Copts white striped with blue. The common people generally wear a long black loose frock, sewed together all down before. The Jews wear a frock of the same fashion, made of cloth; and their caps are like a high-crowned hat, without brims, covered with the same cloth, but not so taper. The Jewish women's are not very unlike the men's, but more light and long. The Greeks are habited like the Turks, only their turbans differ.

Provisions of all kinds are exceedingly plenty; for 20 eggs may be bought for a parah or penny, and bread is six times as cheap as with us. They have almost all sorts of flesh and fish; and in particular have tame buffaloes which are very useful. They bring goats into the streets in great numbers to sell their milk. Their gardens are well stocked with fruit trees of various kinds, as well as roots, herbs, melons, and cucumbers. The most common flesh meat is mutton. The goats are very beautiful, and have ears two feet in length; but their flesh is in no great esteem. See farther the article EGYPT.

CAIROAN, or CAIRWAN, a city of Africa, in the kingdom of Tunis, seated in a sandy barren soil, about five miles from the gulf of Capres. It has neither spring, well, nor river; for which reason they are obliged to preserve rain water in tanks and cisterns. It was built by the Aglabites; and is the ancient Cyrene*, but hath now lost its splendour. There is still, however, a very superb mosque, and the tombs of the kings of Tunis are yet to be seen. E. Long. 9. 12. N. Lat. 35. 40.

* See Barbary.

CAISSON, in the military art, a wooden chest, into which several bombs are put, and sometimes filled only with gunpowder: this is buried under some work whereof the enemy intend to possess themselves, and, when they are masters of it, is fired, in order to blow them up.

CAISSON is also used for a wooden frame or chest used in laying the foundations of the piers of a bridge.

CAITHNESS, otherwise called the *shire of Wick*, is the most northern county of all Scotland; bounded on the east by the ocean, and by Strathnaver and Sutherland on the south and south-west: from these it is divided by the mountain of Orde, and a continued ridge of hills as far as Knockfin, then by the whole course of the river Hallowdale. On the north it is washed by the Pentland or Pictland frith, which flows between this county and the Orkneys. It extends 35 miles from north to south, and about 20 from east to west. The coast is rocky, and remarkable for a number of bays and promontories. Of these, the principal are Sandside-head to the west, pointing to the opening of Pentland frith; Orcas, now Holborn-head, and Dunnet-head, both pointing northward to the frith. Dunnet-head is a peninsula about a mile broad, and seven in compass; affording several lakes, good pasture, excellent mill-stones, and a lead mine. Scribister bay, on the north-west, is a good harbour, where ships may ride securely. Rice-bay, on the east side, extends three miles in breadth; but it is of dangerous access, on account of some sunk rocks at the entrance. At the bottom of this bay appear the ruins of two strong castles, the seat of the earl of Caithness, called *Castle Sinclair*, and Gernego, joined to each other by a draw-bridge. Duncan's bay, otherwise called *Dunsby-head*, is the north-east point of Caithness, and the extremest promontory in Britain. At this place, the breadth of the frith does not exceed 12 miles, and in the neighbourhood is the ordinary ferry to the Orkneys. Here is likewise Clytheness pointing east, and Noshead pointing north-east. The sea in this place is very impetuous, being in continual agitation from violent counter tides, currents, and vortices. The only island belonging to this county is that of Stroma, in the Penthand frith, at the distance of two miles from the main land, extending about a mile in length, and producing good corn. The navigation is here rendered very difficult by conflicting tides and currents, which at both ends of the island produce a great agitation in the sea. At the south end, the waves dance so impetuously, that the sailors term them the *merry men of May*, from the name of a gentleman's seat on the opposite shore of Caithness, which served them as a land mark, in the dangerous passage between the island and the continent. The property of this island was once disputed between the earls of Orkney and Caithness; but adjudged to the latter, in consequence of an experiment, by which it appeared, that venomous creatures will live in Stroma, whereas they die immediately if transported to the Orkneys. The county of Caithness, though chiefly mountainous, flattens towards the sea coast, where the ground is arable, and produces good harvests of oats and barley, sufficient for the natives, and yielding a surplus for exportation. Caithness is well watered with small rivers, brooks, lakes, and fountains, and affords a few woods of birch, but is in general bare of trees; and even those the inhabitants plant are stunted in their growth. Lead is found at Dunnet, copper at Old Urk, and iron ore at several places; but these advantages are not improved. The air of Caithness is temperate, though in the latitude of 58°, where the longest day in summer is computed at 18 hours; and when the sun sets he makes

so

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Caithness. so small an arch of a circle below the horizon, that the people enjoy a twilight until he rises again. The fuel used by the inhabitants of Caithness consists of peat and turf, which the ground yields in great plenty. The forests of Morravins and Berridale afford abundance of red deer and roe-bucks; the county is well stored with hares, rabbits, grouse, heathcocks, plover, and all sorts of game, comprehending a bird called *snow-fleet*, about the size of a sparrow, exceedingly fat and delicious, that comes hither in large flights about the middle of February, and takes its departure in April. The hills are covered with sheep and black cattle; so numerous, that a fat cow has been sold at market for 4s. sterling. The rocks along the coasts are frequented by eagles, hawks, and all manner of sea fowl, whose eggs and young are taken in vast quantities by the natives. The rivers and lakes abound with trout, salmon, and eels; and the sea affords a very advantageous fishery. Divers obelisks and ancient monuments appear in this district, and several Romish chapels are still standing. Caithness is well peopled with a race of hardy inhabitants, who employ themselves chiefly in fishing, and breeding sheep and black cattle: they are even remarkably industrious; for between Wick and Dunbeath, one continued tract of rugged rocks, extending 12 miles, they have formed several little harbours for their fishing boats, and cut artificial steps from the beach to the top of the rocks, where they have erected houses, in which they cure and dry the fish for market.

According to Mr Pennant, this county is supposed to send out in some years about 20,000 head of black cattle, but in bad seasons the farmer kills and salts great numbers for sale. Great numbers of swine are also reared here. These are short, high-backed, long-bristled, sharp, slender, and long-nosed; have long erect ears, and most savage looks. Here are neither barns nor granaries; the corn is threshed out, and preserved in the chaff in byks; which are stacks, in the shape of bee-hives, thatched quite round, where it will keep good for two years. Vast numbers of salmon are taken at Castle-hill, Dunnet, Wick, and Thurso. A miraculous draught at this last place is still talked of, not less than 2500 being taken at one tide within the memory of man; and Mr Smollet informs us, that, in the neighbourhood, above 300 good salmon have been taken at one draught of the net. In the month of November, great numbers of seals are taken in the caverns that open into the sea, and run some hundreds of yards under ground. The entrance of these caverns is narrow, but the inside lofty and spacious. The seal hunters enter these in small boats with torches, which they light as soon as they land, and then with loud shouts alarm the animals, which they kill with clubs as they attempt to pass. This is a hazardous employment; for, should the wind blow hard from sea, these adventurers are inevitably lost. Sometimes a large species of seals, 12 feet long, have been killed on this coast; and it is said the same kind are found on the rock Hiskir, one of the Western islands. During the spring, great quantities of lump fish resort to this coast, and are the prey of the seals, as appears from the number of skins of those fishes which at that season float ashore. At certain times also the seals seem to be visited by a great mortality; for, at those times, multitudes of them are seen dead in the water. Much limestone is found in this county, which when burnt is made into a compost with turf and sea plants.

The discovery of coal has long been an object of great importance in this part of Scotland. In the years 1801 and 1802 some attempts were made for this purpose at the expence of government. But although the business was conducted by persons well skilled in such matters, and long persevered in, it has entirely failed, which leaves little hope of future success.

The following is the population of the county of Caithness, according to the parishes, taken at two different periods, namely in 1755 and in 1798, and extracted from the Statistical History of Scotland.

Parishes.	Population in 1755.	Population in 1790—98.
Bower	1287	1592
Canisby	1481	1950
Dunnet	1235	1399
Halkirk	3075	3180
Latheron	3675	4006
Olrick	875	1001
Reay	2262	2298
Thurso	2963	3146
Wattin	1424	1230
Wick	3938	5000
Total	22,215	24,802
Population in 1811,	23,419	

See Caithness, Supplement.

CAIUS, Kaye, or *Keys*, Dr John, the founder of Caius College in Cambridge, was born at Norwich in 1510. He was admitted very young a student in Gonville Hall in the above-mentioned university; and at the age of 21 translated from Greek into Latin some pieces of divinity, and into English Erasmus's paraphrase on Jude, &c. From these his juvenile labours, it seems probable that he first intended to prosecute the study of divinity. Be that as it may, he travelled to Italy, and at Padua studied physic under the celebrated Montanus. In that university he continued some time, where we are told he read Greek lectures with great applause. In 1543, he travelled through part of Italy, Germany, and France; and returning to England commenced doctor of physic at Cambridge. He practised first at Shrewsbury, and afterwards at Norwich; but removing to London, in 1547, he was admitted fellow of the college of physicians, to which he was several years president. In 1557, being then physician to Queen Mary, and in great favour, he obtained a licence to advance Gonville-hall, where he had been educated, into a college; which he endowed with several considerable estates, adding an entire new square at the expence of 1834l. Of this college he accepted the mastership, which he kept till within a short time of his death. He was physician to Edward VI. Queen Mary, and Queen Elizabeth. Towards the latter end of his life he retired to his own college at Cambridge; where, having resigned the mastership to Dr Legge of Norwich, he spent the remainder of his life as a fellow commoner. He did in July 1573, aged 63; and was buried in the chapel of his own college. Dr Caius was a

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a learned, active, benevolent man. In 1557, he erected a monument in St Paul's to the memory of the famous Linacre. In 1563, he obtained a grant for the college of physicians to take the bodies of two malefactors annually for dissection; and he was the inventor of the *insignia* which distinguish the president from the rest of the fellows. He wrote, 1. Annals of the college from 1555 to 1572. 2. Translation of several of Galen's works; printed at different times abroad. 3. *Hippocrates de Medicamentis*; first discovered and published by our author; also *De ratione victus*, Lov. 1556, 8vo. 4. *De Medendi Methodo.* Basil, 1554. Lond. 1556, 8vo. 5. Account of the sweating sickness in England. Lond. 1556, 1721. It is entitled *De ephemera Britannica.* 6. History of the university of Cambridge. Lond. 1568, 8vo. 1574, 4to. in Latin. 7. *De thermis Britannicis.* Doubtful whether ever printed. 8. Of some rare plants and animals. Lond. 1570. 9. *De canibus Britannicis*, 1570, 1729. 10. *De pronunciatione Græcæ et Latinæ Linguæ.* Lond. 1574. 11. *De libris propriis.* Lond. 1570. Besides many other works which never were printed.

CAKE, a finer sort of bread, denominated from its flat round figure.

We meet with different compositions under the name of *cakes*; as *seed-cakes*, made of flour, butter, cream, sugar, coriander, and caraway seeds, mace, and other spices and perfumes, baked in the oven; *plum-cake*, made much after the same manner, only with fewer seeds, and the addition of currants: *pan-cakes*, made of a mixture of flour, eggs, &c. fried; *cheese-cakes*, made of cream, eggs, and flour, with or without cheese-curd, butter, almonds, &c.; *oat-cakes*, made of fine oaten flour, mixed with yeast and sometimes without, rolled thin, and laid on an iron or stone to bake over a slow fire; *sugar-cakes*, made of fine sugar beaten and searced with the finest flour, adding butter, rose-water, and spices; *rose-cakes*, (*placentæ rosaceæ*), are leaves of roses dried and pressed into a mass, sold in the shops for epithems.

The Hebrews had several sorts of cakes, which they offered in the temple. They were made of the meal either of wheat or barley; they were kneaded sometimes with oil and sometimes with honey. Sometimes they only rubbed them over with oil when they were baked, or fried them with oil in a frying-pan upon the fire. In the ceremony of Aaron's consecration, they sacrificed a calf and two rams, and offered unleavened bread, and cakes unleavened, tempered with oil, and wafers unleavened, anointed with oil; the whole made of fine wheaten flour. Ex. xxix. 1, 2.

CAKET, a town of Asia, in Persia, in the province of Curdistan near Mount Caucasus. Its trade consists chiefly in silks. E. Long. 46. 15. N. Lat. 43. 32.

CALABASH, in *Commerce*, a light kind of vessel formed of the shell of a gourd, emptied and dried, serving to put divers kinds of goods in, as pitch, rosin, and the like. The word in Spanish, *Calabacca*, which signifies the same. The Indians also, both of the North and South sea, put the pearls they have fished in calabashes, and the negroes on the coast of Africa do the same by their gold dust. The smaller calabashes are also frequently used by these people as a measure, by which they sell these precious commodities to the Europeans. The same vessels likewise serve for putting liquors in; and do the office of cups, as well as bottles, for soldiers, pilgrims, &c.

Calabash-Tree. See Crescentia, Botany *Index*.

African Calabash-Tree. See Adansonia, Botany *Index*.

CALABRIA, a country of Italy, in the kingdom of Naples, divided into Calabria Ultra and Calabria Citra, commonly called *Ulterior* and *Citerior*, or Farther and Hither Calabria. Calabria Citerior is one of the 12 provinces of the kingdom of Naples; and bounded on the south by Calabria Ultra, on the north by Basilicata, and on the west and east by the sea: Cosensa is the capital. Calabria Ultra is washed by the Mediterranean sea on the east, south, and west, and bounded by Calabria Citra on the north. Reggio is the capital town.

This country has been almost entirely desolated by the earthquakes of 1783. The reiterated shocks extended from Cape Spartivento to Amantea above the gulf of St Eufemia, and also affected that part of Sicily which lies opposite to the southern extremity of Italy. Those of the 5th and 7th of February, and of the 28th of March, were the most violent, and completed the destruction of every building throughout the above-mentioned space. Not one stone was left upon another south of the narrow isthmus of Squillace: and what is more disastrous, a very large proportion of the inhabitants was killed by the falling of their houses, near 40,000 lives being lost. Some persons were dug out alive after remaining a surprising length of time buried among the rubbish. Messina became a mass of ruins; its beautiful palazzata was thrown in upon the town, and its quay cracked into ditches full of water. Reggio was almost destroyed; Tropea greatly damaged; and every other place in the province levelled to the ground.

Before and during the concussion the clouds gathered, and then hung immoveable and heavy over the earth. At Palmi the atmosphere wore so fiery an aspect, that many people thought part of the town was burning. It was afterwards remembered that an unusual heat had affected the skins of several persons just before the shock; the rivers assumed a muddy ash-coloured tinge, and a sulphureous smell was almost general. A frigate passing between Calabria and Lipari felt so severe a shock, that the steersman was thrown from the helm, and the cannons were raised upon their carriages, while, all around, the sea exhaled a strong smell of brimstone.

Stupendous alterations were occasioned in the face of the country; rivers, choked up by the falling in of the hills, were converted into lakes, which if not speedily drained by some future convulsion, or opened by human labour, will fill the air with pestilential vapours, and destroy the remnants of population. Whole acres of ground, with houses and trees upon them, were broken off from the plains, and washed many furlongs down the deep hollows which the course of the rivers had worn; there, to the astonishment and terror of beholders, they found a new foundation to fix upon, either in an upright or an inclining position. In short, every species of phenomenon, incident to these destructive commotions of the earth, was to be seen in its utmost extent and variety in this desolated country. Their Sicilian majesties, with the utmost expedition, dispatched

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patched vessels loaded with every thing that could be thought of on the occasion for the relief and accommodation of the distressed Calabrians; a general officer went from Naples with engineers and troops to direct the operations of the persons employed in clearing away and rebuilding the houses, and to defend the property of the sufferers. The king ordered this officer to take all the money the royal treasures could supply or borrow; for, rather than it should be wanting on this pressing call, he was determined to part with his plate, nay the very furniture of his palace. A messenger sent off from a town near Reggio, on the 8th of February, travelled four days without shelter, and without being able to procure a morsel of bread; he supported nature with a piece of cheese which he had brought in his pocket, and the vegetables he was lucky enough to find near the road. To add to all their other sufferings, the Calabrians found themselves and the miserable wreck of their fortunes exposed to the depredations of robbers and pirates. Villains landed from boats and plundered several places, and thieves went even from Naples in search of booty: In order to strike a greater terror, they dressed themselves like Algerines; but were discovered and driven off. To this accumulated distress succeeded a most inclement season, which obstructed every effort made to alleviate it; and almost daily earthquakes kept the inhabitants in continual dread, not of being destroyed by the fall of houses, for none were left, but of being swallowed up by the splitting of the earth, or buried in the waves by some sudden inundation.

The two Calabrias in 1815 contained 750,000 inhabitants.

CALADE, in the manege, the descent or sloping declivity of a rising manege ground, being a small eminence upon which we ride down a horse several times, putting him to a short gallop, with his fore hams in the air, to learn him to ply or bend his haunches, and form his stop upon the aides of the calves of the legs, the stay of the bridle, and the caveson seasonably given.

CALAGORINA, or CALAGURIS, distinguished by the surname *Nasica*, in *Ancient Geography*, a city of the Vascones in the Hither Spain: now *Calahorra*.

CALAHORRA, an episcopal town of Spain, in Old Castile, seated on a fertile soil, on the side of a hill which extends to the banks of the river Ebro. W. Long. 2. 7. N. Lat. 42. 12.

CALAIS, a strong town of France, in Lower Picardy, now called the department of the Straits of Calais, which has a citadel and a fortified harbour. It is built in the form of a triangle, one side of which is towards the sea. The citadel is as large as the town, and has but one entrance. It is a trading place, with handsome streets, and several churches and monasteries; the number of inhabitants in 1813 was 7600.

Calais was taken by Edward III. in 1347. Hither he marched his victorious army from Cressy, and invested the town on the 8th of September. But finding that it could not be taken by force without the destruction of great multitudes of his men, he turned the siege into a blockade; and having made strong intrenchments to secure his army from the enemy, huts to protect them from the inclemency of the weather, and stationed a fleet before the harbour to prevent the introduction of provisions, he resolved to wait with patience till the place fell into his hands by famine. The besieged, discovering his intention, turned seventeen hundred women, children, and old people, out of the town, to save their provisions; and Edward had the goodness, after entertaining them with a dinner, and giving them two-pence a piece, to suffer them to pass. The garrison and inhabitants of Calais having at length consumed all their provisions, and even eaten all the horses, dogs, cats, and vermin in the place, the governor John de Vienne appeared upon the walls, and offered to capitulate. Edward greatly incensed at their obstinate resistance, which had detained him eleven months under their walls, at an immense expence both of men and money, sent Sir Walter Mauny, an illustrious knight, to acquaint the governor that he would grant them no terms; but that they must surrender at discretion. At length, however, at the spirited remonstrances of the governor, and the persuasions of Sir Walter Mauny, Edward consented to grant their lives to all the garrison and inhabitants, except six of the principal burgesses, who should deliver to him the keys of the city, with ropes about their necks. When these terms were made known to the people of Calais, they were plunged into the deepest distress; and after all the miseries they had suffered, they could not think without horror of giving up six of their fellow citizens to certain death. In this extremity, when the whole people were drowned in tears, and uncertain what to do, Eustace de St Pierre, one of the richest merchants in the place, stepped forth, and voluntarily offered himself to be one of these six devoted victims. His noble example was soon imitated by other five of the most wealthy citizens. These true patriots, barefooted and bareheaded, with ropes about their necks, were attended to the gates by the whole inhabitants with tears, blessings, and prayers for their safety. When they were brought into Edward's presence, they laid the keys of the city at his feet, and falling on their knees, implored his mercy in such moving strains, that all the noble spectators melted into tears. The king's resentment was so strong for the many toils and losses he had suffered in this tedious siege, that he was in some danger of forgetting his usual humanity; when the queen, falling upon her knees before him, earnestly begged and obtained their lives. This great and good princess conducted these virtuous citizens, whose lives she had saved, to her own apartment, entertained them honourably, and dismissed them with presents. Edward took possession of Calais, August 4.; and in order to secure a conquest of so great importance, and which had cost him so dear, he found it necessary to turn out all the ancient inhabitants, who had discovered so strong an attachment to their native prince, and to people it with English.

Calais remained in subjection to England till the reign of Queen Mary, when it was retaken by the duke of Guise. This general began the enterprise by ordering the privateers of Normandy and Bretagne to cruise in the Channel, more especially in the very straits of Calais; he then detached the duke of Nevers with a

Calais. a considerable army towards the country of Luxemburg; a motion which drew the attention of the Spaniards that way: when all things were ready, he procured an application from the people of Boulogne, for a body of troops to secure them against the incursions of the Spaniards; he sent a strong detachment at their request, which was followed by another, under colour of supporting them; then repaired thither in person, secure that his officers would follow his instructions: and thus, on the first day of the new year, 1557, Calais was invested. He immediately attacked Fort St Agatha, which the garrison quitted and retired into the fort of Nicolai, which, together with the Risbank, the besiegers attacked at the same time, granted good terms to the officer who commanded in the former, but obliged the garrison of the latter to surrender prisoners of war. By these means he opened a communication with the sea: and having received from on board the ships an immense quantity of hurdles, his infantry, by the help of them, passed the morasses that lie round the town. He then made a false attack at the water-gate, which drew the attention of the garrison, who fatigued themselves exceedingly in making intrenchments behind the breach; but when they had finished their work, he began to fire upon the castle, where the walls were very old, and had been neglected on account of the breadth of the ditch, which was also very deep when the tide was in; but a great breach being made, the duke caused it to be attacked in the night, and during the ebb, the soldiers passing almost up to the shoulders. The place was easily carried, though the governor made three vigorous attacks before the break of day, in order to dislodge them; but the French, though they lost a considerable number of men, kept their posts. The governor then saw that it was impracticable to defend the place any longer, and therefore made the best terms for himself that he could obtain, which, however, were not very good: and thus, in eight days, the duke of Guise recovered a fortress which cost the victorious Edward III. a whole year's siege, and which had been now 210 years in the possession of the English, without so much as a single attempt to retake it. There are very different accounts given of this matter. Some English historians say, that King Philip penetrated the design of the French upon this fortress, gave notice of it in England, and offered to take the defence of it upon himself; but that this, out of jealousy, was refused, it being believed to be only an artifice to get a place of such consequence into his own hands. The truth of the matter seems to be this: The strength of Calais consisted in its situation and outworks, which required a very numerous garrison; but this being attended with a very large expence, the best part of the troops had been sent to join Philip's army, so that the governor had not above 500 men, and there were no more than 250 of the townsmen able to bear arms. As to ammunition, artillery, and provisions, the French found there abundance: but with so slender a garrison, it was impossible to make a better defence; and therefore when the Lord Wentworth, who was governor, and whom the French call Lord Dumfort, was tried by his peers for the loss of this place, he was acquitted. The duke obliged all the English inhabitants to quit Calais; and bestowed the government of it upon Des Tormes, who was soon after made a marshal of France.

Calais ‖ Calamine.

The fortifications of Calais are good; but its greatest strength is its situation among the marshes, which may be overflowed at the approach of an enemy. The harbour is not so good as formerly, nor will it admit vessels of any great burden. In times of peace, there are packet boats going backward and forward twice a week from Dover to Calais, which is 21 miles distant. E. Long. 2. 6. N. Lat. 50. 58.

CALAIS *and Zetes*, in fabulous history, sons of Boreas and Orythia, to whom the poets attributed wings: they went on the voyage to Colchis with the Argonauts; delivered Phineus from the harpies; and were slain by Hercules.

CALAMANCO, a sort of woollen stuff manufactured in England and Brabant. It has a fine gloss; and is checkered in the warp, whence the checks appear only on the right side. Some calamancoes are quite plain, others have broad stripes adorned with flowers, some with plain broad stripes, some with narrow stripes, and others watered.

CALAMARIÆ, in *Botany*, an order of plants in the *Fragmenta methodi naturalis* of Linnæus; in which he has the following genera, viz. bobartia, scirpus, cyperus, eriophorum, carex, schœnus, flagellaria, juncus. See BOTANY.

CALAMATA, a considerable town of Turkey in Europe, in the Morea, and province of Belvedera. It was taken by the Venetians in 1685: but the Turks retook it afterwards with all the Morea. It stands on the river Spinarza, eight miles from the sea. E. Long. 22. 15. N. Lat. 37. 8.

CALAMINE, CALAMY, *Lapis Calaminaris* or *Cadmia Fossilis*, a sort of stone or mineral containing zinc, iron, and sometimes other substances. It is considerably heavy; moderately hard and brittle, or of a consistence betwixt stone and earth: the colour sometimes whitish or grey; sometimes yellowish, or of a deep yellow; sometimes red; sometimes brown or blackish. It is plentiful in several places of Europe, as Hungary, Transylvania, Poland, Spain, Sweden, Bohemia, Saxony, Goslar, France, and England, particularly in Derbyshire, Gloucestershire, Nottinghamshire, and Somersetshire, as also in Wales. The calamine of England, however, is by the best judges allowed to be superior in quality to that of most other countries. It seldom lies very deep, being chiefly found in clayey grounds near the surface. In some places it is mixed with lead ores. It is a true ore of zinc, and is used as an ingredient in making of brass.—Newman relates various experiments with this mineral, the only result of which was to show that it contained iron as well as zinc. The most remarkable are the following: A saturated solution of calamine in the marine acid, concentrated by evaporating part of the liquor, exhibits in the cold an appearance of fine crystals, which on the application of warmth dissolve and disappear. A little of this concentrated solution tinges a large quantity of water of a bright yellow colour; and at the same time deposites by degrees a fine, spongy, brownish precipitate. Blue dissolved in this solution, and afterwards inspissated, forms an extremely slippery tenacious mass, which does not become dry, and, were it not too expensive, might be of use for entangling flies, caterpillars, &c. Sulphur boiled in this solution seems to acquire some degree of

 transparency.

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transparency.—This mineral is an article in the materia medica: but before it comes to the shops is usually roasted or calcined, in order to separate some arsenical or sulphureous matter which in its crude state it is supposed to contain, and to render it more easily reducible into a fine powder. In this state it is employed in collyria against defluxions of thin acrid humours upon the eyes, for drying up moist running ulcers, and healing excoriations. It is the basis of an officinal epulotic CERATE.

There is another substance from which this semi-metal is also obtained. This is called *cadmia fornacum* or *cadmia of the furnaces*, to distinguish it from the other. This is a matter sublimed when ores containing zinc, like those of Rammelsberg, are smelted. This cadmia consists of the flowers of the semi-metal sublimed during the fusion, and adhering to the inner surfaces of the walls of furnaces, where they suffer a semi-fusion, and therefore acquire some solidity. So great a quantity of these is collected, that they form very thick incrustations, which must be frequently taken off.

CALAMINT. See MELISSA and MENTHA, BOTANY *Index*.

CALAMUS. See BOTANY *Index*. There is but one species, the rotang. The stem is without branches, has a crown at top, and is everywhere beset with straight spines. This is the true Indian cane, which is not visible on the outside; but the bark being taken off discovers the smooth stick, which has no marks of spine on the bark, and is exactly like those which the Dutch sell to us; keeping this matter very secret, lest travellers going by should take as many canes out of the woods as they please. Sumatra is said to be the place where most of these sticks grow. Such are to be chosen as are of proper growth between two joints suitable to the fashionable length of canes as they are then worn; but such are scarce. The calamus rotang is one of several plants from which the drug called *dragons blood* is obtained.

CALAMUS, in the ancient poets, denotes a simple kind of pipe or fistula, the musical instrument of the shepherds and herdsmen; usually made either of an oaten stalk or a reed.

CALAMUS *Aromaticus*, or *Sweet-scented Flag*, in the materia medica, a species of flag called *acorus* by Linnæus. See ACORUS, BOTANY *Index*.

CALAMUS *Scriptorius*, in antiquity, a reed or rush to write with. The ancients made use of styles to write on tables covered with wax; and of reed or rush, to write on parchment, or Egyptian paper.

CALAMY, EDMUND, an eminent Presbyterian divine, born at London in the year 1600, and educated at Pembroke-hall, Cambridge, where his attachment to the Arminian party excluded him from a fellowship. Dr Felton, bishop of Ely, however, made him his chaplain; and in 1639, he was chosen minister of St Mary Aldermary, in the city of London. Upon the opening of the long parliament, he distinguished himself in defence of the presbyterian cause; and had a principal hand in writing the famous *Smectymnus*, which, himself says, gave the first deadly blow to Episcopacy. The authors of this tract were five, the initials of whose names formed the name under which it was published; viz. Stephen Marshal, Edmund Calamy, Thomas Young, Mathew Newcomen, and William Spurstow. He was after that an active member in the assembly of divines, was a strenuous opposer of sectaries, and used his utmost endeavours to prevent those violences committed after the king was brought from the isle of Wight. In Cromwell's time he lived privately, but was assiduous in promoting the king's return; for which he was afterwards offered a bishopric, but refused it. He was ejected for nonconformity in 1662; and died of grief at the sight of the great fire of London.

CALAMY, *Edmund*, grandson to the preceding, (by his eldest son, Mr Edmund Calamy, who was ejected from the living of Moxton in Essex on St Bartholomew's day 1662) was born in London, April 5. 1671. After having learned the languages, and gone through a course of natural philosophy and logic at a private academy in England, he studied philosophy and civil law at the university of Utrecht, and attended the lectures of the learned Grævius. Whilst he resided here, an offer of a professor's chair in the university of Edinburgh was made him by Mr Carstairs, principal of that university, sent over on purpose to find a person properly qualified for such an office. This he declined; and returned to England in 1691, bringing with him letters from Grævius to Dr Pococke, canon of Christchurch, and regius professor of Hebrew, and to Dr Bernard, Savilian professor of astronomy, who obtained leave for him to prosecute his studies in the Bodleian library. Having resolved to make divinity his principal study, he entered into an examination of the controversy between the conformists and nonconformists; which determined him to join the latter; and coming to London in 1692, he was unanimously chosen assistant to Mr Matthew Sylvester at Blackfriars: and in 1694, he was ordained at Mr Annesley's meeting-house in Little St Helena, and soon after was invited to become assistant to Mr Daniel Williams in Hand-Alley. In 1702, he was chosen to be one of the lecturers in Salters-hall; and in 1703, succeeded Mr Vincent Alsop as pastor of a great congregation in Westminster. He drew up the table of contents to Mr Baxter's history of his life and times, which was sent to the press in 1696; made some remarks on the work itself, and added to it an index; and, reflecting on the usefulness of the book, he saw the expediency of continuing it, for Mr Baxter's history came no lower than the year 1684. Accordingly he composed an abridgement of it, with an account of many other ministers who were ejected after the restoration of Charles II.; their apology, containing the grounds of their nonconformity and practice as to stated and occasional communion with the church of England; and a continuation of their history till the year 1691. This work was published in 1702. He afterwards published a moderate defence of nonconformity, in three tracts, in answer to some tracts of Dr Hoadley. In 1709 Mr Calamy made a tour to Scotland; and had the degree of doctor of divinity conferred on him by the universities of Edinburgh, Aberdeen, and Glasgow. In 1713, he published a second edition of his Abridgement of Mr Baxter's history of his life and times; in which, among other additions, there is a continuation of the history through King William's reign, and Queen Anne's, down to the passing of the occasional bill; and in the close is subjoined the reformed liturgy, which was drawn

drawn up and presented to the bishops in 1661, "that the world may judge (he says in his preface) how fairly the ejected ministers have been often represented as irreconcileable enemies to all liturgies." In 1718, he wrote a vindication of his grandfather, and several other persons, against certain reflections cast upon them by Mr Archdeacon Echard in his History of England; and in 1728 appeared his Continuation of the account of the ministers, lecturers, masters, and fellows of colleges, and schoolmasters, who were ejected, after the Restoration in 1660, by or before the act of uniformity. He died June 3. 1732, greatly regretted not only by the dissenters, but also by the moderate members of the established church, both clergy and laity, with many of whom he lived in great intimacy. Besides the pieces already mentioned, he published a great many sermons on several subjects and occasions. He was twice married, and had 13 children.

CALANDRE, a name given by the French writers to an insect that does vast mischief in granaries. It is properly of the scarab or beetle class; it has two antennæ or horns formed of a great number of round joints, and covered with a soft and short down; from the anterior part of the head there is thrust out a trunk, which is so formed at the end, that the creature easily makes way with it through the coat or skin that covers the grain, and gets at the meal or farina on which it feeds; the inside of the grains is also the place where the female deposites her eggs, that the young progeny may be born with provision about them. When the female has pierced a grain of corn for this purpose, she deposites in it one egg, or at the utmost two, but she most frequently lays them single: these eggs hatch into small worms, which are usually found with their bodies rolled up in a spiral form, and after eating till they arrive at their full growth, they are changed into chrysales, and from these in about a fortnight comes out the perfect calandre. The female lays a considerable number of eggs; and the increase of these creatures would be very great, but nature has so ordered it, that while in the egg state, and even while in that of the worm, they are subject to be eaten by mites: these little vermin are always very plentiful in granaries, and they destroy the far greater number of these larger animals.

CALAS, John, the name of a most unfortunate Protestant merchant at Thoulouse, inhumanly butchered under forms of law cruelly prostituted to shelter the sanguinary dictates of ignorant Popish zeal. He had lived 40 years at Thoulouse. His wife was an English woman of French extraction; and they had five sons; one of whom, Lewis, had turned Catholic through the persuasions of a Catholic maid who had lived 30 years in the family. In October 1761, the family consisted of Calas, his wife, Mark Antony their son, Peter their second son, and this maid. Antony was educated for the bar; but being of a melancholy turn of mind, was continually dwelling on passages from authors on the subject of suicide, and one night in that month hanged himself on a bar laid across two folding doors in their shop. The crowd collected by the confusion of the family on so shocking a discovery, took it into their heads that he had been strangled by the family to prevent his changing his religion, and that this was a common practice among Protestants. The officers of justice adopted the popular tale, and were supplied by the mob with what they accepted as evidences of the fact. The fraternity of White Penitents got the body, buried it with great ceremony, and performed a solemn service for him as a martyr: the Franciscans did the same; and after these formalities no one doubted the guilt of the devoted heretical family. They were all condemned to the torture, to bring them to confession: they appealed to the parliament; who, as weak and as wicked as the subordinate magistrates, sentenced the father to the torture, ordinary and extraordinary, to be broken alive upon the wheel, and then to be burnt to ashes. A diabolical decree! which, to the shame of humanity, was actually carried into execution. Peter Calas, the other son was banished for life; and the rest were acquitted. The distracted widow found some friends, and among the rest M. Voltaire, who laid her case before the council of state at Versailles, and the parliament of Thoulouse was ordered to transmit the proceedings. These the king and council unanimously agreed to annul; the capitoul or chief magistrate of Thoulouse was degraded and fined; old Calas was declared to have been innocent; and every imputation of guilt was removed from the family, who also received from the king and clergy considerable gratuities.

CALASH, or Calesh, a small light kind of chariot or chair, with very low wheels, used chiefly for taking the air in parks and gardens. The calash is for the most part richly decorated, and open on all sides for the conveniency of the air and prospect, or at most enclosed with light mantlets of wax-cloth to be opened and shut at pleasure. In the Philosophical Transactions we have a description of a new sort of calash going on two wheels, not hung on traces, yet easier than the common coaches, over which it has this further advantage, that whereas a common coach will overturn if one wheel go on a surface a foot and a half higher than the other, this will admit of a difference of $3\frac{1}{2}$ feet without danger of overturning. Add, that it would turn over and over; that is, after the spokes being so turned as that they are parallel to the horizon, and one wheel flat over the head of him that rides in it, and the other flat under him, it will turn once more, by which the wheels are placed *in statu quo*, without any disorder to the horse or rider.

CALASIO, Marius, a Franciscan, and professor of the Hebrew language at Rome, of whom there is very little to be said, but that he published there, in the year 1621, a Concordance of the Bible, which consisted of four great volumes in folio. This work has been highly approved and commended both by Protestants and Papists, and is indeed a most admirable work. For besides the Hebrew words in the Bible, which are in the body of the book, with the Latin version over against them; there are, in the margin, the differences between the Septuagint version and the Vulgate; so that at one view may be seen wherein the three Bibles agree, and wherein they differ. Moreover, at the beginning of every article there is a kind of dictionary, which gives the signification of each Hebrew word; affords an opportunity of comparing it with other oriental languages, viz. with the Syriac, Arabic, and Chaldee; and is extremely useful for

for determining more exactly the true meaning of the Hebrew words.

CALASIRIS, in antiquity, a linen tunic fringed at the bottom, and worn by the Egyptians under a white woollen garment: but this last they were obliged to pull off when they entered the temples, being only allowed to appear there in linen garments.

CALATAJUD, a large and handsome town of Spain, in the kingdom of Arragon; situated at the confluence of the rivers Xalon and Xiloca, at the end of a very fertile valley, with a good castle on a rock. W. Long. 2. 9. N. Lat. 41. 22.

CALATHUS, in antiquity, a kind of hand basket made of light wood or rushes; used by the women sometimes to gather flowers, but chiefly after the example of Minerva to put their work in. The figure of the calathus, as represented on ancient monuments, is narrow at the bottom, and widening upwards like that of a top. Pliny compares it to that of a lily. The calathus or work basket of Minerva is no less celebrated among the poets than her distaff.

Calathus was also the name of a cup for wine used in sacrifices.

CALATOR, in antiquity, a crier, or officer appointed to publish something aloud, or call the people together. The word is formed from καλεω, *voco*, "I call." Such ministers the pontifices had, whom they used to send before them when they went to sacrifice on *feriæ* or holidays, to advertise the people to leave off work. The magistrates also used *calatores*, to call the people to the comitia, both *curiata* and *centuriata*. The officers in the army also had *calatores*; as had likewise many private families, to invite their guests to entertainments.

CALATRAVA, a city of New Castile, in Spain, situated on the river Guadiana, 45 miles south of Toledo. W. Long. 4. 20. N. Lat. 39. 0.

Knights of Calatrava, a military order in Spain, instituted by Sancho III. king of Castile, upon the following occasion: When that prince took the strong fort of Calatrava from the Moors of Andalusia, he gave it to the Templars, who, wanting courage to defend it, returned it him again. Then Don Reymond of the order of the Cistercians, accompanied with several persons of quality, made an offer to defend the place, which the king thereupon delivered up to them, and instituted that order. It increased so much under the reign of Alphonsus, that the knights desired they might have a grand master, which was granted. Ferdinand and Isabella afterwards, with the consent of Pope Innocent VIII. reunited the grand mastership of Calatrava to the Spanish crown; so that the kings of Spain are now become perpetual administrators thereof.

The knights of Calatrava bear a cross gules, fleurdelised with green, &c. Their rule and habit was originally that of the Cistercians.

CALAURIA, in *Ancient Geography*, an island of Greece in the Saronic bay, over against the port of Troezen, at the distance of 40 stadia. Hither Demosthenes went twice into banishment; and here he died. Neptune was said to have accepted this island from Apollo, in exchange for Delos. The city stood on a high ridge nearly in the middle of the island, commanding an extensive view of the gulf and its coasts. There was his holy temple. The priestess was a virgin, who was dismissed when marriageable. Seven of the cities near the island held a congress at it, and sacrificed jointly to the deity. Athens, Ægina, and Epidaurus, were of this number, with Nauplias, for which place Argos contributed. The Macedonians, when they had reduced Greece, were afraid to violate the sanctuary, by forcing from it the fugitives, his suppliants. Antipater commanded his general to bring away the orators, who had offended him, alive; but Demosthenes could not be prevailed on to surrender. His monument remained in the second century, within the enclosure of the temple. The city of Calauria has been long abandoned. Traces of buildings and of ancient walls appear nearly level with the ground; and some stones, in their places, each with a seat and back forming a little circle, once perhaps a bath. The temple, which was of the Doric order, and not large, as may be inferred from the fragments, is reduced to an inconsiderable heap of ruins. The island is now called *Poro*. It stretches along before the coast of the Morea in a lower ridge, and is separated from it by a canal only four stadia, or half a mile wide. This, which is called Poro or the Ferry, in still weather may be passed on foot, as the water is not deep. It has given its name to the island; and also to the town, which consists of about 200 houses, mean and low, with flat roofs; rising on the slope of a bare disagreeable rock.

CALCADA or *St Domingo* Calcalda, a town of Spain, situated in W. Long. 3. 5. N. Lat. 42. 36.

CALCAR, a very strong town of Germany, in the circle of Westphalia, and duchy of Cleves. It belongs to the king of Prussia, and is seated near the Rhine, in E. Long. 5. 51. N. Lat. 41. 45.

Calcar, in glass-making, the name of a small oven or reverberatory furnace, in which the first calcination of sand and salt of potashes is made for the turning them into what is called *frit*. This furnace is made in the fashion of an oven, ten feet long, seven broad in the widest part, and two feet deep. On one side of it is a trench six inches square, the upper part of which is level with the calcar, and separated only from it at the mouth by bricks nine inches wide. Into this trench they put sea-coal, the flame of which is carried into every part of the furnace, and is reverberated from the roof upon the frit, over the furnace of which the smoke flies very black, and goes out at the mouth of the calcar; the coals burn on iron grates, and the ashes fall through.

Calcar, *John de*, a celebrated painter, was the disciple of Titian, and perfected himself by studying Raphael. Among other pieces he drew a Nativity, representing the angels around the infant Christ; and so ordered the disposition of his picture, that the light all proceeds from the child. He died at Naples, in 1546, in the flower of his age. It was he who designed the anatomical figures of Vesal, and the portraits of the painters of Vesari.

CALCAREOUS, something that partakes of the nature and qualities of calx, or lime. We say, a *calcareous* earth, *calcareous* stone. See Chemistry *Index*.

CALCEARIUM, in antiquity, a donative or largess

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ges bestowed on Roman soldiers for buying shoes. In monasteries, *calcearium* denoted the daily service of cleaning the shoes of the religious.

CALCEOLARIA. See BOTANY *Index*.

CALCHAS, in fabulous history, a famous diviner, followed the Greek army to Troy. He foretold that the siege would last ten years; and that the fleet, which was detained in the port of Aulis by contrary winds, would not sail till Agamemnon's daughter had been sacrificed to Diana. After the taking of Troy, he retired to Colophon; where, it is said, he died of grief, because he could not divine what another of his profession, called *Mopsus*, had discovered.

CALCINATION, in *Chemistry*, the reducing of substances to a calx, or powder, by fire. Limestone is said to be calcined or burned by being deprived of its carbonic acid, and thus brought to the caustic state. But when a metallic substance is calcined by being exposed to strong heat, it assumes the form of powder or calx, by combining with oxygen. See CHEMISTRY *Index*.

CALCINATO, a town of Italy, in the duchy of Mantua, remarkable for a victory gained over the Imperialists by the French in 1706. E. Long. 9. 55. N. Lat. 45. 25.

CALCULARY *of a* PEAR, a congeries of little strong knots dispersed through the whole parenchyma of the fruit. The calculary is most observed in rough-tasted or choke pears. The knots lie more continuous and compact together towards the part where they surround the ACETARY. About the stalk they stand more distant; but towards the cork, or stool of the flower, they still grow closer, and there at last gather into the firmness of a plum stone. The calculary is no vital or essential part of the fruit; the several knots whereof it consists being only so many concretions or precipitations out of the sap, as we see in urines, wines, and other liquors.

CALCULATION, the act of computing several sums, by adding, subtracting, multiplying, or dividing. See ARITHMETIC.

CALCULATION is more particularly used to signify the computations in astronomy and geometry, for making tables of logarithms, ephemerides, finding the time of eclipses, &c. See ASTRONOMY, GEOMETRY, and LOGARITHMS.

CALCULUS, primarily denotes a little stone or pebble, anciently used in making computations, taking of suffrages, playing at tables, and the like. In after times, pieces of ivory, and counters struck of silver, gold, and other matters, were used in lieu thereof, but still retaining the ancient names. Computists were by the lawyers called *calculones*, when they were either slaves, or newly freed men; those of a better condition were named *calculatores* or *numerarii;* ordinarily there was one of these in each family of distinction. The Roman judges anciently gave their opinions by calculi, which were white for absolution, and black for condemnation. Hence *calculus albus*, in ancient writers, denotes a favourable vote, either in a person to be absolved and acquitted of a charge, or elected to some dignity or post; as *calculus niger* did the contrary. This usage is said to have been borrowed from the Thracians, who marked their happy or prosperous days by *white*, and their unhappy by *black*, pebbles, put each night into an urn.

Besides the diversity of colour, there were some calculi also which had figures or characters engraven on them, as those which were in use in taking the suffrages both in the senate and at assemblies of the people. These calculi were made of thin wood, polished and covered over with wax. Their form is still seen in some medals of the Cassian family; and the manner of casting them into the urns, in the medals of the Licinian family. The letters marked upon these calculi were U. R. for *uti rogas*, and A. for *antiquo;* the first of which expressed an approbation of the law, the latter a rejection of it. Afterwards the judges who sat in capital causes used calculi marked with the letter A. for *absolvo;* C. for *condemno;* and N. L. for *non liquet*, signifying that a more full information was required.

CALCULUS is also used in ancient geometric writers for a kind of weight equal to two grains of cicer. Some make it equivalent to the siliqua, which is equal to three grains of barley. Two calculi made the ceratium.

CALCULUS, in *Mathematics*, is a certain method of performing investigations and resolutions, particularly in mechanical philosophy. Thus there is the *Differential* calculus, the *Exponential*, the *Integral*, the *Literal*, and the *Antecedental*.

CALCULUS *Differentialis*, is a method of differencing quantities, or of finding an infinitely small quantity, which being taken infinite times, shall be equal to a given quantity; or, it is the arithmetic of the infinitely small differences of variable quantities.

The foundation of this calculus is an infinitely small quantity, or an infinitesimal, which is a portion of a quantity incomparable to that quantity, or that is less than any assignable one, and therefore accounted as nothing; the error accruing by omitting it being less than any assignable one. Hence two quantities, only differing by an infinitesimal, are reputed equal. Thus, in astronomy, the diameter of the earth is an infinitesimal, in respect of the distance of the fixed stars; and the same holds in abstract quantities. The term, infinitesimal, therefore, is merely respective, and involves a relation to another quantity; and does not denote any real ens or being. Now infinitesimals are called *differentials*, or *differential quantities*, when they are considered as the differences of two quantities. Sir Isaac Newton calls them *moments;* considering them as the momentary increments of quantities, v. g. of a line generated by the flux of a point, or of a surface by the flux of a line. The differential calculus, therefore, and the doctrine of fluxions, are the same thing under different names; the former given by M. Leibnitz, and the latter by Sir Isaac Newton: each of whom lays claim to the discovery. There is, indeed, a difference in the manner of expressing the quantities resulting from the different views wherein the two authors consider the infinitesimals: the one as moments, the other as differences. Leibnitz, and most foreigners, express the differentials of quantities by the same letters as variable ones, only prefixing the letter d: thus the differential of x is called dx: and that of y, dy: now dx is a positive quantity, if x continually increase; negative, if it decrease. The English, with Sir Isaac Newton,

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Calculus.

Newton, instead of dx write $\dot{x}$ (with a dot over it), for dy, $\dot{y}$, &c. which foreigners object against, on account of that confusion of points, which they imagine arises when differentials are again differenced; besides, that the printers are more apt to overlook a point than a letter. Stable quantities being always expressed by the first letters of the alphabet $da=o$, $db=o$, $dc=o$; wherefore $d\,(x+y-a)=dx+dy$, and $d\,(x-y+a=dx+dy$. So that the differencing of quantities is easily performed by the addition or subtraction of their compounds.

To difference quantities that multiply each other; the rule is, first, multiply the differential of one factor into the other factor, the sum of the two factors is the differential sought: thus, the quantities being x, y, the differential will be $x\,dy+y\,dx$, i. e. $d\,(xy)=x\,dy+y\,dx$. Secondly, If there be three quantities mutually multiplying each other, the factum of the two must then be multiplied into the differential of the third; thus suppose vxy, let $vx=t$, then $vxy=ty$; consequently $d\,(vxy)=t\,dy+y\,dt$: but $dt=v\,dx+x\,dv$. These values, therefore, being substituted in the antecedent differential, $t\,dy+y\,dt$, the result is, $d\,(vxy)=vx\,dy+vy\,dx+xy\,dv$. Hence it is easy to apprehend how to proceed where the quantities are more than three. If one variable quantity increase, while the other y decreases, it is evident $y\,dx-x\,dy$ will be the differential of xy.

To difference quantities that mutually divide each other; the rule is, first, multiply the differential of the divisor into the dividend; and, on the contrary, the differential of the dividend into the divisor: subtract the last product from the first, and divide the remainder by the square of the divisor, the quotient is the differential of the quantities mutually dividing each other. See FLUXIONS.

CALCULUS *Exponentialis*, is a method of differencing exponential quantities, or of finding and summing up the differentials or moments of exponential quantities; or at least bringing them to geometrical constructions.

By exponential quantity, is here understood a power, whose exponent is variable; v. g. x^x. a^x. x^y. where the exponent x does not denote the same in all the points of a curve, but in some stands for 2, in others for 3, in others for 5, &c.

To difference an exponential quantity; there is nothing required but to reduce the exponential quantities to logarithmic ones; which done, the differencing is managed as in logarithmic quantities. Thus, suppose the differential of the exponential quantity x^y required, let

$$x^y=z$$

$$\text{Then will } y\,lx=lz$$

$$lx\,dy+\frac{y\,dx}{x}=\frac{dz}{z}$$

$$lx\,dy+\frac{zy\,dx}{x}=dz$$

That is, $x^y\,lx\,dy+x^{y-1}dx=dz$.

CALCULUS *Integralis*, or *Summatorius*, is a method of integrating, or summing up moments, or differential quantities; i. e. from a differential quantity given, to find the quantity from whose differencing the given differential results.

The integral calculus, therefore, is the inverse of the differential one; whence the English, who usually call the differential method *fluxions*, give this *calculus*, which ascends from the fluxions, to the flowing or variable quantities; or, as foreigners express it, from the differences to the sums, by the name of the *inverse method of fluxions*.

Hence, the integration is known to be justly performed, if the quantity found, according to the rules of the differential calculus, being differenced, produce that proposed to be summed.

Suppose s the sign of the sum, or integral quantity, then $s\,y\,dx$ will denote the sum, or integral of the differential $y\,dx$.

To integrate, or sum up a differential quantity: it is demonstrated, first, that $s\,dx=x$: secondly, $s\,(dx+dy)=x+y$: thirdly, $s\,(x\,dy+y\,dx)-xy$: fourthly, $s\,(m\,x^{m-1}dx)=x^m$: fifthly, $s\,(n:m)\,x^{\frac{n-m}{m}}dx=x^{\frac{n}{m}}$: sixthly, $s(y\,dx-x\,dy):y^2=x:y$. Of these, the fourth and fifth cases are the most frequent, wherein the differential quantity is integrated, by adding a variable unity to the exponent, and dividing the sum by the new exponent multiplied into the differential of the root; v. g. the fourth case, by $m-(1+1)\,dx$, i. e. by $m\,dx$.

If the differential quantity to be integrated doth not come under any of these formulas, it must either be reduced to an integral finite, or an infinite series, each of whose terms may be summed.

It may be here observed, that, as in the analysis of finites, any quantity may be raised to any degree of power: but *vice versa*, the root cannot be extracted out of any number required; so in the analysis of infinites, any variable or flowing quantity may be differenced; but *vice versa*, any differential cannot be integrated. And as, in the analysis of finites, we are not yet arrived at a method of extracting the roots of all equations, so neither has the integral calculus arrived at its perfection; and as in the former we are obliged to have recourse to approximation, so in the latter we have recourse to infinite series, where we cannot attain to a perfect integration.

CALCULUS *Literalis*, or *Literal* CALCULUS, is the same with specious arithmetic, or algebra, so called from its using the letters of the alphabet, in contradistinction to numeral arithmetic, which uses figures. In the literal calculus given quantities are expressed by the first letters, a, b, c, d; and quantities sought by the last, z, y, x, &c. Equal quantities are denoted by the same letters.

CALCULUS, *Antecedental*, a geometrical method of reasoning invented by Mr Glenie, which, without any consideration of notion or velocity, is applicable to all the purposes of fluxions. In this method, says Mr Glenie, "every expression is truly and strictly geometrical, is founded on principles frequently made use of by the ancient geometers, principles admitted into the very first elements of geometry, and repeatedly used by EUCLID himself. As it is a branch of general geometrical proportion, or universal comparison, and is derived from an examination of the antecedents of ratios, having

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ing given consequents and a given standard of comparison in various degrees of augmentation and diminution they undergo by composition and decomposition, I have called it the antecedental calculus. As it is purely geometrical, and perfectly scientific, I have, since it first occurred to me in 1779, always made use of it instead of the fluxionary and differential calculi, which are merely arithmetical. Its principles are totally unconnected with the ideas of motion and time, which, strictly speaking, are foreign to pure geometry and abstract science, though, in mixed mathematics and natural philosophy, they are equally applicable to every investigation, involving the consideration of either with the two numerical methods just mentioned. And as many such investigations require compositions and decompositions of ratios, extending greatly beyond the triplicate and subtriplicate, this calculus in all of them furnishes every expression in a strictly geometrical form. The standards of comparison in it may be any magnitudes whatever, and are of course indefinite and innumerable; and the consequents of the ratios, compounded or decompounded, may be either equal or unequal, homogeneous or heterogeneous. In the fluxionary and differential methods, on the other hand, 1, or unit, is not only the standard of comparison, but also the consequent of every ratio compounded or decompounded." See Phil. Trans. Edin. vol. iv.

Some mathematicians, however, are of opinion that the advantage to be derived from the employment of this calculus is not so great as the author seems to promise from it.

Calculus *Minervæ*, among the ancient lawyers, denoted the decision of a cause, wherein the judges were equally divided. The expression is taken from the history of Orestes, represented by Æschylus and Euripides; at whose trial, before the Areopagites, for the murder of his mother, the votes being equally divided for and against him, Minerva interposed, and gave the casting vote or calculus in his behalf.

M. Cramer, professor at Marpurg, has a discourse express, *De Calculo Minervæ;* wherein he maintains, that all the effect an entire equality of voices can have, is to leave the cause in *statu quo*.

Calculus *Tiburtinus*, a sort of figured stone, formed in great plenty about the cataracts of the Anio, and other rivers in Italy; of a white colour, and in shape oblong, round, or echinated. They are a species of the *stiriæ lapideæ*, or *stalactites*, and generated like them; and so like sugar plums, that it is a common jest at Rome to deceive the unexperienced by serving them up as deserts.

Calculus, in *Medicine*, the disease of the stone in the bladder or kidneys. The term is Latin, and signifies a *little pebble*. The calculus in the bladder is called *lithiasis;* and in the kidneys *nephritis*. See Medicine and Surgery.

Human calculi are commonly formed of different strata or incrustations; sometimes smooth and heavy like mineral stones; but often rough, spongy, light, and full of inequalities or protuberances; chemically analyzed, or distilled in an open fire, they yield nearly the same principles as urine itself, or at least an empyreumatic volatile urinous matter, together with a great deal of air. They never have, nor can have, naturally, any foreign matter for a basis; but they may by accident: an instance of which is related by Dr Percival *. A bougie had unfortunately slipped into the bladder, and upon it a stone of considerable size was formed in less than a year. This stone had so much the appearance of chalk, that the doctor was induced to try whether it could be converted into quicklime. His experiment succeeded, both with that and some other calculi; from which he conjectures, that hard waters which contain calcareous earth may contribute towards the formation of these calculi.

* Essays, vol. iii. p. 165.

CALCUTTA, the capital of the province of Bengal, and of all the British possessions in the East Indies, is situated on the river Hooghly, a branch of the Ganges, about 100 miles from the sea, in N. Lat. 23. and Long. 88. 28. E. from Greenwich. It is but a modern city, built on the site of a village called *Govindpour*. The English first obtained the Mogul's permission to settle in this place in the year 1690; and Mr Job Charnock, the company's agent, made choice of the spot on which the city stands, on account of a large shady grove which grew there; though in other respects it was the worst he could have pitched upon; for three miles to the north coast, there is a salt water lake, which overflows in September, and when the flood retires in December leaves behind such a quantity of fish and other putrescent matter, as renders the air very unhealthy. The custom of the Gentoos throwing the dead bodies of their poor people into the river is also very disgustful, and undoubtedly contributes to render the place unhealthy, as well as the cause already mentioned.

Calcutta is now become a large and populous city, being supposed at present to contain 500,000 inhabitants. It is elegantly built, at least the part inhabited by the English; but the rest, and that the greatest part, is built after the fashion of the cities of India in general. The plan of all these is nearly the same; their streets are exceedingly confined, narrow, and crooked, with a vast number of ponds, reservoirs, and gardens interspersed. A few of the streets are paved with brick. The houses are built, some with brick, others with mud, and a still greater number with bamboos and mats; all which different kinds of fabrics standing intermixed with one another, form a very uncouth appearance. The brick houses are seldom above two stories high, but those of mud and bamboos are only one, and are covered with thatch. The roofs of the brick houses are flat and terraced. These, however, are much fewer in number than the other two kinds; so that fires, which often happen, do not sometimes meet with a brick house to obstruct their progress in a whole street. Within these 20 or 25 years Calcutta has been greatly improved both in appearance and in the salubrity of its air; the streets have been properly drained, and the ponds filled; thereby removing a vast surface of stagnant water, the exhalations of which were particularly hurtful. The citadel is named Fort William, and is superior as a fortress to any in India; but is now on too extensive a scale to answer the purpose for which it was intended, viz. the holding a post in case of extremity. It was begun on this extended plan by Lord Clive immediately after the battle of Plassey. The expence attending it was supposed to amount two millions sterling.

Calcutta is the emporium of Bengal, and the residence

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Calcutta.

dence of the governor-general of India. Its flourishing state may in a great measure be supposed owing to the unlimited toleration of all religions allowed here; the Pagans being suffered to carry their idols in procession, the Mahomedans not being discountenanced, and the Roman Catholics being allowed a church.—At about a mile's distance from the town is a plain where the natives annually undergo a very strange kind of penance on the 9th of April; some for the sins they have committed, others for those they may commit, and others in consequence of a vow made by their parents. This ceremony is performed in the following manner: Thirty bamboos, each about the height of 20 feet, are erected in the plain above mentioned. On the top of these they contrive to fix a swivel, and another bamboo of 30 feet or more crosses it, at each end of which hangs a rope. The people pull down one end of this rope, and the devotee placing himself under it, the bramin pinches up a large piece of skin under both the shoulder-blades, sometimes in the breasts, and thrusts a strong iron hook through each. These hooks have lines of Indian grass hanging to them, which the priest makes fast to the rope at the end of the cross bamboo, and at the same time puts a sash round the body of the devotee, laying it loosely in the hollow of the hooks, lest, by the skin's giving way, he should fall to the ground. When this is done, the people haul down the other end of the bamboo; by which means the devotee is immediately lifted up 30 feet or more from the ground, and they run round as fast as their legs can carry them. Thus the devotee is thrown out the whole length of the rope, where, as he swings, he plays a thousand antic tricks; being painted and dressed in a very particular manner, on purpose to make him look more ridiculous. Some of them continue swinging half an hour, others less. The devotees undergo a preparation of four days for this ceremony. On the first and third they abstain from all kinds of food; but eat fruit on the other two. During this time of preparation they walk about the streets in their fantastical dresses, dancing to the sound of drums and horns; and some to express the greater ardour of devotion, run a rod of iron quite through their tongues, and sometimes through their cheeks also.

Before the war of 1755, Calcutta was commonly garrisoned by 300 Europeans, who were frequently employed in conveying the company's vessels from Patna, loaded with saltpetre, piece goods, opium, and raw silk. The trade of Bengal alone supplied rich cargoes for 50 or 60 ships annually, besides what was carried on in small vessels to the adjacent countries. It was this flourishing state of Calcutta that probably was one motive for the nabob Surajah Dowla to attack it in the year 1756. Having had the fort of Cossimbuzar delivered up to him, he marched against Calcutta with all his forces, amounting to 70,000 horse and foot, with 400 elephants, and invested the place on the 15th of June. Previous to any hostilities, however, he wrote a letter to Mr Drake the governor, offering to withdraw his troops, on condition that he would pay him his duty on the trade for 15 years past, defray the expence of his army, and deliver up the black merchants who were in the fort. This being refused, he attacked one of the redoubts at the entrance of the town; but was repulsed with great slaughter. On the 16th he attacked another advanced post, but was likewise repulsed with great loss. Notwithstanding this disappointment, however, the attempt was renewed on the 18th, when the troops abandoned these posts, and retreated into the fort; on which the nabob's troops entered the town, and plundered it for 24 hours. An order was then given for attacking the fort; for which purpose a small breastwork was thrown up, and two twelve pounders mounted upon it; but without firing oftener than two or three times an hour. The governor then called a council of war, when the captain of the train informed them, that there was not ammunition in the fort to serve three days; in consequence of which the principal ladies were sent on board the ships lying before the fort. They were followed by the governor, who declared himself a Quaker, and left the place to be defended by Mr Holwell the second in council. Besides the governor, four of the council, eight gentlemen of the company's service, four officers, and 100 soldiers, with 52 free merchants, captains of ships, and other gentlemen, escaped on board the ships, where were also 59 ladies, with 33 of their children. The whole number left in the fort was about 250 effective men, with Mr Holwell, four captains, five lieutenants, six ensigns, and five serjeants; as also 14 sea captains, and 29 gentlemen of the factory. Mr Holwell then having held a council of war, divided three chests of treasure among the discontented soldiers, making them large promises also, if they behaved with courage and fidelity; after which he boldly stood on the defence of the place, notwithstanding the immense force which opposed him. The attack was very vigorous; the enemy having got possession of the houses, galled the English from thence, and drove them from the bastions; but they themselves were several times dislodged by the fire from the fort, which killed an incredible number, with the loss of only five English soldiers the first day. The attack, however, was continued till the afternoon of the 20th; when many of the garrison being killed and wounded, and their ammunition almost exhausted, a flag of truce was hung out. Mr Holwell intended to have availed himself of this opportunity to make his escape on board the ships, but they had fallen several miles down from the fort, without leaving even a single boat to facilitate the escape of those who remained. In the mean time, however, the back-gate was betrayed by the Dutch guard, and the enemy, entering the fort, killed all they first met, and took the rest prisoners.

The fort was taken before six in the evening; and, in an hour after, Mr Holwell had three audiences of the nabob, the last being in the durbar or council. In all of these the governor had the most positive assurances that no harm should happen to any of the prisoners; but he was surprised and enraged at finding only 5000l. in the fort instead of the immense treasures he expected; and to this, as well as perhaps to the resentment of the jemmidaars or officers, of whom many were killed in the siege, we may impute the catastrophe that followed.

As soon as it was dark, the English prisoners, to the number of 146, were directed by the jemmidaars who guarded them, to collect themselves into one body, and sit down quietly under the arched veranda,

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Calcutta. or piazza, to the westward of the Black Hole prison. Besides the guard over them, another was placed at the south end of this veranda, to prevent the escape of any of them. About 500 gunmen, with lighted matches, were drawn up on the parade; and soon after the factory was in flames to the right and left of the prisoners, who had various conjectures on this appearance. The fire advanced with rapidity on both sides; and it was the prevailing opinion of the English, that they were to be suffocated between the two fires. On this they soon came to a resolution of rushing on the guard, seizing their scimitars, and attacking the troops upon the parade, rather than be thus tamely roasted to death: but Mr Holwell advanced, and found the Moors were only searching for a place to confine them in. At this time Mr Holwell might have made his escape, by the assistance of Mr Leech, the company's smith, who had escaped when the Moors entered the fort, and returned just as it was dark, to tell Mr Holwell he had provided a boat, and would ensure his escape, if he would follow him through a passage few were acquainted with, and by which he then entered. This might easily have been accomplished, as the guard took little notice of it; but Mr Holwell told Mr Leech, he was resolved to share the fate of the gentlemen and the garrison; to which Mr Leech gallantly replied, that "then he was resolved to share Mr Holwell's fate, and would not leave him."

The guard on the parade advanced, and ordered them all to rise and go into the barracks. Then, with their muskets presented, they ordered them to go into the Black Hole prison; while others, with clubs and scimitars pressed upon them so strong, that there was no resisting it; but, like one agitated wave impelling another, they were obliged to give way and enter: the rest following like a torrent. Few among them, the soldiers excepted, had the least idea of the dimensions or nature of a place they had never seen; for if they had, they should at all events have rushed upon the guard, and been cut to pieces by their own choice as the lesser evil.

It was about eight o'clock when these 146 unhappy persons, exhausted by continual action and fatigue, were thus crammed together into a dungeon about eighteen feet square, in a close sultry night in Bengal; shut up to the east and south, the only quarters from whence air could reach them, by dead walls, and by a wall and door to the north; open only to the west by two windows, strongly barred with iron, from which they could receive scarce any circulation of fresh air.

They had been but few minutes confined before every one fell into a perspiration so profuse, that no idea can be formed of it. This brought on a raging thirst, which increased in proportion as the body was drained of its moisture. Various expedients were thought of to give more room and air. Every man was stripped, and every hat put in motion: they several times sat down on their hams; but at each time several of the poor creatures fell, and were instantly suffocated or trode to death.

Before nine o'clock every man's thirst grew intolerable, and respiration difficult. Efforts were again made to force the door; but still in vain. Many insults were used to the guards, to provoke them to fire in upon the prisoners, who grew outrageous, and many delirious. "Water, water," became the general cry. Some water was brought: but these supplies, like sprinkling water on fire, only served to raise and feed the flames. The confusion became general and horrid from the cries and ravings for water; and some were trampled to death. This scene of misery proved entertainment to the brutal wretches without, who supplied them with water, that they might have the satisfaction of seeing them fight for it, as they phrased it; and held up lights to the bars, that they might lose no part of the inhuman diversion.

Before eleven o'clock, most of the gentlemen were dead, and one-third of the whole. Thirst grew intolerable: but Mr Holwell kept his mouth moist by sucking the perspiration out of his shirt sleeves, and catching the drops as they fell, like heavy rain, from his head and face. By half an hour after eleven, most of the living were in an outrageous delirium. They found that water heightened their uneasiness; and "Air, air," was the general cry. Every insult that could be devised against the guard; all the opprobrious names that the viceroy and his officers could be loaded with, were repeated, to provoke the guard to fire upon them. Every man had eager hopes of meeting the first shot. Then a general prayer to heaven, to hasten the approach of the flames to the right and left of them, and put a period to their misery. Some expired on others; while a steam arose as well from the living as the dead, which was very offensive.

About two in the morning, they crowded so much to the windows, that many died standing, unable to fall by the throng and equal pressure round. When the day broke, the stench arising from the dead bodies was insufferable. At that juncture, the soubah, who had received an account of the havock death had made among them, sent one of his officers to enquire if the chief survived. Mr Holwell was shown to him; and near six an order came for their release.

Thus they had remained in this infernal prison from eight at night until six in the morning, when the poor remains of 146 souls, being only 23, came out alive; but most of them in a high putrid fever. The dead bodies were dragged out of the hole by the soldiers, and thrown promiscuously into the ditch of an unfinished ravelin, which was afterwards filled with earth.

The injuries which Calcutta suffered at this time, however, were soon repaired. The place was retaken by Admiral Watson and Colonel Clive, early in 1757; Surajah Dowla was defeated, deposed, and put to death; and Meer Jaffier, who succeeded him in the nabobship, engaged to pay an immense sum for the indemnification of the inhabitants. Since that time, the immense acquisition of territory by the British in this part of the world, with the constant state of security enjoyed by this city, have given an opportunity of embellishing and improving it greatly beyond what it was before.—Among these improvements we may reckon that of Sir William Jones, who on the 15th of January, 1784, instituted a society for inquiring into the history, civil and natural, the antiquities, arts, sciences, and literature of Asia; and thus the literature of

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Calcutta ‖ Calderwood.

of Europe, and along with it, it is to be hoped, the arts of humanity, beneficence, and peace, have at length obtained a footing in the rich empire of Indostan, so long a prey to the rapine and violence of tyrants. See Calcutta, Supplement.

CALDARIUM, in the ancient baths, denoted a brazen vessel or cistern, placed in the hypocaustum, full of hot water, to be drawn thence into the *piscina* or bath, to give it the necessary degree of heat. In this sense the *caldarium* stood contradistinguished from the *tepidarium* and *frigidarium*.

Caldarium, also denoted the stove, or sudatory, being a close vaulted room, wherein, by hot dry fumes, without water, people were brought to a profuse sweat. In which sense, *caldarium* was the same with what was otherwise denominated *vaporarium*, *sudatorium*, and *laconium*; in the Greek baths, *hypocaustum*, ὑποκαυστον.

CALDERINUS, Domitius, a learned critic, born at Calderia near Verona. He read lectures upon polite literature at Rome with great reputation; and was the first who ventured to write upon the most difficult of the ancient poets. He died very young in 1477.

CALDERON, de la Barca, Don Pedro, a Spanish officer, who after having signalized himself in the military profession, quitted it for the ecclesiastical, and then commenced dramatic writer. His dramatic works make 9 vols. in 4to. and some Spanish authors have compared him to Shakespeare. He flourished about the year 1640.

CALDERWOOD, David, a famous divine of the church of Scotland, and a distinguished writer in behalf of the Presbyterians, was descended of a good family in that kingdom; and being early designed for the ministry, he applied with great diligence to the study of the Scriptures in their original tongues, the works of the fathers, the councils, and the best writers on church history. He was settled about the year 1604 at Crelling near Jedburgh. King James I. of Great Britain, being desirous of bringing the church of Scotland nearer to a conformity with that of England, laboured earnestly to restore the episcopal authority, and enlarge the powers of the bishops who were then in Scotland. This design was very warmly opposed by many of the ministers, and particularly by Mr David Calderwood; who, when Mr James Law, bishop of Orkney, came to visit the presbyteries of Merse and Tiviotdale, declined his jurisdiction by a paper under his hand, dated May 5. 1608. But the king having its success much at heart, sent the earl of Dunbar, the high-treasurer of Scotland, with Dr Abbot, afterward archbishop of Canterbury, and two other divines, into that kingdom, with instructions to employ every method to persuade both the clergy and laity of his majesty's sincere desire to promote the good of the church, and of his zeal for the Protestant religion. Mr Calderwood did not assist at the general assembly held at Glasgow, June 8. 1610, in which Lord Dunbar presided as commissioner; and it appears from his writings, that he looked upon every thing transacted in it as null and void. In May following, King James went to Scotland; and on the 17th of June held a parliament at Edinburgh. At that time the clergy met in one of the churches, to hear and advise with the bishops, which kind of assembly, it seems, was contrived in order to resemble the English convocation. Mr Calderwood was present at it, but declared publicly that he did not take any such meetings to resemble a convocation; and being opposed by Dr Whitford and Dr Hamilton, who were friends to the bishops, he took his leave of them in these words: "It is absurd to see men sitting in silks and satins, and to cry poverty in the kirk, when purity is departing." The parliament proceeded in the meanwhile in the dispatch of business; and Mr Calderwood, with several other ministers, being informed that a bill was depending to empower the king, with the advice of the archbishops, bishops, and such a number of the ministry as his majesty should think proper, to consider and conclude as to matters decent for the external policy of the church, not repugnant to the word of God; and that such conclusions should have the strength and power of ecclesiastical laws; against this they protested, for four reasons: 1. Because their church was so perfect, that, instead of needing reformation, it might be a pattern to others. 2. General assemblies, as now established by law, and which ought always to continue, might by this means be overthrown. 3. Because it might be a means of creating schism, and disturb the tranquillity of the church. 4. Because they had received assurances, that no attempts should be made to bring them to a conformity with the church of England. They desired, therefore, that, for these and other reasons, all thoughts of passing such a law might be laid aside: but in case this be not done, they protest for themselves and their brethren who shall adhere to them, that they can yield no obedience to this law, when it shall be enacted, because it is destructive of the liberty of the church; and therefore shall submit to such penalties, and think themselves obliged to undergo such punishments, as may be inflicted on them for disobeying that law. This protest was signed by Mr Archibald Simson on behalf of the members, who subscribed another separate roll, which he kept for his justification. This protest was presented to the clerk register, who refused to read it before the states in parliament. However, though not read, it had its effect; for although the bill had the consent of parliament, yet the king thought fit to cause it to be laid aside, and not long after called a general assembly at St Andrew's. Soon after the parliament was dissolved, and Mr Calderwood was summoned to appear before the high commission court at St Andrew's, on the 8th of July following, to answer for his mutinous and seditious behaviour. July 10th, the king came to that city in person; when Mr Calderwood, being called upon, and refusing to comply with what the king in person required of him, was committed to prison. Afterwards the privy council, according to the power exercised by them at that time, directed him to banish himself out of the king's dominions before Michaelmas next; and not to return without licence. Having applied to the king for a prorogation of his sentence without success, because he would neither acknowledge his offence, nor promise conformity for the future, he retired to Holland, where, in 1623, he published his celebrated piece entitled *Altare Damascenum*. Mr Calderwood having in the year 1624 been afflicted with a long fit of sickness, and nothing having been heard of him for some time, one Mr Patrick Scott, as Calderwood himself informs us, took it for granted that he

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he was dead; and thereupon wrote a recantation in his name, as if, before his decease, he had changed his sentiments. This imposture being detected, Scott went over to Holland, and staid three weeks at Amsterdam, where he made a diligent search for the author of Altare Damascenum, with a design to have dispatched him. But Calderwood had privately retired into his own country, where he lived several years. Scott gave out that the king had furnished him with the matter for the pretended recantation, and that he only put it in order. During his retirement, Mr Calderwood collected all the memorials relating to the ecclesiastical affairs of Scotland, from the beginning of the reformation there down to the death of King James, which collection is still preserved in the university library of Glasgow; that which was published under the title of "The True History of Scotland," is only an extract from it. In the advertisement prefixed to the last edition of his Altare Damascenum, mention is made of his being minister of Pencaitland near Edinburgh in 1638, but we find nothing said there, or anywhere else, of his death.

CALDRON, a large kitchen utensil, commonly made of copper; having a moveable iron handle, whereby to hang it on the chimney hook. The word is formed from the French *chaudron*, or rather the Latin *caldarium.*

Boiling in CALDRONS (*caldariis decoquere*), is a capital punishment spoken of in the middle-age writers, decreed to divers sort of criminals, but chiefly to debasers of the coin. One of the torments inflicted on the ancient Christian martyrs, was boiling in caldrons of water, oil, &c.

CALDWALL, RICHARD, a learned English physician, born in Staffordshire about the year 1513. He studied physic in Brazen-nose College, Oxford; and was examined, admitted into, and made censor of, the College of Physicians at London, all in one day. Six weeks after he was chosen one of the electa; and in the year 1570, he was made president of that college. Mr Wood tells us, that he wrote several pieces in his profession; but he does not tell us what they were, only that he translated a book on the art of surgery, written by one Horatio More, a Florentine physician. We learn from Camden, that Caldwall founded a chirurgical lecture in the College of Physicians, and endowed it with a handsome salary. He died in 1585.

CALEA. See BOTANY *Index*.

CALEB, one of the deputies sent by the Israelites to take a view of the land of Canaan. He made a good report of the country, and by this means revived the spirits of the dejected people; on which account, he and Joshua were the only persons who, after their leaving Egypt, settled in the land of Canaan. Caleb had for his share the mountains and the city of Hebron, from which he drove three kings. Othniel his nephew having taken the city of Debir, Caleb gave him his daughter Achsah in marriage; and died, aged 114.

CALEDONIA, the ancient name of Scotland. From the testimonies of Tacitus, Dio, and Solinus, we find, that the ancient Caledonia comprehended all that country lying to the north of the rivers Forth and Clyde. In proportion as the Silures or Cimbri advanced towards the north, the Caledonians being circumscribed within narrower limits, were forced to transmigrate into the islands which crowd the western coasts of Scotland. It is in this period, probably, we ought to place the first great migration of the British Gaël into Ireland; that kingdom being much nearer to the promontory of Galloway and Cantire than many of the Scotish isles are to the continent of North Britain.

To the country which the Caledonians possessed, they gave the name of *Caël-doch;* which is the only appellation the Scots, who speak the Gaelic language, know for their own division of Britain. *Caël-doch* is a compound, made up of *Gaël* or *Caël*, the first colony of the ancient Gauls who transmigrated into Britain, and *doch*, a district or division of a country. The Romans, by transposing the letter *l* in *Cael*, and by softening into a Latin termination the *ch* of *doch*, formed the well-known name of Caledonia.

When the tribes of North Britain were attacked by the Romans, they entered into associations, that, by uniting their strength, they might be more able to repel the common enemy. The particular name of that tribe, which either its superior power or military reputation placed at the head of the association, was the general name given by the Romans to all the confederates. Hence it is that the *Mœatæ*, who with other tribes inhabited the districts of Scotland lying southward of the frith, and the *Caledonians*, who inhabited the west and north-west parts, have engrossed all the glory which belonged in common, though in an inferior degree, to all the other nations settled of old in North Britain. It was for the same reason that the name of *Mœatæ* was entirely forgotten by foreign writers after the third century, and that of the *Caledonians* themselves but seldom mentioned after the fourth.

Britons, *Caledonians*, *Mœatæ*, *Barbarians*, are the names constantly given to the old inhabitants of North Britain, by Tacitus, Herodian, Dio, Spartian, Vopiscus, and other ancient writers. The successors of these Britons, Caledonians, Mœats, and barbarians, are called Picts, Scots, and Attacots, by some Roman writers of the fourth century.

The origin of the appellations *Scoti* and *Picti*, introduced by later Roman authors, has occasioned much controversy among the antiquarians of these days. The dispute seems now to be fully decided by some learned critics of the present century, whose knowledge of the Gaelic language assisted their investigation. See SCOTLAND, PICTS, and HIGHLANDERS.

CALEDONIA, the name of a settlement made by the Scots on the west side of the gulf of Darien, in 1698; out of which they were starved at the request of the East India Company; for the English government prohibited the other colonies sending them any provisions; so they were obliged to leave it in 1700.

New CALEDONIA, an island in the South sea, lately discovered by Captain Cook, and next to New Holland and New Zealand, is the largest island that hath yet been discovered in that sea. It extends from 19. 37. to 22. 30. S. Lat. and from 163. 37. to 167. 14. E. Long. Its length from north-west to south-east is about 80 leagues: but its greatest breadth does not exceed ten leagues. This island is diversified with hills and valleys of various size and extent. From the hills issue abundance of rivulets, which contribute to fertilize the plains.

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Caledonia. plains. Along its north-east shore the land is flat; and being well watered, and cultivated by the inhabitants after their manner, appeared to great advantage to Captain Cook's people. Was it not, indeed, for those fertile spots on the plains, the whole country might be called a *dreary waste:* the mountains and higher parts of the land are in general incapable of cultivation. They consist chiefly of rocks, many of which are full of mundic; the little soil that is upon them is scorched and burnt up by the sun: it is, however, covered with coarse grass and other plants, and here and there covered with trees and shrubs. The country in general bears a great resemblance to those parts of New South Wales which lie under the same parallel of latitude. Several of its natural productions are the same, and the woods are without underwood as well as in that country. The whole coast seems to be surrounded by reefs and shoals, which render all access to it extremely dangerous; but at the same time guard the coasts against the attacks of the wind and sea; rendering it easily navigable along the coast by canoes, and causing it abound with fish. Every part of the coast seems to be inhabited; the plantations in the plains are laid out with great judgment, and cultivated with much labour. They begin their cultivation by setting fire to the grass, &c. with which the ground is covered, but have no notion of preserving its vigour by manure; they, however, recruit it by letting it lie for some years untouched. On the beach was found a large irregular mass of rock, not less than a cube of ten feet, consisting of a close grained stone speckled full of granites somewhat bigger than pins heads, from whence it seems probable that some valuable minerals may be found on this island. It differs from all the other islands yet discovered in the South sea, by being entirely destitute of volcanic productions. Several plants of a new species were found here; and a few young bread fruit trees, not then sufficiently grown to bear fruit, seemed to have come up without culture; plantains and sugar canes are here in small quantity, and the cocoa-nut trees are small and thinly planted. A new species of passion flower was likewise met with, which was never known to grow wild anywhere but in America. Several *Caputi* (MELALEUCA) trees were also found in flower. Musquetos here are very numerous. A great variety of birds was seen of different classes, which were for the most part entirely new; particularly a beautiful species of parrot before unknown to zoologists. A new species of fish, of the genus called by Linnæus *tetraodon*, was caught here; and its liver, which was very large, presented at supper Several species of this genus being reckoned poisonous, and the present species being remarkably ugly, Messrs Fosters hinted their suspicions of its quality; but the temptations of a fresh meal, and the assurances of Captain Cook that he had formerly eaten this identical sort of fish without harm, got the better of their scruples, and they ate of it. Its oiliness, however, though it had no other bad taste than what proceeded from this, prevented them from taking more than a morsel or two. In a few hours after they had retired to rest they were awaked by very alarming symptoms, being all seized with an extreme giddiness; their hands and feet were numbed, so that they were scarcely able to crawl; and a violent languor and oppression seized them. Emetics were administered with some success, but sudorifics gave the greatest relief. Some dogs who had eaten the remainder of the liver were likewise taken ill; and a pig which had eaten the entrails died soon after, having swelled to an unusual size. The effects of this poison on the gentlemen did not entirely go off in less than six weeks.—Abundance of turtle was seen here. The natives had not the least notion of goats, hogs, dogs, or cats, and had not even a name for any of them.

The inhabitants are very stout, tall, and in general well proportioned; their features mild; their beards and hair black, and strongly frizzled, so as to be somewhat woolly in some individuals: their colour is swarthy, or a dark chesnut brown. A few were seen who measured six feet four inches. They are remarkably courteous, not at all addicted to pilfering and stealing: in which character of honesty they are singular, all the other nations in the South sea being remarkably thievish. Some wear their hair long, and tie it up to the crown of their heads: others suffer only a large lock to grow on each side, which they tie up in clubs; many others, as well as all the women, wear it cropt short. They make use of a kind of comb made of sticks or hard wood, from seven to nine or ten inches long, and about the thickness of knitting needles; a number of these, seldom exceeding 20, but generally fewer, are fastened together at one end, parallel to and near one-tenth of an inch from each other: the ends, which are a little pointed, will spread out or open like the sticks of a fan. These combs they always wear in their hair on one side of their head. Some had a kind of concave cylindrical stiff black cap, which appeared to be a great ornament among them, and was supposed to be worn only by the chiefs and warriors. A large sheet of strong paper, whenever they got one in exchange, was commonly applied to this purpose. The men go naked; only tying a string round their middle, and another round their neck. A little piece of a brown cloth made of the bark of a fig tree, sometimes tucked up to the belt, and sometimes pendulous, scarcely deserves the name of a covering; nor indeed does it seem at all intended for that purpose. This piece of cloth is sometimes of such a length, that the extremity is fastened to a string round the neck; to this string they likewise hang small round beads of a pale green nephritic stone. Coarse garments were seen among them made of a sort of matting; but they seemed never to wear them, except when in their canoes and unemployed. The women seemed to be in a servile state: they were the only persons of the family who had any employment, and several of them brought bundles of sticks and fuel on their backs: those who had children carried them on their backs in a kind of satchel. The women also were seen to dig up the earth in order to plant it. They are in general of a dark chesnut, and sometimes mahogany brown; their stature middle-sized, some being rather tall, and their whole form rather stout and somewhat clumsy. Their dress is the most disfiguring that can be imagined, and gives them a thick squat shape; it is a short petticoat or fringe, consisting of filaments or little cords, about eight inches long, which are fastened to a very long string, which they have tied several times round their waist. The filaments, or little ropes, therefore, lie above each other in several layers, forming a kind of thick

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thick thatch all round the body, but which does not near cover the thigh; these filaments were sometimes dyed black; but frequently those on the outside only were of that colour, the rest being of a dirty grey. There was not a single instance, during the ship's stay in this island, of the women permitting any indecent familiarity with an European; they took pleasure in practising the arts of a jilting coquette, but never became absolute wantons. The general ornaments of both sexes are ear-rings of tortoise shells; necklaces, or amulets, made of both shells and stones; and bracelets made of large shells, which they wear above the elbows.

The houses, or huts, in New Caledonia, are circular, something like a bee-hive, and full as close and warm; the entrance is by a small door, or long square hole, just big enough to admit a man bent double: the side walls are about four feet and a half high; but the roof is lofty, and peaked to a point at the top, above which is a post or stick of wood, which is generally ornamented either with carving or shells, or both. The framing is of small spars, reeds, &c. and both sides and roof are thick, and close covered with thatch made of coarse long grass. In the inside of the house are set up posts, to which cross spars are fastened, and platforms made for the conveniency of laying any thing on. Some houses have two floors, one above another; the floor is laid with dried grass, and here and there mats are spread for the principal people to sit or sleep on. In these houses there was no passage for the smoke but through the door: they were intolerably smoky, and so hot as to be insupportable to those unaccustomed to them: probably the smoke is intended to drive out the musquetos which swarm here. They commonly erect two or three of these huts near each other under a cluster of lofty fig trees, whose leaves are impervious to the rays of the sun.

The canoes used here are very heavy clumsy vessels; they are made of two trees hollowed out, having a raised gunnel about two inches high, and closed at each end with a bulk head of the same height; so that the whole is like a long square trough about three feet shorter than the body of the canoe. Two canoes thus fitted are fastened to each other about three feet asunder, by means of cross spars, which project about a foot over each side. Over these is laid a deck or heavy platform made of plank and small round spars, on which they have a fire-hearth, and generally a fire burning; they are navigated by one or two latteen sails, extended to a small latteen yard, the end of which is fixed in a notch or hole in the deck.

Notwithstanding the inoffensive disposition of the inhabitants of New Caledonia, they are well provided with offensive weapons; as clubs, spears, darts, and slings for throwing stones. Their clubs are about two feet and a half long, and variously formed; some like a scythe, others like a pick-axe; some have a head like a hawk, and others have round heads; but all are neatly made; many of their darts and spears are no less neat, and ornamented with carvings. The slings are as simple as possible; but they take some pains to form the stones that they use into a proper shape, which is something like an egg, supposing both ends to be like the small one. They drive the dart by the assistance of short cords, knobbed at one end and looped at the other, called by the seamen *beckets*. These contain a quantity of red wool taken from the vampyre, or great Indian bat. Bows and arrows are wholly unknown among them.

Their language bears no affinity to that spoken in the other South sea islands, the word *arrekee* and one or two more excepted. This is the more extraordinary, as different dialects of one language were spoken not only in the easterly islands, but at New Zealand.

A musical instrument, a kind of whistle, was procured here. It was a little polished piece of brown wood about two inches long, shaped like a kind of bell, though apparently solid, with a rope fixed at the small end; two holes were made in it near the base, and another near the insertion of the rope, all which communicated with each other; and by blowing in the uppermost, a shrill sound like whistling was produced: no other instrument was seen among them that had the least relation to music.

Many of the New Caledonians were seen with prodigiously thick legs and arms, which seemed to be affected with a kind of leprosy; the swelling was found to be extremely hard, but the skin was not alike harsh and scaly in all those who were afflicted with the disorder. The preternatural expansion of the arm or leg did not appear to be a great inconvenience; and they seemed to intimate that they very rarely felt any pain in it; but in some the disorder began to form blotches, which are marks of a great degree of virulence. This disease is probably *elephantiasis*.

Here they bury their dead in the ground. The grave of a chief who had been slain in battle here resembled a large mole-hill, and was decorated with spears, darts, paddles, &c. all stuck upright in the ground round about it.

CALEDONIAN CANAL, a canal extending across the Highlands of Scotland, in a north-east and south-west direction, from Fort William to Inverness. It was begun in 1803, and is expected to be completed in 1821. See CALEDONIAN CANAL, SUPPLEMENT.

CALEFACTION, the production of heat in a body from the action of fire, or that impulse impressed by a hot body on others around it. This word is used in pharmacy, by way of distinction from *coction*, which implies boiling; whereas calefaction is only heating a thing.

CALENBERG, a castle of Germany, in the duchy of Brunswick and principality of Calenberg. It is seated on the river Leine, and is 15 miles south of Hanover. It is subject to the duke of Brunswick Lunenburg, elector of Hanover, and king of Great Britain. E. Long. 9. 43. N. Lat. 52. 20.

CALENBERG, a principality of Lower Saxony, and one of the three parts of the duchy of Brunswick, is bounded on the north by the duchy of Verden, on the east by the principality of Zell, on the south by the principalities of Grubenhagen and Wolfenbuttle, and on the west by Westphalia. It belongs to the elector of Hanover.

CALENDAR, in *Astronomy* and *Chronology*. See KALENDAR.

CALENDAR of prisoners, in *Law*, a list of all the prisoners names in the custody of each respective sheriff*.

CALENDARIUM FLORÆ, in *Botany*, a calendar containing

* See the article *Execution*.

containing an exact register of the respective times in which the plants of any given province or climate germinate, expand, and shed their leaves and flowers, or ripen and disperse their seeds. For particulars on this curious subject, see the articles DEFOLIATIO, EFFLORESCENTIA, FRONDESCENTIA, FRUCTESCENTIA, and GERMINATIO.

CALENDER, a machine used in manufactories to press certain woollen and silken stuffs and linens, to make them smooth, even, and glossy, or to give them waves, or water them, as may be seen in mohairs and tabbies. This instrument is composed of two thick cylinders, or rollers, of very hard and well polished wood, round which the stuffs to be calendered are wound: these rollers are placed cross-wise between two very thick boards, the lower serving as a fixed base, and the upper moveable by means of a thick screw with a rope fastened to a spindle, which makes its axis: the uppermost board is loaded with large stones weighing 20,000lb. or more. At Paris they have an extraordinary machine of this kind, called the *royal calender*, made by order of M. Colbert. The lower table or plank is made of a block of smooth marble, and the upper is lined with a plate of polished copper. The alternate motion of the upper board sometimes one way and sometimes another, together with the prodigious weight laid upon it, gives the stuffs their gloss and smoothness; or gives them the waves, by making the cylinders on which they are put roll with great force over the undermost board. When they would put a roller from under the calender, they only incline the undermost board of the machine. The dressing alone, with the many turns they make the stuffs and linens undergo in the calender, gives the waves, or waters them, as the workmen call it. It is a mistake to think, as some have asserted, that they use rollers with a shallow indenture or engraving cut in them. See CALENDERING, SUPPLEMENT.

CALENDER *of Monteith*, a district in the south-west corner of Perthshire in Scotland, from which a branch of the ancient family of Livingstone had the title of earl. The chief seat of the family near Falkirk is also called *Calender*. Both estate and title were forfeited in consequence of the possessor being engaged in the rebellion 1715.

CALENDERS, a sort of Mahometan friars, so called from Santon Calenderi their founder. This Santon went bareheaded, without a shirt, and with the skin of a wild beast thrown over his shoulders. He wore a kind of apron before, the strings of which were adorned with counterfeit precious stones. His disciples are rather a sect of epicures than a society of religious. They honour a tavern as much as they do a mosque; and think they pay as acceptable worship to God by the free use of his creatures, as others do by the greatest austerities and acts of devotion. They are called, in Persia and Arabia, *Abdals*, or *Abdallat*, i. e. persons consecrated to the honour and service of God. Their garment is a single coat, made up of a variety of pieces, and quilted like a rug. They preach in the market places, and live upon what their auditors bestow on them. They are generally very vicious persons: for which reason they are not admitted into any houses.

CALENDS, in Roman antiquity. See KALENDS.

CALENDULA, the MARIGOLD. See BOTANY *Index*.

CALENTIUS, ELISIUS, a Neapolitan poet and prose author. He was preceptor to Frederick the son of Ferdinand king of Naples, and the earliest writer on the illegality of putting criminals to death, except for murder. He died in 1503.

CALENTURE, a feverish disorder incident to sailors in hot countries; the principal symptom of which is their imagining the sea to be green fields: hence, attempting to walk abroad in these imaginary places of delight, they are frequently lost. Vomiting, bleeding, a spare diet, and the neutral salts, are recommended in this disorder; a single vomit commonly removing the delirium, and the cooling medicines completing the cure.

CALEPIN, AMBROSIUS, an Augustine monk of Calepio, whence he took his name, in the 16th century. He is author of a dictionary of eight languages, since augmented by Passerat and others.

CALES, in *Ancient Geography*, a municipal city of some note in Campania, at no great distance from Casilinum. The epithet *Calenus* is by Horace and Juvenal applied to a generous wine which the territory produced.

CALETES, in *Ancient Geography*, a people of Gallia Celtica, on the confines of Belgica, situated between the sea and the Sequana. Now called *le Pais de Caux*, in Normandy.

CALETURE, a fort on the island of Ceylon, at the mouth of a river of the same name. The Dutch became masters of it in 1655; but were afterwards obliged to leave it. E. Long. 80. 51. N. Lat. 6. 38.

CALF, in *Zoology*, the young of the ox kind.

There are two ways of breeding calves that are intended to be reared. The one is to let the calf run about with its dam all the year round; which is the method in the cheap breeding countries, and is generally allowed to make the best cattle. The other is to take them from the dam after they have sucked about a fortnight: they are then to be taught to drink flat milk, which is to be made but just warm for them, it being very dangerous to give it them too hot. The best time of weaning calves is from January to May: they should have milk for 12 weeks after; and a fortnight before that is left off, water should be mixed with the milk in larger and larger quantities. When the calf has been fed on milk for about a month, little wisps of hay should be placed all about him in cleft sticks to induce him to eat. In the beginning of April they should be turned out to grass; only for a few days they should be taken in for the night, and have milk and water given them: the same may also be given them in a pail sometimes in the field, till they are so able to feed themselves that they do not regard it. The grass they are turned into must not be too rank, but short and sweet, that they may like it, and yet get it with some labour. Calves should always be weaned at grass; for if it be done with hay and water, they often grow big-bellied on it, and are apt to rot. When those among the males are selected which are to be kept as bulls, the rest should be gelt for oxen: the sooner the better. Between 10 and 20 days is a pro-

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Calf ‖ Caliber.

per age. About London almost all the calves are fatted for the butcher. The reason of this is, that there is a good market for them: and the lands there are not so profitable to breed upon as in cheaper countries. The way to make calves fat and fine, is the keeping them very clean; giving them fresh litter every day; and the hanging a large chalk stone in some corner where they can easily get at it to lick it, but where it is out of the way of being fouled by their dung and urine. The coops are to be plaeed so as not to have too much sun upon them, and so high above the ground that the urine may run off. They also bleed them once when they are a month old, and a second time before they kill them; which is a great addition to the beauty and whiteness of their flesh; the bleeding is by some repeated much oftener, but this is sufficient. Calves are very apt to be loose in their bowels; which wastes and very much injures them. The remedy is to give them chalk scraped among milk, pouring it down with a horn. If this does not succeed, they give them bole armenic in large doses, and use the cold bath every morning. If a cow will not let a strange calf suck her, the common method is to rub both her nose and the calf's with a little brandy; this generally reconciles them after a few smellings.

Golden Calf, an idol set up and worshipped by the Israelites at the foot of Mount Sinai, in their passage through the wilderness to the land of Canaan. Our version makes Aaron fashion this calf with a graving tool after he had cast it in a mould; the Geneva translation makes him engrave it first, and cast it afterwards. Others, with more probability, render the whole verse thus: "And Aaron received them (the golden earrings), and tied them up in a bag, and got them cast into a molten calf:" which version is authorised by the different senses of the word *tsur*, which signifies to tie up or bind, as well as to shape or form; and of the word *cherret*, which is used both for a graving tool and a bag. Some of the ancient fathers have been of opinion that this idol had only the face of a calf, and the shape of a man from the neck downwards, in imitation of the Egyptian Isis. Others have thought it was only the head of an ox without a body. But the most general opinion is, that it was an entire calf in imitation of the Apis worshipped by the Egyptians; among whom, no doubt, the Israelites had acquired their propensity to idolatry. This calf Moses is said to have *burnt with fire*, reduced to powder, and strewed upon the water which the people were to drink. How this could be accomplished hath been a question. Most people have thought that as gold is indestructible, it could only be burnt by the miraculous power of God; but M. Stahl conjectures that Moses dissolved it by means of liver of sulphur *. The Rabbins tell us that the people were made to drink of this water in order to distinguish the idolaters from the rest; for that as soon as they had drunk of it, the beards of the former turned red. The Cabbalists add, that the calf weighed 125 quintals; which they gather from the Hebrew word *massekah*, whose numerical letters make 125.

* See Chemistry *Index*.

Calf-Skins, in the leather manufacture, are prepared and dressed by the tanners, skinners, and curriers, who sell them for the use of the shoemakers, saddlers, bookbinders, and other artificers, who employ them in their several manufactures.

Calf-Skin dressed in sumach, denotes the skin of this animal curried black on the hair side, and dyed of an orange colour on the flesh side, by means of sumach, chiefly used in the making of belts.

The English calf-skin is much valued abroad, and the commerce thereof very considerable in France and other countries; where divers attempts have been made to imitate it, but hitherto in vain. What is like to baffle all endeavours for imitating the English calf in France is, the smallness and weakness of the calves about Paris; which at 15 days old are not so big as the English ones when they come into the world.

Sea-Calf. See Phoca, Mammalia *Index*.

CALI, a town of Popayan in South America, seated in a valley of the same name on the river Cauca. The governor of the province usually resides there. W. Long. 78. 5. N. Lat. 3. 15.

CALIBER, or Calliper, properly denotes the diameter of any body; thus we say, two columns of the same caliber, the caliber of the bore of a gun, the caliber of a bullet, &c.

Caliber compasses, a sort of compasses made with arched legs to take the diameter of round or swelling bodies. See Compasses.

Caliber compasses are chiefly used by gunners for taking the diameters of the several parts of a piece of ordnance, or of bombs, bullets, &c. Their legs are therefore circular, and move on an arch of brass, whereon is marked the inches and half inches, to show how far the points of the compasses are opened asunder.

Some are also made for taking the diameter of the bore of a gun or mortar.

The gaugers also sometimes use calibers, to embrace the two heads of any cask, in order to find its length.

The caliber used by carpenters and joiners, is a piece of board notched triangular-wise in the middle for the taking of measure.

Caliber Rule, or *Gunners Callipers*, is an instrument wherein a right line is so divided as that the first part being equal to the diameter of an iron or leaden ball of one pound weight, the other parts are to the first as the diameters of balls of two, three, four, &c. pounds are to the diameter of a ball of one pound. The caliber is used by engineers, from the weight of the ball given, to determine its diameter or caliber, or *vice versa*.

The gunners callipers consist of two thin plates of brass joined by a rivet, so as to move quite round each other: its length from the centre of the joint is between six inches and a foot, and its breadth from one to two inches; that of the most convenient size is about nine inches long. Many scales, tables, and proportions, &c. may be introduced on this instrument; but none are essential to it, except those for taking the caliber of shot and cannon, and for measuring the magnitude of salient and entering angles. The most complete callipers is exhibited Plate CXXXIII. the furniture and use of which we shall now briefly describe. Let the four faces of this instrument be distinguished by the letters A, B, C, D: A and D consist of of a circular head and leg; B and C consist only of a leg.

On the circular head adjoining to the leg of the face A are divisions denominated *shot diameters:* which show the distance in inches and tenths of an inch of the points of the callipers when they are opened; so that if a ball not exceeding ten inches be introduced between them, the bevil edge E marks its diameter among these divisions.

On the circular bevil part E of the face B is a scale of divisions distinguished by *lb. weight of iron shot.* When the diameter of any shot is taken between the points of the callipers, the inner edge of the leg A shows its weight in avoirdupois pounds, provided it be lib. $\frac{1}{2}$, 1, $1\frac{1}{2}$, 2, 3, 4, $5\frac{1}{2}$, 6, 8, 9, 12, 16, 18, 24, 26, 32, 36, or 42; the figures nearest the bevil edge answering to the short lines in the scale, and these behind them to the longer strokes. This scale is constructed on the following geometrical theorem, viz. that the weights of spheres are as the cubes of their diameters.

On the lower part of the circular head of the face A is a scale of divisions marked *bores of guns;* for the use of which, the legs of the callipers are slipped across each other, till the steel points touch the concave surface of the gun in its greatest breadth; then the bevil edge F of the face B will cut a division in the scale showing the diameter of the bore in inches and tenths.

Within the scales of *shot* and *bore* diameters on the circular part of A, are divisions marked *pounders:* the inner figures $\frac{1}{4}$, $1\frac{1}{2}$, 3, $5\frac{1}{2}$, 8, 12, 18, 26, 36, correspond to the longest lines; and the figures, 1, 2, 4, 6, 9, 16, 24, 32, 42, to the short strokes. When the bore of a gun is taken between the points of the callipers, the bevil edge F will either cut or be near one of these divisions, and show the weight of iron shot proper for that gun.

On the upper half of the circular head of the face A are three concentric scales of degrees; the outer scale consisting of 180 degrees numbered from right to left, 10, 20, &c. the middle numbered the contrary way, and the outer scale beginning at the middle, with 0, and numbered on each side to 90 degrees. These scales serve to take the quantity of an angle, either entering or salient. For an entering or internal angle, apply the legs of the callipers so that its outward edges coincide with the legs of the given angle, the degree cut by the bevil edge F in the outer scale shows the measure of the angle sought: for a salient or external angle, slip the legs of the callipers across each other, so that their outward edges may coincide with the legs forming the angle, and the degree marked on the middle scale by the bevil edge E will show the measure of the angle required. The inner scale will serve to determine the elevation of cannon and mortars, or of any oblique plane. Let one end of a thread be fixed into the notch on the plate B, and any weight tied to the other end: apply the straight side of the plate A to the side of the body whose inclination is sought; hold it in this position, and move the plate B, till the thread falls upon the line near the centre marked *perp.* Then will the bevil edge F cut the degrees on the inner scale, showing the inclination of that body to the horizon.

On the face C near the point of the callipers is a little table showing the proportion of troy and avoirdupois weights, by which one kind of weight may be easily reduced into another.

Near the extreme of the face D of the callipers are two tables showing the proportion between the pounds weight of London and Paris, and also between the lengths of the foot measure of England and France.

Near the extreme on the face A is a table containing four rules of the circle and sphere; and geometrical figures with numbers annexed to them: the first is a circle including the proportion in round numbers of the diameter to its circumference; the second is a circle, inscribed in a square, and a square within that circle, and another circle in the inner square: the numbers 28, 22, above this figure, exhibit the proportion of the outward square to the area of the inscribed circle: and the numbers 14, 11, below it, show the proportion between the area of the inscribed square and the area of its inscribed circle. The third is a cube inscribed in a sphere; and the number $89\frac{4}{7}$ shows that a cube of iron, inscribed in a sphere of 12 inches in diameter, weighs $89\frac{4}{7}$lb. The fourth is a sphere in a cube, and the number 243 expresses the weight in pounds, of a sphere inscribed in a cube whose side is 12 inches: the fifth represents a cylinder and cone of one foot diameter and height: the number in the cylinder shows, that an iron cylinder of that diameter and height weighs 364.5lb. and the number 121.5 in the cone expresses the weight of a cone, the diameter of whose base is 12 inches, and of the same height: the sixth figure shows that an iron cube, whose side is 12 inches, weighs 464lb. and that a square pyramid of iron, whose base is a square foot, and height 12 inches, weighs $154\frac{2}{3}$lb. The numbers which have been hitherto fixed to the four last figures were not strictly true; and therefore they have been corrected in the figure here referred to; and by these the figures on any instrument of this kind should be corrected likewise.

On the leg B of the callipers, is a table showing the weights of a cubic inch or foot of various bodies in pounds avoirdupois.

On the face D of the circular head of the callipers is a table contained between five concentric segments of rings: the inner one marked *Guns* shows the nature of the gun, or the weight of ball it carries; the two next rings contain the quantity of powder used for proof and service to brass guns, and the two outermost rings show the quantity for proof and service in iron cannon.

On the face A is a table exhibiting the method of computing the *number of shot or shells* in a triangular, square, or rectangular pile. Near this is placed a table containing the principal rules relative to the *fall of bodies*, expressed in an algebraic manner; nearer the centre we have another table of rules for raising water, calculated on the supposition, that one horse is equal in this kind of labour to five men, and that one man will raise a hogshead of water to eight feet of height in one minute, and work at that rate for some hours. N. B. Hogsheads are reckoned at 60 gallons.

Some of the leading principles in gunnery, relating to *shooting* in cannon and mortars, are expressed on the face B of the callipers. Besides the articles already enumerated,

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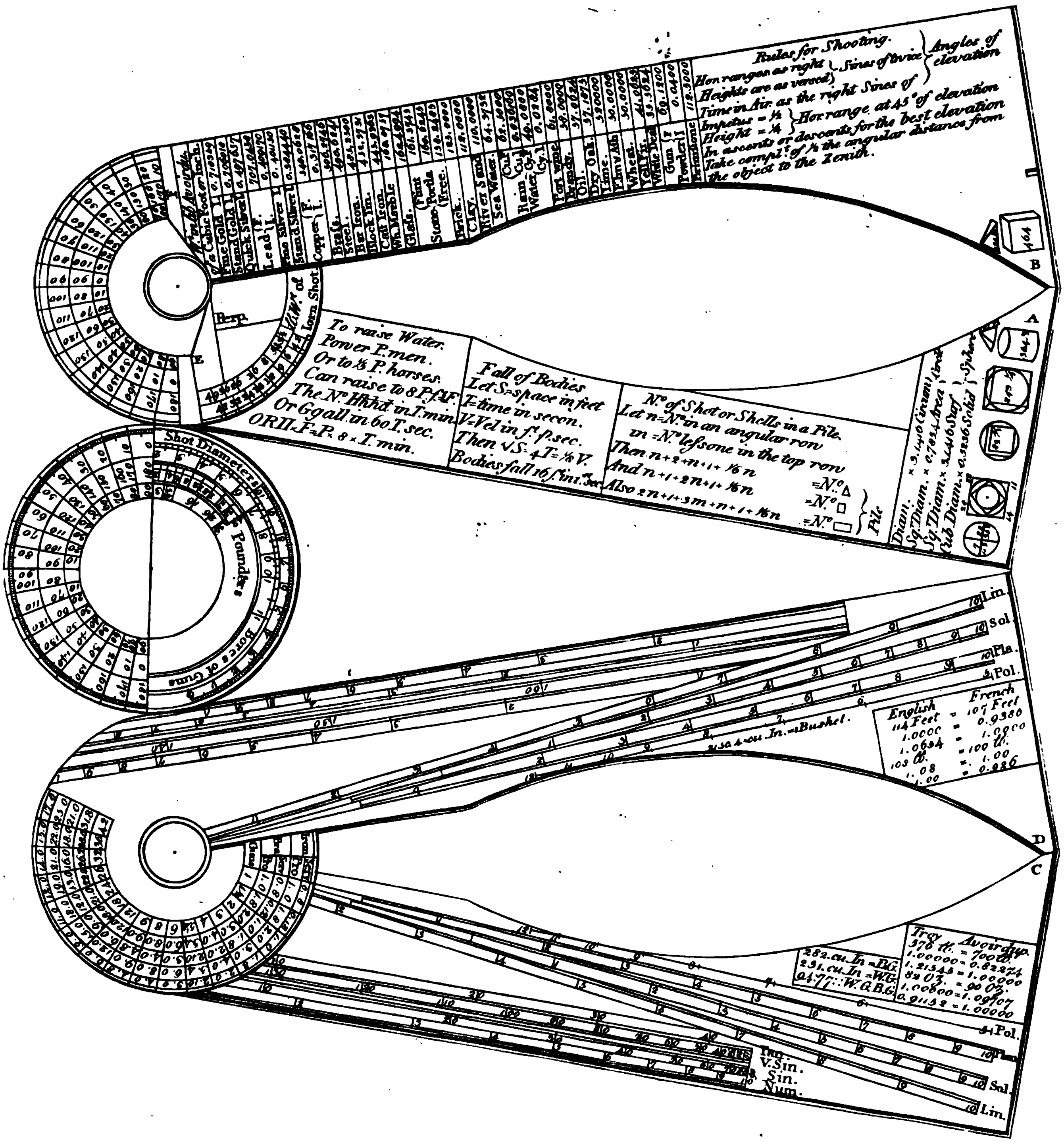
CALIBER RULE. PLATE CXXXIII.



W. Archibald sculp.

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enumerated, the scales usually marked on this sector are laid down on this instrument: thus the line of inches is placed on the edge of the callipers, or on the straight borders of the faces C, D; the logarithmic scales of numbers, sines, versed sines, and tangents, are placed along these faces near the straight edges: the line of lines is placed on the same faces in an angular position, and marked *Lin*. The lines of planes or superfices are also exhibited on the faces C and D, tending towards the centre, and marked *Plan*. Finally, The lines of solids are laid on the same faces tending towards the centre, and distinguished by *Sol*.

CALICOULAN, or Quillon, a town of Asia, in the East Indies, on the coast of Malabar, and in the peninsula on this side the Ganges, where the Dutch have a factory. E. Long. 75. 21. N. Lat. 9. 5.

CALICUT, a kingdom of India, on this side the Ganges, upon the coast of Malabar. It is about 63 miles long, and as much broad. It has many woods, rivers, and marshes, and is very populous; but does not produce much corn, abundance of rice being imported from Canara. The land along the sea-coast is low and sandy, and produces a number of cocoa trees. The higher grounds produce pepper and cardamoms of a very good quality. They have likewise timber for building, white and yellow sanders, cassia lignea, cassia fistula, nux vomica, and cocculus indicus. The woods abound with parrots and monkeys, as well as different kinds of game. They have also plenty of fish, several sorts of medicinal drugs, and their mountains produce iron. The *samorin*, or king, of Calicut, was once master of all the coast of Malabar; but at his death, he left it by will among four of his nephews. He who governs Calicut has a palace of stone, and there is some appearance of grandeur about his court. He carries on a considerable trade, which makes the people of Calicut richer than their neighbours. In former times they had several strange customs, some of which are still kept up; particularly the samorin's wife must be first enjoyed by the high priest, who may have her three nights if he pleases. The nobles permit the other priests to take the same liberty, but the lower people cannot have that honour. A woman may marry a number of husbands; each of whom has her ten days or more, by turns, as they agree among themselves; and provide her all things necessary during that time. When she proves with child she names the father; who, after the child is weaned, takes care of its education. These people have no pens, ink, or paper; but write with a bodkin on flags that grow by the sides of the rivers. By this means the letters are in some sense engraved; and so tough are the flags, that they will last for a great number of years. This was the first land discovered by the Portuguese in 1498.

Calicut, a town of Asia, in the kingdom of that name on the coast of Malabar. It contains a great number of mean low houses, each of which has a garden. The English had a factory here, but it is removed to Tellichery. E. Long. 76. 4. N. Lat. 11. 21.

CALIDÆ plantæ (from *calor*, heat); plants that are natives of warm climates. Such are those of the East Indies, South America, Egypt, and the Canary islands. These plants, says Linnæus, will bear a degree of heat which is as 40 on a scale in which the freezing point is 0, and 100 the heat of boiling water. In the 10th degree of cold they cease to grow, lose their leaves, become barren, are suffocated, and perish.

CALIDUCT, in antiquity, a kind of pipes or canal disposed along the walls of houses or apartments, used by the ancients for conveying heat to several remote parts of the house from one common furnace.

CALIFORNIA, the most northerly of all the Spanish dominions on the continent of America, is sometimes distinguished by the name of *New Albion*, and the *Islas Carrabiras*: but the most ancient appellation is *California*; a word probably owing to some accident, or to some words spoken by the Indians and misunderstood by the Spaniards. For a long time California was thought to be an island; but Father Caino, a Geman Jesuit, discovered it to be a peninusla joining to the coast of New Mexico and the southern parts of America. The peninsula extends from Cape St Sebastian, lying in north latitude 43. 30. to Cape St Lucar, which lies in north latitude 22. 32. It is divided from New Mexico by the gulf, or as some call it the *lake*, of California, or *Vermilion sea*, on the east; on the north, by that part of the continent of North America which is least known; and on the west and south, by the Pacific ocean or great South sea. The coasts, especially towards the Vermilion sea, are covered with inhabited islands, on some of which the Jesuits have established settlements, such as St Clement, Paxaros, St Anne, Cedars (so called from the great number of these trees it produces), St Joseph, and a multitude of others. But the islands best known are three lying off Cape St Lucar towards the Mexican coast. These are called *Les Tres Marias*, "the three Maries." They are small, but have good wood and water, salt pits, and abundance of game; therefore the English and French pirates have sometimes wintered there, when bound on cruises in the South seas.

As California lies altogether within the temperate zone, the natives are neither chilled with cold nor scorched with heat; and indeed the improvements in agriculture made by the Jesuits afford strong proofs of the excellency of the climate. In some places the air is extremely hot and dry; and the earth wild, rugged, and barren. In a country stretching about 800 miles in length, there must be considerable variations of soil and climate; and indeed we find, from good authority, that California produces some of the most beautiful lawns, as well as many of the most inhospitable deserts, in the universe. Upon the whole, although California is rather rough and craggy, we are assured by the Jesuit Vinegas, and other good writers, that with due culture it furnishes every necessary and conveniency of life; and that, even where the atmosphere is hottest, vapours rising from the sea, and dispersed by pleasant breezes, render it of a moderate temperature.

The peninsula of California is now stocked with all sorts of domestic animals known in Spain and Mexico. Horses, mules, asses, oxen, sheep, hogs, goats, and all other quadrupeds imported, thrive and increase in this country. Among the native animals is a species of deer of the size of a young heifer, and greatly resembling it in shape; the head is like that of a deer, and the horns thick and crooked like those of a ram. The hoof of the animal is large, round, and cloven, the skin spotted, but

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California. the hair thinner, and the tail sharper than those of a deer. Its flesh is greatly esteemed. There is another animal peculiar to this country, larger and more bulky than a sheep, but greatly resembling it in figure, and, like it, covered with a fine black or white wool. The flesh of this animal is nourishing and delicious; and, happily for the natives, it is so abundant, that nothing more is required than the trouble of hunting, as these animals wander about in droves in the forests and on the mountains. Father Torquemado describes a creature, which he calls a *species of large bear*, something like a buffalo, of the size of a steer, and nearly of the figure of a stag. Its hair is a quarter of a yard in length, its neck long and awkward, and on its forehead are horns branched like those of a stag. The tail is a yard in length, and half a yard in breadth; and the hoofs cloven like those of an ox. With regard to birds we have but an imperfect account; only, in general, Father Vinegas tells us that the coast is plentifully stored with peacocks, bustards, geese, cranes, and most of the birds common in other parts of the world. The quantity of fish which resort to these coasts is incredible. Salmon, turbot, barbel, skate, mackerel, &c. are caught here with very little trouble; together with pearl oysters, common oysters, lobsters, and a variety of exquisite shell fish. Plenty of turtle are also caught on the coasts. On the South sea coasts are some shell fish peculiar to it, and perhaps the most beautiful in the world; their lustre surpassing that of the finest pearl, and darting their rays through a transparent varnish of an elegant vivid blue, like the lapis lazuli. The fame of California for pearls soon drew forth great numbers of adventurers, who searched every part of the gulf, and are still employed in that work, notwithstanding fashion has greatly diminished the value of this elegant natural production. Father Torquemado observes that the sea of California affords very rich pearl fisheries; and that the *hastias*, or beds of oysters, may be seen in three or four fathom water, almost as plain as if they were on the surface.

The extremity of the peninsula towards Cape St Lucar is more level, temperate, and fertile, than the other parts, and consequently more woody. In the more distant parts, even to the farthest missions on the east coast, no large timber hath yet been discovered. A species of manna is found in this country, which, according to the accounts of the Jesuits, has all the sweetness of refined sugar, without its whiteness. The natives firmly believe that this juice drops from heaven.

The Californians are well made, and very strong. They are extremely pusillanimous, inconstant, stupid, and even insensible, and seem extremely deserving of the character given to the Indians in general, under the article AMERICA. Before the Europeans penetrated into California, the natives had no form of religion. The missionaries indeed tell us many tales concerning them, but they so evidently bear the marks of forgery, as not to be worth repeating. Each nation was then an assemblage of several cottages more or less numerous, that were all mutually confederated by alliances, but without any chief. They were strangers even to filial obedience. No kind of dress was used by the men; but the women made use of some coverings, and were even fond of ornamenting themselves with pearls, and such other trinkets as the country afforded. What most displayed their ingenuity was the construction of their fishing nets, which are said by the Jesuits to have even exceeded in goodness those made in Europe. They were made by the women, of a coarse kind of flax procured from some plants which grow there. Their houses were built of branches and leaves of trees; nay, many of them were only enclosures of earth and stone, raised half a yard high, without any covering; and even these were so small, that they could not stretch themselves at length in them. In winter they dwelt under ground, in caves either natural or artificial.

In 1526 Ferdinand Cortez having reduced and settled Mexico, attempted the conquest of California; but was obliged to return, without even taking a survey of the country, a report of his death having disposed the Mexicans to a general insurrection. Some other attempts were made by the officers of Cortez, but these were also unsuccessful; and this valuable coast was long neglected by the Spaniards, who, to this day, have but one settlement upon it. In 1595 a galleon was sent to make discoveries on the Californian shore; but the vessel was unfortunately lost. Seven years after, the Count de Monteroy, then viceroy of New Spain, sent Sebastian Biscayno on the same design with two ships and a tender; but he made no discovery of importance. In 1684 the Marquis de Laguna, also viceroy of New Spain, dispatched two ships with a tender to make discoveries on the lake of California. He returned with an indifferent account, but was among the first who asserted that California was not an island; which was afterwards confirmed by Father Caino, as already related. In 1697, the Spaniards being discouraged by their losses and disappointments, the Jesuits solicited and obtained permission to undertake the conquest of California. They arrived among the savages with curiosities that might amuse them, corn for their food, and clothes for which they could not but perceive the necessity. The hatred these people bore the Spanish name could not support itself against these demonstrations of benevolence. They testified their acknowledgments as much as their want of sensibility and their inconstancy would permit them. These faults were partly overcome by the religious institutors, who pursued their project with a degree of warmth and resolution peculiar to the society. They made themselves carpenters, masons, weavers, and husbandmen; and by these means succeeded in imparting knowledge, and in some measure a taste for the useful arts, to this savage people, who have been all successively formed into one body. In 1745 they composed 43 villages, separated from each other by the barrenness of the soil and the want of water. The inhabitants of these small villages subsist principally on corn and pulse, which they cultivate; and on the fruits and domestic animals of Europe, the breeding of which last is an object of continual attention. The Indians have each their field, and the property of what they reap; but such is their want of foresight, that they would squander in a day what they had gathered, if the missionary did not take upon himself to distribute it to them as they stand in need of it. They manufacture some coarse stuffs; and the necessaries they are in

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in want of are purchased with pearls, and with wine nearly resembling that of Madeira, which they sell to the Mexicans and to the galleons, and which experience hath shown the necessity of prohibiting in California. A few laws, which are very simple, are sufficient to regulate this rising state. In order to enforce them, the missionary chooses the most intelligent person of the village; who is empowered to whip and imprison; the only punishments of which they have any knowledge. In all California there are only two garrisons, each consisting of 30 men, and a soldier with every missionary. These troops were chosen by the legislators, though they are paid by the government. Were the court of Madrid to push their interest with half the zeal of the Jesuits, California might become one of the most valuable of their acquisitions, on account of the pearls and other valuable articles of commerce which the country contains. At present the little Spanish town near Cape St Lucar is made use of for no other purpose than as a place of refreshment for the Manilla ships, and the head residence of the missionaries.

CALIGA, in Roman antiquity, was the proper soldier's shoe, made in the sandal fashion, without upper leather to cover the superior part of the foot, though otherwise reaching to the middle of the leg, and fastened with thongs. The sole of the caliga was of wood, like the sabot of the French peasants, and its bottom stuck full of nails; which clavi are supposed to have been very long in the shoes of the scouts and sentinels; whence these were called by way of distinction, *caligæ speculatoriæ;* as if, by mounting the wearer to a higher pitch, they gave a greater advantage to the sight: though others will have the *caligæ speculatoriæ* to have been made soft and woolly, to prevent their making a noise. From these *caligæ* it was that the emperor Caligula took his name, as having been born in the army, and afterwards bred up in the habit of a common soldier.

According to Du Cange, a sort of *caliga* was also worn by monks and bishops, when they celebrated mass pontifically.

CALIGATI, an appellation given by some ancient writers to the common soldiers in the Roman armies, by reason of the caliga which they wore. The caliga was the badge or symbol of a soldier; whence to take away the caliga and belt, imported a dismissing or cashiering.

CALIGO, or CALIGATIO, in *Medicine*, an opacity, or cloudiness of the anterior surface of the crystalline lens of the eye, causing a dimness or suffusion of sight.

CALIGULA, the Roman emperor and tyrant, A. D. 37, began his reign with every promising appearance of becoming the real father of his people; but at the end of eight months he was seized with a fever, which it is thought left a frenzy on his mind: for his disposition totally changed, and he committed the most atrocious acts of impiety, cruelty, and folly; such as proclaiming his horse consul, feeding it at his table, introducing it to the temple in the vestments of the priests of Jupiter, &c. and causing sacrifices to be offered to himself, his wife, and the horse. After having murdered many of his subjects with his own hand, and caused others to be put to death without any just cause, he was assassinated by a tribune of the people as he came out of the amphitheatre, A. D. 41, in the 29th year of his age, and 4th of his reign.

CALIN, a compound metal, whereof the Chinese make tea canisters, and the like. The ingredients seem to be lead and tin.

CALIPH, or KHALIF, the supreme ecclesiastical dignity among the Saracens: or, as it is otherwise defined, sovereign dignity among the Mahometans, vested with absolute authority in all matters relating both to religion and policy. In the Arabic it signifies *successor* or *vicar;* the caliphs bearing the same relation to Mahomet that the popes pretend they do to Jesus Christ or St Peter. It is at this day one of the Grand Signior's titles, as successor of Mahomet; and of the Sophi of Persia, as successor of Ali. One of the chief functions of the caliph, in quality of imam or chief priest of Mussulmanism, was to begin the public prayers every Friday in the chief mosque, and to deliver the *khothbak* or sermon. In after times, they had assistants for this latter office; but the former the caliphs always performed in person. The caliph was also obliged to lead the pilgrims to Mecca in person, and to march at the head of the armies of his empire. He granted investiture to princes; and sent swords, standards, gowns, and the like, as presents to princes of the Mahometan religion; who, though they had thrown off the yoke of the caliphate, nevertheless held of it as vassals. The caliphs usually went to the mosque mounted on mules; and the sultans Selgiucides, though masters of Bagdad, held their stirrups, and led their mule by the bridle some distance on foot, till such time as the caliph gave them the sign to mount on horseback. At one of the windows of the caliph's palace there always hung a piece of black velvet 20 cubits long, which reached to the ground, and was called the *caliph's sleeve:* which the grandees of his court never failed to kiss every day, with great respect. After the destruction of the caliphate by Hulaku, the Mahometan princes appointed a particular officer, in their respective dominions, who sustains the sacred authority of caliph. In Turkey, he goes under the denomination of *mufti*, and in Persia under that of *sadne*.

CALIPHATE, the office or dignity of Caliph: See the preceding article. The successions of caliphs continued from the death of Mahomet till the 655th year of the Hegira, when the city of Bagdad was taken by the Tartars. After this, however, there were persons who claimed the caliphate, as pretending to be of the family of the Abassides, and to whom the sultans of Egypt rendered great honours at Cairo, as the true successors of Mahomet: but this honour was merely titular, and the rights allowed them only in matters relating to religion; and though they bore the sovereign title of *caliphs*, they were nevertheless subjects and dependents of the sultans. In the year of the Hegira 361, a kind of caliphate was erected by the Fatemites in Africa, and lasted till it was suppressed by Saladin. Historians also speak of a third caliphate in Yemen or Arabia Felix, erected by some princes of the family of the Jobites. The emperors of Morocco assume the title of *grand cherifs;* and pretend to be the true caliphs, or successors of Mahomet, though under another name.

CALIPPIC PERIOD, in *Chronology*, a series of seventy-six seventy-six years, perpetually recurring; which elapsed, the middle of the new and full moons, as its inventor Calippus, an Athenian, imagined, return to the same day of the solar year. Meton, a hundred years before, had invented the period, or cycle, of nineteen years; assuming the quantity of the solar year 365*d.* 6*h.* 18′ 56″ 50‴ 41⁗ 34‴‴: and the lunar month, 29*d.* 12*h.* 45′ 47″ 26‴ 48⁗ 30‴‴: but Calippus, considering that the Metonic quantity of the solar year was not exact, multiplied Meton's period by 4, and thence arose a period of 76 years, called the *Calippic*. The Calippic period, therefore, contains 27,759 days: and since the lunar cycle contains 235 lunations, and the *Calippic period* is quadruple of this, it contains 940 lunations. This period began in the third year of the 112th Olympiad, or the 4384th of the Julian period. It is demonstrated, however, that the Calippic period itself is not accurate; that it does not bring the new and full moons precisely to their places; 8*h.* 5′ 52″ 60‴, being the excess of 940 lunations, above 76 solar years; but brings them too late, by a whole day in 225 years.

CALISTA, in fabulous history, the daughter of Lycaon king of Arcadia, and one of the nymphs of Diana. Being beloved by Jupiter, that god assumed the form of the goddess of chastity, by which means he debauched her: but her disgrace being revealed, as she was bathing with her patroness, the incensed deity turned her and the son with which she was pregnant into bears; when Jupiter, in compassion to her sufferings, took them up into the heavens, and made them the constellations Ursa Major and Ursa Minor.

CALIX. See CALYX.

CALIXTINS, a name given to those, among the Lutherans, who follow the sentiments of George Calixtus, a celebrated divine, and professor at Helmstadt in the duchy of Brunswick, who died in 1656: he opposed the opinion of St Augustin, on predestination, grace, and free will, and endeavoured to form an union among the various members of the Romish, Lutheran, and reformed churches; or rather, to join them in the bonds of mutual forbearance and charity.

CALIXTINS also denote a sect in Bohemia, derived from the Hussites, about the middle of the 15th century, who asserted the use of the cup as essential to the eucharist. And hence their name; which is formed from the Latin *calyx*, a cup.

The Calixtins are not ranked by Romanists in the list of heretics, since in the main they still adhered to the doctrine of Rome. The reformation they aimed at terminated in the four following articles. 1. In restoring the cup to the laity. 2. In subjecting the criminal clerks to the punishment of the civil magistrate. 3. In stripping the clergy of their lands, lordships, and all temporal jurisdiction. 4. In granting liberty to all capable priests to preach the word of God.

CALKA, a kingdom of Tartary, in Asia, to the east of Siberia.

CALKING. See CAULKING.

CALKINS, the prominent parts at the extremities of a horse shoe, bent downwards, and forged to a sort of point.

Calkins are apt to make horses trip: they also occasion bleymes, and ruin the back sinews. If fashioned in form of a hare's ear, and the horn of a horse's heel be pared a little low, they do little damage; whereas the great square calkins quite spoil the foot.

Calkins are either single or double, that is, at one end of the shoe, or at both: these last are deemed less hurtful, as the horses can tread more even.

CALL, among hunters, a lesson blown upon the horn, to comfort the hounds.

CALL, an English name for the mineral called tungsten or wolfram by the Germans.

CALL, among sailors, a sort of whistle or pipe, of silver or brass, used by the boatswain and his mates to summon the sailors to their duty, and direct them in the different employments in the ship. As the call can be sounded to various strains, each of them is appropriated to some particular exercise; such as hoisting, heaving, lowering, veering away, belaying, letting go a tackle, &c. The act of winding this instrument is called piping, which is as attentively observed by sailors as the beat of the drum to march, retreat, rally, charge, &c. is obeyed by soldiers.

CALL, among fowlers, the noise or cry of a bird, especially to its young, or to its mate in coupling time. One method of catching partridges is by the natural call of a hen trained for the purpose, which drawing the cocks to her, they are entangled in a net. Different birds require different sorts of calls; but they are most of them composed of a pipe or reed, with a little leathern bag or purse, somewhat in form of a bellows; which, by the motion given thereto, yields a noise like that of the species of bird to be taken. The call for partridges is formed like a boat bored through, and fitted with a pipe or swan's quill, &c. to be blown with the mouth, to make the noise of the cock partridge, which is very different from the call of the hen. Calls for quails, &c. are made of a leathern purse in shape like a pear, stuffed with horse hair, and fitted at the end with the bone of a cat's, hare's, or coney's leg, formed like a flageolet. They are played, by squeezing the purse in the palm of the hand, at the same time striking on the flageolet part with the thumb, to counterfeit the call of the hen quail.

CALL of the House. See CALLING.

CALLA, WAKE-ROBIN, or *Ethiopian Arum.* See BOTANY *Index.*

CALLA Susung, a town of Asia, in the island of Bouton in the East Indies. It is seated about a mile from the sea, on the top of a small hill surrounded with cocoa-nut trees. See BOUTON.

CALLAO, a strong town of South America, in Peru. It is the port of Lima, from which it is distant about five miles. The town is built on a low flat point of land on the sea shore. It is fortified; but the fortifications were much damaged by the last great earthquake, and have not since been repaired. The town is not above nine or ten feet above the level of high water mark; but the tide does not commonly rise or fall above five feet. The streets are drawn in a line; but are full of dust, which is very troublesome. In a square near the sea side are the governor's house, the viceroy's palace, the parish church, and a battery of three pieces of cannon. On the north side are the warehouses for the merchandise brought from Chili, Mexico, and other parts of Peru. The other churches are built with reeds, and covered with timber or clay, but they look tolerably neat. There are five monasteries

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ries and an hospital, though the number of families does not exceed 400. The trade of Callao is considerable. From Chili they bring cordage, leather, tallow, dried fish, and corn; from Chiloe, cedar planks, woollen manufactures, and carpets; from Peru, sugars, wines, brandy, masts, cordage, timber for shipping, cacao, tobacco, and melasses; from Mexico, pitch, tar, woods for dyeing, sulphur, balsam of Peru, both white and brown, as well as commodities from China. At the port of Callao the watering is easy, but the wood is a mile or two distant. Earthquakes are very frequent in these parts, which have done vast mischief to Lima and Callao. W. Long. 76. 15. S. Lat. 12. 29.

CALLE, in *Ancient Geography*, a town of Hither Spain, situated on an eminence which hangs over the river Durius; whose port was at the mouth of the river. Now *Porto*, *Oporto*, or *Port a Port*.

CALLEN, a town of Ireland, in the county of Kilkenny and province of Leinster, about ten miles south-west of Kilkenny. W. Long. 7. 22. N. Lat. 52. 25.

CALLICARPA. See JOHNSONIA.

CALLICO, in commerce, a sort of cloth resembling linens made of cotton. The name is taken from that of Calicut, a city on the coast of Malabar, being the first place at which the Portuguese landed when they discovered the India trade. The Spaniards still call it *callicu*.

Callicoes are of different kinds, plain, printed, painted, stained, dyed, chintz, muslins, and the like, all included under the general denomination of *callicoes*. Some of them are painted with various flowers of different colours; others are not stained, but have a stripe of gold and silver quite through the piece, and at each end is fixed a tissue of gold, silver, and silk, intermixed with flowers. The printing of callicoes was first set on foot in London about the year 1676.

CALLICRATES, an ancient sculptor, who engraved some of Homer's verses on a grain of millet, made an ivory chariot that might be concealed under the wing of a fly, and an ant of ivory in which all the members were distinct: but Ælian justly blames him for exerting his genius and talents in things so useless, and at the same time so difficult. He flourished about the year 472 before Christ.

CALLIGONUM. See BOTANY *Index*.

CALLIGRAPHUS, anciently denoted a copyist, or scrivener, who transcribed fair, and at length, what the notaries had taken down in notes or minutes. The word is compounded of καλλος, *beauty*, and γραφω, I *write*. The minutes of acts, &c. were always taken in a kind of cypher, or short hand; such as the notes of Tyro in Gruter: by which means the notaries, as the Latins called them, or the σημειογραφοι and ταχυγραφοι, as the Greeks called them, were enabled to keep pace with a speaker or person who dictated. These notes, being understood by few, were copied over fair, and at length, by persons who had a good hand, for sale, &c. These persons were called *calligraphi*; a name frequently met with in the ancient writers.

CALLIGRAPHY, the art of fair writing. Callicrates is said to have written an elegant distich on a sesamum seed. Junius speaks of a person, as very extraordinary, who wrote the apostles creed, and beginning of St John's Gospel, in the compass of a farthing. What would he have said of our famous Peter Bale, who in 1575 wrote the Lord's prayer, creed, ten commandments, and two short prayers in Latin, with his own name, motto, day of the month, year of the Lord, and reign of the queen, in the compass of a single penny, enchased in a ring and border of gold, and covered with a crystal, all so accurately wrought as to be very legible?

CALLIMACHUS, a celebrated architect, painter, and sculptor, born at Corinth, having seen by accident a vessel about which the plant called *acanthus* had raised its leaves, conceived the idea of forming the Corinthian capital; hence the Corinthian order of architecture. The ancients assure us, that he worked in marble with wonderful delicacy. He flourished about 540 B. C.

CALLIMACHUS, a celebrated Greek poet, native of Cyrene in Libya, flourished under Ptolemy Philadelphus and Ptolemy Euergetes, kings of Egypt, about 280 years before Christ. He passed, according to Quintilian, for the prince of the Greek elegiac poets. His style is elegant, delicate, and nervous. He wrote a great number of small poems, of which we have only some hymns and epigrams remaining. Catullus has closely imitated him, and translated into Latin verse his small poem on the locks of Berenice. Callimachus was also a good grammarian and a learned critic. There is an edition of his remains, by Mes. le Fevre, quarto; and another in two volumes 8vo. with notes by Spanheim, Grævius, Bentley, &c.

CALLING the HOUSE, in the British Parliament, is the calling over the members names, every one answering to his own, and going out of the house, in the order in which he is called: this they do in order to discover whether there be any person there not returned by the clerk of the crown, or if any member be absent without the leave of the house.

CALLINICUS of Heliopolis, inventor of a composition to burn in the water, called the *Greek*, and since *Wild-fire*, See *Grecian* FIRE.

CALLINUS of Ephesus, a very ancient Greek poet, inventor of elegiac verse; some specimens of which are to be found in the collection of Stobeus. He flourished about 776 years before Christ.

CALLIONYMUS, the DRAGONET. See ICHTHYOLOGY *Index*.

CALLIOPE, in the Pagan mythology, the Muse who presides over eloquence and heroic poetry. She was thus called from the sweetness of her voice, and was reckoned the first of the nine sisters. Her distinguishing office was to record the worthy actions of the living; and accordingly she is represented with tablets in her hand.

CALLIPÆDIA, the art of getting or breeding fine and beautiful children. We find divers rules and practices relating to this art, in ancient and modern writers. Among the Magi, a sort of medicine called *ermesia* was administered to pregnant women, as a means of producing a beautiful issue. Of this kind were the kernels of pine nuts ground with honey, myrrh, saffron, palm wine, and milk. The Jews are said to have been so solicitous about the beauty of their children, that care was taken to have some very beautiful child placed at the door of the public baths, that the women

at

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at going out being struck with his appearance, and retaining the idea, might all have children as fine as he. The Chinese take still greater care of their breeding women, to prevent uncouth objects of any kind from striking their imagination. Musicians are employed at night to entertain them with agreeable songs and odes, in which are set forth all the duties and comforts of a conjugal and domestic life; that the infant may receive good impressions even before it is born, and not only come forth agreeably formed in body, but well disposed in mind. Callipædia, nevertheless, seems to have been first erected into a just art by Claude Quillet de Chinon, a French abbot, who, under the fictitious name of *Calvides Lætus*, has published a fine Latin poem in four books, under the title of *Callipædia, seu de pulchræ prolis habendæ ratione;* wherein are contained all the precepts of that new art. There is a translation of it into English verse by Mr Rowe.

CALLIPOLIS, in *Ancient Geography*, the name of several cities of antiquity, particularly one upon the Hellespont, next the Propontis, and opposite to Lampsacus in Asia. Now GALLIPOLI.

CALLIPPIC PERIOD. See CALIPPIC.

CALLIRRHOE, in *Ancient Geography*, surnamed *Enneacrunos*, from its nine springs or channels; a fountain not far from Athens, greatly adorned by Pisistratus, where there were several wells, but this the only running spring. Callirrhoe was also the name of a very fine spring of hot water beyond Jordan near the Dead sea, into which it empties itself.

CALLISIA. See BOTANY *Index*.

CALLISTEA, in Grecian antiquity, a Lesbian festival, wherein the women presented themselves in Juno's temple, and the prize was assigned to the fairest. There was another of these contentions at the festival of Ceres Eleusinia among the Parrhasians, and another among the Eleans, where the most beautiful man was presented with a complete suit of armour, which he consecrated to Minerva, to whose temple he walked in procession, being accompanied by his friends, who adorned him with ribbons, and crowned him with a garland of myrtle.

CALLISTHENES the philosopher, disciple and relation of Aristotle, by whose desire he accompanied Alexander the Great in his expeditions; but proving too severe a censurer of that hero's conduct, he was by him put to the torture (on a suspicion of a treasonable conspiracy), and died under it, 328 years before Christ.

CALLISTRATUS, an excellent Athenian orator, was banished for having obtained too great an authority in the government. Demosthenes was so struck with the force of his eloquence, and the glory it procured him, that he abandoned Plato, and resolved from thenceforward to apply himself to oratory.

CALLITRICHE, or STAR-GRASS, in *Botany*, a genus of the digynia order, belonging to the monandria class of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. There is no calyx, but two petals, and the capsule is bilocular and tetraspermous.

CALLOO, a fortress in the Netherlands, in the territory of Waes, on the river Scheldt, subject to the house of Austria. The Dutch were defeated here by the Spaniards in 1638. E. Long. 4. 10. N. Lat. 51. 15.

CALLOSUM CORPUS, in *Anatomy*, a whitish hard substance, joining the two hemispheres of the brain, and appearing in view when the two hemispheres are drawn back. See ANATOMY *Index*.

CALLOT, JAMES, a celebrated engraver, born at Nancy in 1593. In his youth he travelled to Rome to learn designing and engraving: and from thence went to Florence, where the grand duke took him into his service. After the death of that prince, Callot returned to his native country; when he was very favourably received by Henry duke of Lorrain, who settled a considerable pension upon him. His reputation being soon after spread all over Europe, the infanta of the Netherlands drew him to Brussels, where he engraved the siege of Breda. Louis XIII. made him design the siege of Rochelle, and that of the isle of Rhé. The French king, having taken Nancy in 1631, made Callot the proposal of representing that new conquest, as he had already done the taking of Rochelle: but Callot begged to be excused; and some courtiers resolving to oblige him to do it, he answered, that he would sooner cut off his thumb than do any thing against the honour of his prince and country. This excuse the king accepted; and said, that the duke of Lorrain was happy in having such faithful and affectionate subjects. Callot followed his business so closely, that, though he died at 43 years of age, he is said to have left of his own execution about 1500 pieces. The following are a few of the principal. 1. The *murder of the innocents*, a small oval plate, engraved at Florence. Callot engraved the same subject at Nancy, with some difference in the figures on the back ground. The former is the most rare; a fine impression of it is very difficult to be found. 2. The *marriage of Cana in Galilee*, from Paolo Veronese, a middling sized plate lengthwise. 3. The *passion of Christ*, on 12 very small upright plates: first impressions very scarce. 4. *St John in the island of Patmos*, a small plate, nearly square. 5. The *temptation of St Anthony*, a middling sized plate lengthwise. He also engraved the same subject larger; which, though not the best, is notwithstanding the scarcest print. There is a considerable difference in the treatment of the subject in the two prints. 6. The *punishments*, wherein is seen the execution of several criminals. The marks of the best impressions of this plate are, a small square tower which appears above the houses, towards the left, and a very small image of the Virgin placed in an angle of the wall, near the middle of the print. 7. The *miseries of war*, 18 small plates, lengthwise. There is another set on the same subject, consisting of seven plates less than the former. 8. The *great fair of Florence*, so called because it was engraved at Florence. As several parts of this plate were not equally bitten by the aquafortis, it is difficult to meet with a fine impression. Callot, on his return to Nancy, re-engraved this plate without any alteration. The copy, however, is by no means equal to the original. The first is distinguished from the second by the words *in Firenza*, which appear below at the right-hand corner of the plate. The second has these words in the same place, *Fe. Florientis, excudit Nancei.* There is also a large copy of this print, reversed, published by Savery; but the difference is easily distinguished between it and the true print. 9. The *little fair*, otherwise called the *players at bowls;* where also some peasants are represented

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presented dancing. This is one of the scarcest of Callot's prints; and it is very difficult to meet with a fine impression of it; for the distances and other parts of the plate failed in the biting it with the aquafortis. 10. The *tilting, or the new street at Nancy*, a middling sized plate, lengthwise. 11. The *Garden of Nancy*, where young men are playing with a balloon, the same. 12. *View of the Pont Neuf*, a small plate, lengthwise. 13. *View of the Louvre*, the same. 14. *Four landscapes*, small plates, lengthwise.

CALLUS, or CALLOSITY, in a general sense, any cutaneous, corneous, or osseous hardness, whether natural or preternatural; but most frequently it means the callus generated about the edges of a fracture, provided by nature to preserve the fractured bones, or divided parts, in the situation in which they are replaced by the surgeon. A callus, in this last sense, is a sort of jelly, or liquid viscous matter, that sweats out from the small arteries and bony fibres of the divided parts, and fills up the chinks or cavities between them. It first appears of a cartilaginous substance; but at length becomes quite bony, and joins the fractured part so firmly together, that the limb will often make greater resistance to any external violence, with this part than with those which were never broken.

CALLUS is also a hard, dense, insensible knob, rising on the hands, feet, &c. by much friction and pressure against hard bodies.

CALM, the state of rest which appears in the air and sea when there is no wind stirring. A calm is more dreaded by a seafaring man than a storm, if he has a strong ship and sea room enough; for under the line excessive heat sometimes produces such dead calms, that ships are obliged to stay two or three months without being able to stir one way or other. Two opposite winds will sometimes make a calm. This is frequently observed in the gulf of Mexico, at no great distance from the shore, where some gust or land wind will so poise the general easterly wind, as to produce a perfect calm.

Calms are never so great on the ocean as on the Mediterranean, because the flux and reflux of the former keep the water in a continual agitation, even where there is no wind; whereas there being no tides in the latter, the calm is sometimes so dead, that the face of the water is as clear as a looking glass; but such calms are almost constant presages of an approaching storm. On the coasts about Smyrna, a long calm is reputed a prognostic of an earthquake.

It is not uncommon for the vessels to be calmed, or becalmed, as the sailors express it, in the road of the constant Levantine winds, in places where they ride near the land. Thus between the two capes of Cartooche towards the main, and Cape Antonio in Cuba, the sea is narrow, and there is often a calm produced by some gust of a land wind, that poises the Levantine wind, and renders the whole perfectly still for two or three days. In this case, the current that runs here is of use to the vessels, if it sets right; when it sets easterly, a ship will have a passage in three or four days to the Havannah; but if otherwise, it is often a fortnight or three weeks sail, the ship being embayed in the gulf of Mexico.

When the weather is perfectly calm, no wind at all stirring, the sailors try which way the current sets, by means of a boat which they send out, and which will ride at anchor, though there is no bottom to be found, as regularly and well as if fastened by the strongest anchor to the bottom. The method is this: they row the boat to a little distance from the ship, and then throw over their plummet, which is about forty pounds weight; they let this sink to about two hundred fathoms; and then, though it never reaches the bottom, the boat will turn head against the current, and ride as firmly as can be.

CALM Latitudes, in sea language, are situated in the Atlantic ocean, between the tropic of Cancer and the latitude of 29° N. or they denote the space that lies between the trade and variable winds, because it is frequently subject to calms of long duration.

CALMAR, a strong sea port of Sweden, in the province of Smaland, divided into two towns, the old and the new; but of the former there remains only the church and a few houses. The new town is built a little way from the other, and has large handsome houses. E. Long. 16. 15. N. Lat. 56. 48.

CALMET, AUGUSTINE, one of the most learned and laborious writers of the 18th century, was born at Mesnil le Horgne, a village in the diocese of Toul in France, in the year 1672, and took the habit of the Benedictines in 1688. Among the many works he published are, 1. A literal exposition, in French, of all the books in the Old Testament, in nine volumes folio. 2. An historical, critical, chronological, geographical, and literal dictionary of the Bible, in four vols folio, enriched with a great number of figures of Jewish antiquities. 3. A civil and ecclesiastical history of Lorrain, three vols folio. 4. A history of the Old and New Testament, and of the Jews, in two volumes folio, and seven volumes duodecimo. 5. An universal sacred and profane history, in several volumes quarto. He died in 1757.

CALMUCKS. See KALMUCKS.

CALNE, a town of Wiltshire in England, seated on a river of the same name. It has a handsome church, and sends two members to parliament. W. Long. 1. 59. N. Lat. 51. 30. Population in 1811, 3457.

CALNEH, in *Ancient Geography*, a city in the land of Shinar, built by Nimrod, and the last city mentioned (Gen. x. 10.) as belonging to his kingdom. It is believed to be the same with Calno, mentioned in Isaiah (x. 9.) and with Canneh in Ezekiel (xxvii. 23.) with still greater variation. It is observed, that it must have been situated in Mesopotamia, since these prophets join it with Haran, Eden Assyrian, and Chilmad, which carried on a trade with Tyre. It is said by the Chaldee interpreters, as also by Eusebius and Jerome, to be the same with Ctesiphon, standing upon the Tigris, about three miles distant from Seleucia, and that for some time it was the capital city of the Parthians.

CALOGERI, in church history, monks of the Greek church, divided into three degrees: the novices, called *archari*; the ordinary professed, called *microchemi*; and the more perfect, called *megalochemi*: they are likewise divided into cœnobites, anchorites, and recluses. The cœnobites are employed in reciting their offices from midnight to sunset, they are obliged to make three genuflexions at the door of the choir, and, returning, to bow to the right and to the left, to their bre-

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thren. The anchorets retire from the conversation of the world, and live in hermitages in the neighbourhood of the monasteries; they cultivate a little spot of ground, and never go out but on Sundays and holidays to perform their devotions at the next monastery. As for the recluses, they shut themselves up in grottoes and caverns on the tops of mountains, which they never go out off, abandoning themselves entirely to Providence: they live on the alms sent them by the neighbouring monasteries.

CALOMEL, or dulcified sublimate of mercury, is a combination of mercury with the muriatic acid, in the present nomenclature called a *sub-muriate of mercury.* See PHARMACY and CHEMISTRY *Index.*

CALOPHYLLUM. See BOTANY *Index.*

CALOTTE, a cap or coif of hair, satin, or other stuff; an ecclesiastical ornament in most Popish countries. See CAP.

CALOTTE, in *Architecture*, a round cavity or depressure, in form of a cap or cup, lathed and plastered, used to diminish the rise or elevation of a moderate chapel, cabinet, alcove, &c. which without such an expedient would be too high for other pieces of the apartment.

CALPE, a mountain of Andalusia in Spain; at the foot of which, towards the sea, stands the town of Gibraltar. It is half a league in height towards the land, and so steep that there is no approaching it on that side.

CALPURNIUS, TITUS, a Latin Sicilian poet, lived under the emperor Carus and his son. We have seven of his eclogues remaining.

CALQUING, or CALKING, a term used in painting, &c. where the back side of any thing is covered over with a black or red colour, and the strokes or lines traced through on a waxed plate, wall, or other matter, by passing lightly over each stroke of the design with a point, which leaves an impression of the colour on the plate or wall.

CALTHA. See BOTANY *Index.*—There is only one species known, which grows naturally in moist boggy lands in many parts of England and Scotland. The flowers gathered before they expand, and preserved in salted vinegar, are a good substitute for capers. The juice of the petals, boiled with a little alum, stains paper yellow. The remarkable yellowness of the butter in spring is supposed to be caused by this plant: but cows will not eat it, unless compelled by extreme hunger; and then, Boerhaave says, it occasions such an inflammation, that they generally die. Upon May-day, the country people strew the flowers upon the pavement before their doors. Goats and sheep eat this plant; horses, cows, and swine, refuse it.

CALTROP. See TRIBULUS, BOTANY *Index.*

CALTROP, in military affairs, an instrument with four iron points, disposed in a triangular form, so that three of them are always on the ground, and the fourth in the air. They are scattered over the ground where the enemy's cavalry is to pass, in order to embarrass them.

CALVARIA, in *Anatomy*, the hairy scalp or upper part of the head, which, either by disease or old age, grows bald first.

CALVART, DENIS, a celebrated painter, was born at Antwerp in 1552; and had for his masters Prospero Fontana and Lorenzo Sabbatini. He opened a school at Bologna, which became celebrated; and from which proceeded Guido, Albani, and other great masters. Calvart was well skilled in architecture, perspective, and anatomy, which he considered as necessary to a painter, and taught them to his pupils. His principal works are at Bologna, Rome, and Reggio. He died at Bologna in 1619.

CALVARY, a term used in Catholic countries for a kind of chapel of devotion raised on a hillock near a city, in memory of the place where Jesus Christ was crucified near the city of Jerusalem. The word comes from the Latin *calvarium*; and that from *calvus*, bald, in regard the top of that hillock was bare and destitute of verdure; which is also signified by the Hebrew word *golgotha*. Such is the Calvary of St Valerian near Paris, which is accompanied with several little chapels, in each of which is represented in sculpture one of the mysteries of the Passion.

CALVARY, in *Heraldry*, a cross so called, because it resembles the cross on which our Saviour suffered. It is always set upon steps.

CALVERT, GEORGE, afterwards Lord Baltimore, was born at Kipling in Yorkshire about the year 1582; and educated at Oxford, where he took the degree of bachelor of arts, and afterwards travelled. At his return, he was made secretary to Sir Robert Cecil: he was afterwards knighted, and in 1618 appointed one of the principal secretaries of state. But after he had enjoyed that post about five years, he willingly resigned it; freely owning to his majesty that he was become a Roman Catholic, so that he must either be wanting to his trust, or violate his conscience in discharging his office. This ingenuous confession so affected King James, that he continued him privy counsellor all his reign, and the same year created him baron of Baltimore in the kingdom of Ireland. He had before obtained a patent for him and his heirs, for the province of Avelon in Newfoundland: but that being exposed to the insults of the French, he abandoned it, and afterwards obtained the grant of a country on the north part of Virginia from Charles I. who called it *Maryland*, in honour of his queen: but he died in April 1632 (aged 50), before the patent was made out. It was, however, filled up to his son Cecil Calvert Lord Baltimore; and bears date June 20. 1632. It is held from the crown as part of the manor of Windsor, on one very singular condition, viz. to present two Indian arrows yearly, on Easter Tuesday, at the castle, where they are kept and shown to visitors.—His lordship wrote, 1. A Latin poem on the death of Sir Henry Upton. 2. Speeches in parliament. 3. Various letters of state. 4. The answer of Tom Tell-truth. 5. The Practice of Princes. And, 6. The Lamentation of the Kirk.

CALVI, a town of the province of Lavoro, in the kingdom of Naples, situated near the sea, about fifteen miles north of the city of Naples. E. Long. 14. 45. N. Lat. 41. 15.

CALVI is also the name of a sea-port in the island of Corsica, situated on a bay, on the west side of the island, about 40 miles south-west of Bastia. E. Long. 9. 5. N. Lat. 42. 16.

CALVIN, JOHN, the celebrated reformer of the Christian church from Romish superstitions and doctrinal

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Calvin. nal errors, and founder of the sect since called *Calvinists*, was born in 1509. He was the son of a cooper of Noyon in Picardy; and his real name was *Chauvin*, which he chose to latinize into *Calvinus*, styling himself in the title page to his first work (a Commentary on *Seneca de Clementia*), "Lucius Calvinus, Civis Romanus;" an early proof of his pride, at about 24 years of age. In 1529, he was rector of Pont l'Eveque; and in 1534 he threw up this benefice, separating himself entirely from the Romish church. The persecution against the Protestants in France (with whom he was now associated) obliged him to retire to Basle in Switzerland: here he published his famous Institutes of the Christian religion in 1535. The following year he was chosen professor of divinity, and one of the ministers of the church at Geneva. The next year, viz. 1537, he made all the people solemnly swear to a body of doctrines; but finding that religion had not yet had any great influence on the morals of the people, he, assisted by other ministers, declared, that since all their admonitions and warnings had proved unsuccessful, they could not celebrate the holy sacrament as long as these disorders reigned; he also declared, that he could not submit to some regulations made by the synod of Berne. Upon which the syndics having summoned the people, it was ordered that Calvin and two other ministers should leave the city within two days. Upon this Calvin retired to Strasburg, where he established a French church, of which he was the first minister, and was also chosen professor of divinity there. Two years after he was chosen to assist at the diet appointed by the emperor to meet at Worms and at Ratisbon in order to appease the troubles occasioned by the difference of religion. He went with Beucer, and entered into a conference with Melancthon. The people of Geneva now entreated him to return; to which he consented, and arrived at Geneva, September 13. 1541. He began with establishing a form of ecclesiastical discipline, and a consistorial jurisdiction, with the power of inflicting all kinds of canonical punishments. This was greatly disliked by many persons, who imagined that the papal tyranny would soon be revived. Calvin, however, asserted on all occasions the rights of his consistory with inflexible strictness; and he caused Michael Servetus to be burnt at the stake for writing against the doctrine of the Trinity. But though the rigour of his proceedings sometimes occasioned great tumults in the city, yet nothing could shake his steadiness and inflexibility. Amongst all the disturbances of the commonwealth, he took care of the foreign churches in England, France, Germany, and in Poland; and did more by his pen than his presence, sending his advice and instructions by letter, and writing a greater number of books. This great reformer died on the 27th of May 1564, aged 55. His works were printed together at Amsterdam in 1671, in nine volumes folio; the principal of which are his Institutions, in Latin, the best edition of which is that of Robert Stephens in 1553, in folio; and his Commentaries on the Holy Scriptures.—Calvin is universally allowed to have had great talents, an excellent genius and profound learning. His style is grave and polite. Independent of his spiritual pride, his morals were exemplary; for he was pious, sober, chaste, laborious, and disinterested. But his memory can never be purified from the stain of burning Servetus; it ill became a reformer, to adopt the most odious practice of the corrupt church of Rome.

Calvin ‖ Calvinists.

CALVINISM, the doctrine and sentiments of Calvin and his followers. Calvinism subsists in its greatest purity in the city of Geneva: and from thence it was first propagated into Germany, France, the United Provinces, and England. In France it was abolished by the revocation of the edict of Nantz in 1685. It has been the prevailing religion in the United Provinces ever since the year 1571. The theological system of Calvin was adopted, and made the public rule of faith in England, under the reign of Edward VI. and the church of Scotland was modelled by John Knox, the disciple of Calvin, agreeably to the doctrine, rites, and form of ecclesiastical government, established at Geneva. In England, it has declined since the time of Queen Elizabeth; though it still subsists, some say a little allayed, in the articles of the established church; and in its rigour in Scotland.

The distinguishing theological tenets of Calvinism, as the term is now generally applied, respect the doctrines of PREDESTINATION, or particular ELECTION and REPROBATION, original SIN, particular REDEMPTION, effectual, or, as some have called it, irresistible GRACE in regeneration, JUSTIFICATION by faith, PERSEVERANCE, and the TRINITY. See each of these articles.

Besides the doctrinal part of Calvin's system, which, so far as it differs from that of other reformers of the same period, principally regarded the absolute decree of God, whereby the future and eternal condition of the human race was determined out of mere sovereign pleasure and free will; it extended likewise to the discipline and government of the Christian church, the nature of the Eucharist, and the qualification of those who were entitled to the participation of it. Calvin considered every church as a separate and independent body, invested with the power of legislation for itself. He proposed that it should be governed by presbyteries and synods, composed of clergy and laity, without bishops, or any clerical subordination; and maintained, that the province of the civil magistrate extended only to its protection and outward accommodation. In order to facilitate an union with the Lutheran church, he acknowledged a real, though spiritual, presence of Christ, in the Eucharist, that true Christians were united to the man Christ in this ordinance, and that divine grace was conferred upon them, and sealed to them, in the celebration of it; and he confined the privilege of communion to pious and regenerate believers. In France the Calvinists are distinguished by the name of *Huguenots*; and, among the common people, by that of *Parpaillots*. In Germany they are confounded with the Lutherans, under the general title *Protestants*; only sometimes distinguished by the name *Reformed*.

CALVINISTS, in church history, those who follow the opinions of CALVIN. See the two preceding articles.

Crypto-CALVINISTS, a name given to the favourers of Calvinism in Saxony, on account of their secret attachment to the Genevan doctrine and discipline. Many of them suffered by the decrees of the convocation of Torgaw, held in 1576. The Calvinists in their

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Calvinists ‖ Calumet.

progress have divided into various branches, or lesser sects.

CALVISIUS, Seth, a celebrated German chronologer in the beginning of the 17th century. He wrote *Elenchus calendarii Gregoriani, et duplex calendarii melioris forma*, and other learned works, together with some excellent treatises on music. He died in 1617, aged 61.

CALVITIES, or Calvitium, in *Medicine*, baldness, or a want of hair, particularly on the sinciput, occasioned by the moisture of the head, which should feed it, being dried up, by some disease, old age, or the immoderate use of powder, &c. See Alopecia.

CALUMET, a symbolical instrument of great importance among the American Indians.—It is nothing more than a pipe, whose bowl is generally made of a soft red marble; the tube of a very long reed, ornamented with the wings and feathers of birds. No affair of consequence is transacted without the calumet. It ever appears in meetings of commerce or exchanges; in congresses for determining of peace or war; and even in the very fury of a battle. The acceptance of the calumet is a mark of concurrence with the terms proposed; as the refusal is a certain mark of rejection. Even in the rage of a conflict this pipe is sometimes offered; and if accepted, the weapons of destruction instantly drop from their hands, and a truce ensues. It seems the sacrament of the savages; for no compact is ever violated which is confirmed by a whiff from this holy reed. When they treat of war, the pipe and all its ornaments are usually red, or sometimes red only on one side. The size and decorations of the calumet are for the most part proportioned to the quality of the persons to whom they are presented, and to the importance of the occasion. The calumet of peace is different from that of war. They make use of the former to seal their alliances and treaties, to travel with safety, and to receive strangers; but of the latter to proclaim war. It consists of a red stone, like marble, formed into a cavity resembling the head of a tobacco pipe, and fixed to a hollow reed. They adorn it with feathers of various colours; and name it the calumet of the sun, to which luminary they present it, in expectation of thereby obtaining a change of weather as often as they desire. From the winged ornaments of the calumet, and its conciliating uses, writers compare it to the caduceus of Mercury, which was carried by the caduceatores, or messengers of peace, with terms to the hostile states. It is singular, that the most remote nations, and the most opposite in their other customs and manners, should in some things have, as it were, a certain consent of thought. The Greeks and the Americans had the same idea, in the invention of the caduceus of the one, and the calumet of the other.

Dance of the Calumet, is a solemn rite among the Indians on various occasions. They dare not wash themselves in rivers in the beginning of summer, nor taste of the new fruits, without performing it; and the same ceremony always confirms a peace or precedes a war. It is performed in the winter time in their cabins, and in summer in the open fields. For this purpose they choose a spot among trees to shade them from the heat of the sun, and lay in the middle a large mat, as a carpet, setting upon it the monitor, or god, of the chief of the company. On the right hand of this image, they place the calumet, as their great deity, erecting around it a kind of trophy with their arms. Things being thus disposed, and the hour of dancing come, those who are to sing take the most honourable seats under the shade of the trees. The company is then ranged round, every one, before he sits down, saluting the monitor, which is done by blowing upon it the smoke of their tobacco. Each person next receives the calumet in rotation, and holding it with both hands, dances to the cadence of the vocal music, which is accompanied with the beating of a sort of drum. During this exercise, he gives a signal to one of their warriors, who takes a bow, arrow, and axe, from the trophies already mentioned, and fights him; the former defending himself with the calumet only, and both of them dancing all the while. This mock engagement being over, he who holds the calumet makes a speech, in which he gives an account of the battles he has fought, and the prisoners he has taken, and then receives a cloak, or some other present, from the chief of the ball. He then resigns the calumet to another, who, having acted a similar part, delivers it to a third, who afterwards gives it to his neighbour, till at last the instrument returns to the person that began the ceremony, who presents it to the nation invited to the feast, as a mark of their friendship, and a confirmation of their alliance, when this is the occasion of the entertainment.

Calumet ‖ Calx.

CALUMNY, the crime of accusing another falsely, and knowingly so, of some heinous offence.

Oath of Calumny, Juramentum (or rather *Jusjurandum*) *Calumniæ*, among civilians and canonists, was an oath which both parties in a cause were obliged to take; the plaintiff that he did not bring his charge, and the defendant that he did not deny it, with a design to abuse each other, but because they believed their cause was just and good; that they would not deny the truth, nor create unnecessary delays, nor offer the judge or evidence any gifts or bribes. If the plaintiff refused this oath, the complaint or libel was dismissed; if the defendant, it was taken *pro confesso*. This custom was taken from the ancient athletæ; who, before they engaged, were to swear that they had no malice, nor would use any unfair means for overcoming each other. The *juramentum calumniæ* is much disused, as a great occasion of perjury. Anciently the advocates and proctors also took this oath; but of late it is dispensed with, and thought sufficient that they take it once for all at their first admission to practice. See also Law, Part III. N° clxxxiv. 7.

CALVUS, Cornelius Licinius, a celebrated Roman orator, was the friend of Catullus; and flourished 64 B. C. Catullus, Ovid, and Horace, speak of him.

CALX properly signifies *lime*, but has been used by chemists and physicians for a fine powder remaining after the calcination of metals. All metallic calces are found to weigh more than the metal from which they were originally produced. This arises from the metal having combined with oxygen during the process of calcination or burning; and hence in the present chemical nomenclature they are called *oxides*.

Calx Nativa, in *Natural History*, a kind of marly earth, of a dead whitish colour, which, if thrown into water,

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water, makes a considerable bubbling and hissing noise, and has, without previous burning, the quality of making a cement like lime or plaster of Paris.

Calx Viva, or *Quicklime*, that whereon no water has been cast; in contradiction to lime which has been slaked by pouring water on it.

CALYBITES, the inhabitants of a cottage, an appellation given to divers saints on account of their long residence in some hut by way of mortification.

The word is formed from καλυπτω, *tego*, *I cover*; whence καλυβη, *a little cot*. The Romish church commemorates St John the Calybite on the 15th of December.

CALYCANTHEMÆ, in *Botany*, an order of plants in the *Fragmenta methodi naturalis* of Linnæus, in which are the following genera, viz. epilobium, œnothera, jussiæa, ludivigia, oldenlandia, isnarda, &c. See Botany, *Natural Orders*.

CALYCANTHUS. See Botany *Index*.

CALYCIFLORÆ, in *Botany*, the 16th order in Linnæus's *Fragmenta methodi naturalis*; consisting of plants which, as the title imports, have the stamina (the flower) inserted into the calyx. This order contains the following genera, viz. eleagnus, hippophae, osyris, and trophis. See Botany.

CALYCISTÆ, (from *calyx*, the flower-cup), systematic botanists, so named by Linnæus, who have arranged all vegetables from the different species, structure, and other circumstances, of the calyx or flower-cup. The only systems of this kind are the *Character Plantarum Novus*, a posthumous work of Magnolius, professor of botany at Montpelier, published in 1720; and Linnæus's *Methodus Calycina*, published in his *Classes Plantarum*, at Leyden, in 1738. See Botany, *History*.

CALYDON, in *Ancient Geography*, a town of Ætolia, situated seven miles and a half from the sea, and divided by the river Evenus; the country was anciently called *Æolis*, from the Æolians its inhabitants. This country was famous for the story of Meleager and the Calydonian boar.

CALYPSO, in fabulous history, a goddess who was the daughter of Oceanus and Tethys, or, as others say, of Atlas. She was queen of the island of Ogygia, which from her was called the island of *Calypso*. According to Homer, Ulysses suffered shipwreck on her coast, and staid with her several years.

CALYPTRA, among botanists, a thin membranaceous involucrum, usually of a conic figure, which covers the parts of fructification. The capsules of most of the mosses have calyptræ.

CALYX, among botanists, a general term, expressing the cup of a flower, or that part of a plant which surrounds and supports the other parts of the flower.

The cups of flowers are very various in their structure, and on that account distinguished by several names, as *perianthium*, *involucrum*, *spatha*, *gluma*, &c. See Botany.

CALZADA, a town of Old Castile in Spain, seated on the river Leglera. W. Long. 2. 47. N. Lat. 42. 12.

CAMÆA, in *Natural History*, a genus of the semi-pellucid gems, approaching to the onyx structure, being composed of zones, and formed on a crystalline basis: but having their zones very broad and thick, and laid alternately one on another, with no common matter between; usually less transparent, and more debased with earth, than the onyxes.

1. One species of the camæa is the dull-looking onyx, with broad, black, and white zones; and is the camæa of the moderns, and the Arabian onyx. This species is found in Egypt, Arabia, Persia, and the East Indies. 2. Another species of the camæa is the dull broad-zoned, green and white camæa, or the jaspi-camæo of the Italians: it is found in the East Indies, and in some parts of America. 3. The third is the hard camæa, with broad white and chesnut-coloured veins. 4. The hard camæa, with bluish, white, and flesh-coloured broad veins, being the sardonyx of Pliny's time, only brought from the East Indies.

CAMAIEU, or Camayeu, a word used to express a peculiar sort of onyx: also by some to express a stone, whereon are found various figures, and representations of landscapes, &c. formed by a kind of *lusus naturæ*, so as to exhibit pictures without painting. The word comes from *camahuia*, a name the Orientals give to the onyx, when they find, in preparing it, another colour; as who should say, *a second stone*. It is of these *camaieux* Pliny is to be understood when he speaks of the manifold picture of gems, and the party-coloured spots of precious stones: *Gemmarum pictura tam multiplex lapidumque tam discolores maculæ*.

Camaieu is also applied by others to those precious stones, as onyxes, cornelians, and agates, whereon the lapidaries employ their art to aid nature, and perfect these representations. See Camæa.

Camaieu is also frequently applied to any kind of gem, whereon figures may be engraved either indentedly or in relievo. In this sense the lapidaries of Paris are called in their statutes, *cutters of camayeux*.

A society of learned men at Florence undertook to procure all the *cameos* or *camayeux* and intaglios in the great duke's gallery to be engraven; and began to draw the heads of divers emperors in *cameos*.

Camaieu is also used for a painting, wherein there is only one colour; and where the lights and shadows are of gold, wrought on a golden or azure ground. When the ground is yellow, the French call it *cirage*; when gray, *grissaile*. This kind of work is chiefly used to represent basso relievos: the Greeks call pieces of this sort μονοχρωματα.

CAMALDULIANS, Camaldunians, or Camaldolites, an order of religious, founded by Romuald, an Italian fanatic, in 1023, in the horrible desert of Camaldoli, otherwise called Campo Maldoli, situated in the state of Florence, on the Apennines. Their rule is that of St Benedict; and their houses, by the statutes, are never to be less than five leagues from cities. The *Camaldulians* have not borne that title from the beginning of their order; till the close of the eleventh century they were called *Romualdins*, from the name of their founder. Till that time, *Camaldulian* was a particular name for those of the desert Camaldoli; and D. Grandi observes, was not given to the whole order in regard it was in this monastery that the order commenced, but because the regulation was best maintained here.

Guido Grandi, mathematician of the grand duke of Tuscany,

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Tuscany, and a monk of this order, has published *Camaldulian* Dissertations, on the origin and establishment of it.

The *Camaldulites* were distinguished into two classes, of which the one were COENOBITES, and the other EREMITES.

CAMALODUNUM, in *Ancient Geography*, a town of the Trinobantes, the first Roman colony in Britain, of veterans under the emperor. From the Itineraries it appears to have stood where now Malden stands. It continued to be an open place under the Romans; a place of pleasure rather than strength; yet not unadorned with splendid works, as a theatre and a temple of Claudius: which the Britons considered as badges of slavery, and which gave rise to several seditions and commotions. It stands on a bay of the sea, at the mouth of the Chelmer, in the county of Essex: the modern name is curtailed from the ancient.

CAMARANA, an island of Arabia, in the Red sea, whose inhabitants are little and black. It is the best of all the islands in this sea, and here they fish for coral and pearls. N. Lat. 15. 0.

CAMASSEI, or CAMACE, ANDREA, painter of history and landscape, was born at Bevagna, and at first learned the principles of design and colouring from Domenichino; but afterwards he studied in the school of Andrea Sacchi, and proved a very great painter. He was employed in St Peter's at Rome, as also at St John Lateran; and his works are extremely admired, for the sweetness of his colouring, the elegance of his thoughts and design, and likewise for the delicacy of his pencil. Sandrart laments that the world was deprived of so promising a genius, in the very bloom of life, when his reputation was daily advancing. He died in 1657. At St John Lateran are to be seen, the Battle of Constantine and Maxentius; and the Triumph of Constantine; which are noble and grand compositions; and they afford sufficient proofs of the happiness of his invention, and the correctness of his execution. Also at Wilton, the seat of the earl of Pembroke, there is a picture of Venus with the Graces, said to be by the hand of Camassei.

CAMARCUM, in *Ancient Geography*, the capital of the Nervii, a people of Gallia Belgica, (Antonine, Peutinger); before whose time no mention was made of it. Now Cambray, capital of the Cambresis, in French Flanders. E. Long. 3. 15. Lat. 50. 15.

CAMARINA, in *Ancient Geography*, a city of Sicily, built by the Syracusans on an eminence near the sea, in the south of Sicily, to the west of the promontory Pachynum, between two rivers, the Hipparis and Oanus. Of so famous a city nothing now remains but its name and ancient walls, a mile and a half in compass, with the slight remains of houses: now called *Camarana*.

CAMARINA Palus, a marsh or lake near the city Camarina, and from which it took its name. In a time of drought, the stench of the lake produced a pestilence; upon which the inhabitants consulted the oracle, whether they should not quite drain it. The oracle dissuaded them: they notwithstanding drained it, and opened a way for their enemies to come and plunder their city: hence the proverb *Ne moveas Camarinam*, that is, not to remove one evil to bring on a greater. *Lago di Camarana*, situated in a beautiful plain, under the very walls of Camarina, and of a triangular form.

CAMAYEU. See CAMAIEU.

CAMBAIA, or CAMPAY, a town of Asia, in India, and in the peninsula on this side the Ganges; capital of a province of the same name; but more commonly called *Guzerat*. It is seated at the bottom of a gulf of the same name, on a small river; is a large place with high walls, and has a pretty good trade. The product and manufactures are inferior to few towns in India, for it abounds in corn, cattle, and silk; and cornelian and agate stones are found in its rivers. The inhabitants are noted for embroidery; and some of their quilts have been valued at 40l. It came into the possession of the British in 1803. E. Long. 72. 15. N. Lat. 22. 30.

CAMBAYES, in commerce, cotton cloths made at Bengal, Madras, and some other places on the coast of Coromandel. They are proper for the trade of Marseilles, whither the English at Madras send great numbers of them. Many are also imported into Holland.

CAMBER, according to our monkish historians, one of the three sons of Brute, who, upon his father's death, had that part of Britain assigned him for his share, called from him *Cambria*, now Wales.

CAMBER-Beam, among builders, a piece of timber in an edifice cut archwise, or with an obtuse angle in the middle, commonly used in platforms, as church leads, and on other occasions where long and strong beams are required.

CAMBERED DECKS, among ship-builders. The deck or flooring of a ship is said to be cambered, or to lie cambering, when it is higher in the middle of the ship's length, and droops towards the stem and stern, or the two ends. Also when it lies irregular; a circumstance which renders the ship very unfit for war.

CAMBERT, a French musician in the 17th century, was at first admired for the manner in which he touched the organ, and became superintendant of the music to Anne of Austria the queen-mother. The Abbé Perin associated him in the privilege he obtained of his majesty, of setting up an opera in 1669. Cambert set to music two pastorals, one entitled *Pomona*, the other *Ariadne*, which were the first operas given in France. He also wrote a piece entitled *The pains and pleasures of love*. These pieces pleased the public; yet in 1672, Lully obtaining the privilege of the opera, Cambert was obliged to come to England, where he became superintendant of the music to King Charles II. and died there in 1677.

CAMBIO, an Italian word which signifies *exchange*, commonly used in Provence, and in some other countries, particularly Holland.

CAMBIST, a name given in France to those who trade in notes and bills of exchange. The word *cambist*, though a term of antiquity, is even now a technical word, of some use among merchants, traders, and bankers. Some derive it from the Latin *cambium*, or rather *cambio*.

CAMBLET, or CHAMBLET, a stuff sometimes of wool, sometimes silk, and sometimes hair, especially that of goats, with wool or silk: in some, the warp

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warp is silk and wool twisted together, and the woof hair.

The true or oriental camblet is made of the pure hair of a sort of goat, frequent about Angora, and which makes the riches of that city, all the inhabitants whereof are employed in the manufacture and commerce of camblets. It is certain we find mentioned in middle-age writers stuffs made of camels hair, under the denominations of *camelotum* and *camelinum*, whence probably the origin of the term; but these are represented as strangely coarse, rough, and prickly, and seem to have been chiefly used among the monks by way of mortification, as the hair shirt of latter times.

We have no camblets made in Europe of the goats hair alone; even at Brussels, they find it necessary to add a mixture of woollen thread.

England, France, Holland, and Flanders, are the chief places of this manufacture. Brussels exceeds them all in the beauty and quality of its camblets; those of England are reputed the second.

Figured CAMBLETS, are those of one colour, whereon are stamped various figures, flowers, foliage, &c. by means of hot irons, which are a kind of moulds, passed together with the stuff under a press. These are chiefly brought from Amiens and Flanders; the commerce of these was anciently much more considerable than at present.

Watered CAMBLETS, those which, after weaving, receive a certain preparation with water; and are afterwards passed under a hot press, which gives them a smoothness and lustre.

Waved CAMBLETS, are those whereon waves are impressed, as on tabbies; by means of a calender, under which they are passed and repassed several times.

The manufacturers, &c. of camblets are to take care they do not acquire any false and needless plaits; it being almost impossible to get them out again. This is notorious even to a proverb; we say a person is like camblet he has taken his plait.

CAMBODIA, a kingdom of Asia, in the East Indies, bounded on the north by the kingdom of Laos, on the east by Cochin-China and Chiapa, and on the south and west by the gulf and kingdom of Siam; divided by a large river called *Mecon*. The capital town is of the same name, seated on the western shore of the said river, about 150 miles north of its mouth. This country is annually overflowed in the rainy season, between June and October; and its productions and fruits are much the same with those usually found between the tropics. E. Long. 104. 15. N. Lat. 12. 40.

CAMBODUNUM, (Itinerary); a town of the Brigantes in Britain; now in ruins, near Almonbury in Yorkshire. Westchester, (Talbot.) Also a town of Vindelicia, on the Cambus; now Kempten in Suabia.

CAMBOGIA, in *Botany*, a genus of the monogynia order, belonging to the polyandria class of plants; and in the natural method ranking under the 38th order, *Tricoccæ*. The corolla is tetrapetalous; the calyx tetraphyllous; and the fruit is a pome with eight cells, and solitary seeds. There is but one species, the gutta, a native of India, which yields the gum-resin known by the name of *gamboge* in the shops. See GAMBOGE.

CAMBRASINES, in commerce, fine linen made in Egypt, of which there is a considerable trade at Cairo, Alexandria, and Rosetta, or Raschit. They are called *cambrasines* from their resemblance to cambries.

CAMBRAY, an archiepiscopal city, the capital of the Cambresis, in the Low Countries, seated on the Scheldt. It is defended by good fortifications, and has a fort on the side of the river; and as the land is low on that side, they can lay the adjacent parts under water by means of sluices. Its ditches are large and deep, and those of the citadel are cut into a rock. Clodion became master of Cambray in 445. The Danes burnt it afterwards; since which time it became a free imperial city. It has been the subject of contest between the emperors, the kings of France, and the earls of Flanders. Francis I. let it remain neutral during the war with Charles V. but this last took possession of it in 1543. After this it was given to John of Montluc by Henry III. of France, whom he created prince of Cambray; but the Spaniards took it from Montluc in 1593, which broke his heart. It continued under the dominion of the house of Austria till 1677, when the king of France became master of it, in whose hands it has continued ever since.

The buildings of Cambray are tolerably handsome, and the streets fine and spacious. The place or square for arms is of an extraordinary largeness, and capable of receiving the whole garrison in order of battle. The cathedral dedicated to the Virgin Mary is one of the finest in Europe. The body of the church is very large, and there are rich chapels, the pillars of which are adorned with marble tombs that are of exquisite workmanship, and add greatly to the beauty of the place.

There are two galleries, one of which is of copper, finely wrought. The door of the choir is of the same metal, and well carved. The steeple of this church is very high, and built in the form of a pyramid; and from its top you have a view of the city, which is one of the finest and most agreeable in the Low Countries. There are nine parishes, four abbeys, and several convents for both sexes. The citadel is very advantageously situated on the high ground, and commands the whole city. Cambray is one of the most opulent and commercial cities in the Low Countries; and makes every year a great number of pieces of cambric, with which the inhabitants drive a great trade. E. Long. 3. 20. N. Lat. 50. 11.

CAMBRAY, *M. de Fenelon, archbishop of*. See FENELON.

CAMBRESIS, a province of France, in the Netherlands, about 25 miles in length. It is bounded on the north and east by Hainault, on the south by Picardy, and on the west by Artois. It is a very fertile and populous country; and the inhabitants are industrious, active, and ingenious. The trade consists principally in corn, sheep, very fine wool, and fine linen cloth. Cambray is the capital town.

CAMBRIA, a name for the principality of Wales.

CAMBRIC, in commerce, a species of linen made of flax, very fine and white; the name of which was originally derived from the city of Cambray, where they were first manufactured. They are now made at other places in France.

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Cambric, Cambridge.

The manufacture of cambrics hath long since proved of extraordinary advantage to France. For many years it appeared that England did not in this article contribute less than 200,000l. per annum to the interest of France. This proved motive sufficient to induce the parliament of Great Britain to enact many salutary laws to prevent this great loss of our wealth. See 18 Geo. II. c. 38. and 21 Geo. II. c. 26. See also stat. 32 Geo. II. c. 32. and 4 Geo. III. c. 37. which regulates the cambric manufactory, not long since introduced into Winchelsea in Sussex; but very soon abolished. The cambrics now allowed in this country are manufactured in Scotland and Ireland. Any persons convicted of wearing, selling (except for exportation), or making up for hire any cambric or French lawns, are liable to a penalty of 5l. by the two first statutes cited above.

CAMBRIDGE, a town of England, and capital of the county of that name. It takes the name of Cambridge from the bridge over the Cam, which divides the town into two parts. Either it or a place in the neighbourhood was styled *Camboritum*, in the time of the Romans. It suffered much during the wars with the Danes. Here was a castle built by William the Conqueror, of which the gatehouse yet remains, and is now the county gaol. By Doomsday-book it appears that it then had ten wards, containing 387 houses. In William Rufus's reign it was quite destroyed by Roger de Montgomery; but Henry I. bestowed many privileges upon it to encourage its restoration, particularly an exemption from the power of the sheriff, on condition of its paying yearly into the exchequer 100 merks (equivalent to 1000 pounds now), and from tolls, lastage, pontage, passage, and stallage, in all fairs of his dominions. It was afterwards often plundered in the barons wars by the outlaws from the isle of Ely, till Henry III. secured it by a deep ditch. In 1388, Richard II. held a parliament there. In the rebellion of Wat Tyler and Jack Straw against that prince, the university records were taken and burnt in the market place.

The modern town is about one mile long from south to north, and about half a mile broad in the middle, diminishing at the extremities. It has 14 parish churches, of which two are without any towers. It contained 11,108 inhabitants in 1811; but the private buildings are neither elegant nor large, owing chiefly to their being held on college leases. It is governed by a mayor, high steward, recorder, 13 aldermen and 24 common council men, a town clerk, &c. Its chief trade is water carriage from hence to Downham, Lynn, Ely, &c. The Jews, being encouraged to settle in England by William I. and II. were very populous here for several generations, and inhabited that street now called the *Jewry*. They had a synagogue, since converted to a parish church, called from the shape of its tower *Round Church;* though others are of opinion that it was built by the Knights Templars, it bearing a resemblance to the Temple church in London. The market place is situated in the middle of the town, and consists of two spacious oblong squares united together; at the top of the angle stands the shire hall, lately erected at the expence of the county. At the back of the shire hall is the town hall and gaol. In the market place, fronting the shire hall, is a remarkably handsome stone conduit, to which water is conveyed by an aqueduct, which was the benefaction of the celebrated Hobson, a carrier in the reign of James I. who was a native of this town. A fine road for the benefit of the inhabitants and students was made a few years since for four miles, from this town to Gogmagog hills, pursuant to the will of Mr Worts. The late Dr Addenbroke also left it 4000l. towards building and furnishing an hospital for the cure of poor diseased people gratis; of which charity the master of Catharine hall is a trustee; which hospital has been erected at the south-east end of the town. At a little distance from Bennet college is the botanic garden of five acres, and a large house for the use of the governors and the residence of the curator, given to the university by the late Dr Walker, who settled an estate on it towards its support, to which the late Mr Edward Betham added a very considerable benefaction. The town has fairs on June 24. and August 14.

Cambridge.

The glory of Cambridge is its university; but when it had its beginning is uncertain. At first there was no public provision for the accommodation or maintenance of the scholars; but afterwards inns began to be erected by pious persons for their reception, and in the time of Edward I. colleges began to be built and endowed. This university, not inferior to any in Christendom, consists of 12 colleges and 4 halls, which have the same privileges as the colleges. The whole body, which is commonly about 1500, enjoys very great privileges granted by several of our sovereigns; but it was James I. who empowered it to send two members to parliament, as the town had done from the first. The university is governed, 1. By a chancellor, who is always some nobleman, and may be changed every three years, or continued longer by the tacit consent of the university. 2. By a high steward, chosen by the senate, and holding his place by patent from the university. 3. By a vice-chancellor, who is the head of some college or hall, and chosen yearly by the body of the university, the heads of the colleges naming two. 4. By two proctors chosen every year, according to the cycle of colleges and halls; as are two taxors, who with the proctors regulate the weights and measures, as clerks of markets. The proctors also inspect the behaviour of the scholars, who must not be out of their colleges after nine at night. Here are also 2 moderators, 2 scrutators, a commissary, public orator, 2 librarians, a register, a school-keeper, 3 esquire beadles and a yeoman beadle, 18 professors, and the caput, consisting of the vice-chancellor, a doctor of divinity, a doctor of laws, a doctor of physic, a regent and a non-regent master of arts. Henry VI. granted it the power to print all books of any kind within itself, a privilege which Oxford had not. The senate house of the university is an elegant building of the Corinthian order, cost near 16,000l. building; in which on the north side is a fine statue of George I. erected in 1739 at the expence of the late Lord Townshend; opposite to this on the south side is another of George II. erected in 1765 at the expence of the late duke of Newcastle: at the east end, on each side of the entrance, are two others; one, the late duke of Somerset, after the Vandyke taste; the other, an Italian emblematical figure of Gloria. This is allowed to be the most superb room in England, being 101 feet long,

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Cambridge. long, 42 broad, and 32 high; and it has a gallery which can contain 1000 persons. This building forms the north side of the quadrangle, as the schools and public library do the west, the schools being the ground floor, and the library over them surrounding a small court. North of the philosophy school is the repository of Dr Woodward's fossils, ores, shells, &c. The doctor, together with that collection, and a part of his library, left a sum of money to this university for erecting a professorship for natural philosophy, with a provision of 150l. a-year for ever. At the south-east corner of this building is an elegant geometrical stone staircase which leads to the old library, and consists of 18 classes; at the end of which is an elegant square room, in which are deposited the MSS. and a valuable cabinet of oriental books and curiosities, &c. This room opens to two other rooms, containing 26 large classes, consisting of 30,000 volumes presented to the university by George I. being the entire collection of Dr Moore, bishop of Ely, and purchased of the doctor's executors by his majesty for 6000 guineas; before which his majesty gave the university 2000l. to defray the expence of fitting up the apartments, and erecting classes for their reception; they consist of the first editions of the Greek and Latin classics and historians, and the greatest part of the works of the first printers; large collections of prints by the greatest masters; and a valuable MS. of the Gospels and Acts of the Apostles, on vellum, in Greek and Latin capitals, given to the university by Theodore Beza, and supposed to be as old as any MS. extant. The other part of the library has been rebuilt in an elegant manner, and forms the west side of the intended quadrangle. The books which are contained in the last room are part of the old library, augmented with a considerable number of the best modern books, several of which are presents from foreign sovereigns and eminent men. The south side of the quadrangle is designed for a building to contain the printing-office, &c. of the university, for which preparations began lately to be made by pulling down the old buildings on the spot. St Mary's church forms the east side of this quadrangle; here the university have their public sermons; and the pulpit, which stands in the centre of the church, and faces the chancel, has no soundingboard. In a grand gallery over part of the chancel is a seat for the chancellor, vice-chancellor, &c. George I. when he gave the books, also established a professor of modern history and modern languages in this university, with a salary of 400l. for himself and two persons under him, qualified to instruct in that branch 20 scholars, to be nominated by the king, each of whom is obliged to learn at least two of the languages. A fellowship is founded at Magdalen college, appropriated to the gentlemen of Norfolk, and called *the travelling Norfolk fellowship.* All the libraries in Cambridge, except that of King's college, are lending libraries: and those at Oxford are studying libraries. The different colleges are as follow:

1. St Peter's, the most ancient, and the first on entering the town from London, consisting of two courts, separated by a cloister and gallery. The largest is 144 feet long, and 84 broad. The buildings in this court have been lately repaired in an elegant manner. The lesser court is divided by the chapel, which is a fine old building, 54 feet long, 27 broad, and 27 high. This college was founded in 1257. There are three colleges in Oxford, which dispute the antiquity with this. Cambridge and Oxford were universities long before they were possessed of any colleges in their own right, the students then lodging and boarding with the townsmen, and they then hired hotels for their exercises and disputations. A hotel or hall, now denominated *Pythagoras's school*, situated on the west side of the river, is one of the ancient hotels that remain undemolished, and in which Erasmus read his first Greek lectures in England. 2. Clare hall, on the brink of the river, over which it has an elegant stone bridge, was founded in 1326, consisting of one grand court, 150 feet long, and 111 broad. The front of this building that faces the fields has the appearance of a palace. To this college a new chapel has been added. 3. Pembroke hall is near St Peter's college, and was founded in 1343; it consists of two courts. It has an elegant chapel, built by Sir Christ. Wren. 4. Corpus Christi or Bennet college, founded in 1350, has but a mean appearance, but is possessed of a remarkably large collection of valuable and curious ancient manuscripts. 5. Trinity hall, on the north of Clare hall, near the river, was founded in 1351; it is a small but remarkably neat building. 6. Gonvil and Caius college is near the middle of the town, north of the senate house, and has three courts. It was founded in 1348, and augmented in 1557. 7. King's college, the most noble foundation in Europe, was first endowed by Henry VI. The old court resembles a decayed castle, more than a college. The new building is very magnificent, near 300 feet long. The chapel is one of the finest pieces of Gothic architecture now remaining in the world. It is 304 feet long, 73 broad on the outside, and 40 within, and 91 high; and yet not a single pillar to sustain its ponderous roofs, of which it has two: the first is of stone, most curiously carved; the other of wood, covered with lead, between which is a vacancy of 10 feet. There is such a profusion of carvings, both within and without, as is nowhere to be equalled. Henry VII. enlarged it 188 feet in length, and Henry VIII. gave the elegant stalls and organ gallery, with its inimitable carvings, where are the coats of arms of that king and those of Anne Boleyn quartered. He gave also the elegant painted glass windows, which are in fine preservation, and were permitted by Cromwell to be preserved when almost every other in England was destroyed, as he had a particular regard for this university, where he had his education, and for the town which he had represented in parliament. A new altar has been lately erected, which corresponds with the architecture of the building, embellished with an antique painting of Christ taken down from the cross, purchased in Italy, and presented to the college by the earl of Carlisle. In this chapel are put up the Spanish colours taken at the reduction of Manilla by Colonel Draper, a member of this college. This college has an ancient stone bridge over the Cam. 8. Queen's college, near the river, south of King's, was founded in 1448, and consists of two courts, with a fine grove, and gardens on both sides of the river, connected with each other and the college by two wooden bridges, one of which is of a curious structure. 9. Catharine hall is east of Queen's, and its principal front on the west,

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Cambridge, Cambridge-shire. west, the most extensive and regular in the university. It contains only one court, 180 feet long, and 120 broad. and was founded in 1475. 10. Jesus college is at the east end of the town, surrounded by groves and gardens. The principal front faces the south, 180 feet long, regularly built and sashed: it was originally a Benedictine convent, and converted to the present use in 1576. 11. Christ's college is opposite to St Andrew's church, on the east side of the town; and was founded by Henry VIIth's mother, in 1505. It has lately had a thorough repair, and is now a neat and beautiful structure. 12. St John's college was founded by the same lady, in 1509, on the site of a dissolved priory. It consists of three courts, and has a large library filled with scarce and valuable books. To this college belongs a fine stone bridge over the river, which leads to their grand walks. 13. Magdalen college, the only one that stands on the north side of the river, near the great bridge, consists of two courts, and was founded in 1519. 14. Trinity college is east of the river, having St John's college on the north, and Caius's college and Trinity hall on the south. It contains two large quadrangles, the first of which is 344 feet long, and 280 broad. It has two noble entrances; and on the north side of it is the chapel, 204 feet long, 34 broad, and 44 high. It has every grand ornament, and the much admired statue of Sir Isaac Newton, who was a student in this college. The hall is above 100 feet long, 40 broad, and 50 high. The inner court is esteemed the finest in the university, and surpasses any in Oxford. It is very spacious, and has an elegant cloister of stone pillars, supporting grand apartments: on the west is the library, the most elegant structure of the kind in the kingdom, 190 feet long, 40 broad, and 38 high within. Its entrance is by a staircase, the steps black marble, and the walls incrusted with ancient Roman monuments. The entrance into the library is by folding doors at the north end. Its inside appearance is inexpressibly grand, having at the south end (lately erected) a beautiful painted glass window of his present majesty in his robes; and the classes are large, beautiful, and noble, well stocked with books, manuscripts, &c. Its outside has every suitable embellishment, and was erected by Sir Christopher Wren, at the expence of near 20,000l. Under this building is a spacious piazza of equal dimensions; out of which open three gates to a lawn that leads to the river, over which is a new elegant cycloidal bridge of three arches, leading to extensive walks. In the middle is a remarkable vista. This college was founded on the site of two other colleges and a hall in 1546, by Henry VIII. 15. Emanuel college is at the south-east end of the town; consists of two courts, the principal of which is very neat; and was built on the site of a Dominican convent. It has been lately in great part rebuilt and elegantly embellished. 16. Sidney-Sussex college is in Bridge-street. Its hall is elegant, but the chapel remarkable only for standing north and south, as others do east and west. The number of inhabitants in the town of Cambridge in 1801, was 10,087.

CAMBRIDGESHIRE, an inland county of England, bounded on the east by Norfolk and Suffolk, on the south by Essex and Hertfordshire, on the west by Bedfordshire and Huntingdonshire, and on the north by Lincolnshire. Prior to the arrival of the Romans it was included in the ancient division of the Iceni; and after their conquest, in the third province of Flavia Cæsariensis, which reached from the Thames to the Humber. During the Heptarchy it belonged to the kingdom of the East Angles, the sixth kingdom, which began in 575, and ended in 792, having had 14 kings; and it is now included in the Norfolk circuit, the diocese of Ely, and province of Canterbury, except a small part which is in the diocese of Norwich. It is about 40 miles in length from north to south, and 25 in breadth from east to west, and is 130 miles in circumference, containing near 570,000 acres. It has about 17,400 houses, 140,000 inhabitants: is divided into 17 hundreds, in which are one city, Ely; 8 market towns, viz. Cambridge, which is the shire town, and a celebrated university, Caxton, Linton, Merch, Newmarket, Soham, Wisbeach, Thorney, and part of Royston; 220 villages, 64 parishes: sends 2 members to parliament (exclusive of 2 for the town, and 2 for the university), pays one part of the land tax, and provides 480 men in the militia. Its only rivers are the Cam, the Nene, and the Ouse. A considerable tract of land in this county is distinguished by the name of the Isle of Ely. It consists of fenny ground, divided by innumerable channels and drains: and is part of a very spacious level, containing 300,000 acres of land, extending into Norfolk, Suffolk, Huntingdonshire, and Lincolnshire. The Isle of Ely is the north division of the county, and extends south almost as far as Cambridge. The whole level of which this is part, is bounded on one side by the sea, and on the others by uplands; which, taken together, form a rude kind of semicircle, resembling a horse shoe. The air is very different in different parts of the county. In the fens it is moist and foggy, and therefore not so wholesome; but in the south and east parts it is very good, these being much drier than the other; but both, by late improvements, have been rendered very fruitful, the former by draining, and the latter by cinquefoil: so that it produces plenty of corn, especially barley, saffron, and hemp, and affords the richest pastures. The rivers abound with fish, and the fens with wild fowl. The principal manufactures of the county are malt, paper, and baskets. As the above tract appears to have been dry land formerly, the great change it has undergone must have been owing either to a violent breach and inundation of the sea, or to earthquakes. As the towns in and about the fens were great sufferers by the stagnation of the waters in summer, and want of provisions in winter, many attempts were made to drain them, but without success, until the time of Charles I. in which, and that of his son, the work was happily completed, and an act of parliament passed, by which a corporation was established for its preservation and government. By the same act, 83,000 acres were vested in the corporation, and 10,000 in the king. In these fens are a great many DECOYS, in which incredible numbers of ducks, and other wild fowl, are caught during the season. The population of Cambridgeshire in 1811 amounted to 100,109 persons. See CAMBRIDGESHIRE, SUPPLEMENT.

Cambridgeshire, New Cambridge. *New* CAMBRIDGE, a town of New England, about three

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three miles from Boston, remarkable for an university consisting of three colleges. W. Long. 70. 4. N. Lat. 42. 0.

CAMBRIDGE *Manuscript*, a copy of the Gospels and Acts of the Apostles, in Greek and Latin. Beza found it in the monastery of Irenæus at Lyons in the year 1562, and gave it to the university of Cambridge in 1582. It is a quarto size, and written on vellum; 66 leaves of it are much torn and mutilated, ten of which are supplied by a later transcriber. Beza conjectures, that this manuscript might have existed so early as the time of Irenæus: Wetstein apprehends that it either returned or was first brought from Egypt into France: that it is the same copy which Druthmar, an ancient expositor who lived about the year 840, had seen, and which, he observes, was ascribed to St Hilary: and that R. Stephens had given a particular account of it in his edition of the New Testament in 1550. It is usually called *Stephen's second Manuscript*. Mill agrees with F. Simon in opinion, that it was written in the western part of the world by a Latin scribe, and that it is to a great degree interpolated and corrupted: he observes that it agrees so much with the Latin Vulgate, as to afford reason for concluding, that it was corrected or formed upon a corrupt and faulty copy of that translation. From this and the Clermont copy of St Paul's Epistles, Beza published his larger Annotations in 1582.

CAMBYSES. See (*History of*) PERSIA.

CAMDEN, WILLIAM, the great antiquarian, was born in London in the year 1551. His father was a native of Lichfield in Staffordshire, who settling in London, became a member of the company of paper-stainers, and lived in the Old Bailey. His mother was of the ancient family of Curwen, of Workington, in Cumberland. He was educated first at Christ's hospital, and afterwards at St Paul's school: from thence he was sent, in 1566, to Oxford, and entered servitor of Magdalen college; but being disappointed of a demy's place, he removed to Broadgate hall, and somewhat more than two years after to Christ-church, where he was supported by his kind friend and patron Dr Thornton. About this time he was a candidate for a fellowship of All-souls college, but lost it by the intrigues of the Popish party. In 1570, he supplicated the regents of the university to be admitted bachelor of arts; but in this also he miscarried. The following year Mr Camden came to London, where he prosecuted his favourite study of antiquity, under the patronage of Dr Goodman, dean of Westminster, by whose interest he was made second master of Westminster school in 1575. From the time of his leaving the university to this period, he took several journeys to different parts of England, with a view to make observations and collect materials for his *Britannia*, in which he was now deeply engaged. In 1581 he became intimately acquainted with the learned President Brisson, who was then in England; and in 1586 he published the first edition of his Britannia; a work which, though much enlarged and improved in future editions, was even then esteemed an honour to its author, and the glory of its country. In 1593 he succeeded to the head mastership of Westminster school on the resignation of Dr Grant. In this office he continued till 1597, when he was promoted to be Clarencieux king at arms. In the year 1600 Mr Camden made a tour to the north, as far as Carlisle, accompanied by his friend Mr (afterwards Sir Robert) Cotton. In 1606 he began his correspondence with the celebrated President de Thou, which continued to the death of that faithful historian. In the following year he published his last edition of the Britannia, which is that from which the several English translations have been made; and in 1608, he began to digest his materials for a history of the reign of Queen Elizabeth. In 1609, after recovering from a dangerous illness, he retired to Chislehurst in Kent, where he continued to spend the summer months during the remainder of his life. The first part of his annals of the queen did not appear till the year 1615, and he determined that the second volume should not appear till after his death (A). The work was entirely finished in 1617; and from that time he was principally employed in collecting more materials for the further improvement of his Britannia. In 1622, being now upwards of 70, and finding his health decline apace, he determined to lose no time in executing his design of founding a history lecture in the university of Oxford. His deed of gift was accordingly transmitted by his friend Mr Heather to Mr Gregory Wheare, who was, by himself, appointed his first professor. He died at Chislehurst in 1623, in the 73d year of his age; and was buried with great solemnity in Westminster Abbey, in the south aisle, where a monument of white marble was erected to his memory. Camden was a man of singular modesty and integrity; profoundly learned in the history and antiquities of this kingdom, and a judicious and conscientious historian. He was reverenced and esteemed by the literati of all nations, and will be ever remembered as an honour to the age and country wherein he lived. Besides the works already mentioned, he was author of an excellent Greek grammar, and of several tracts in Hearne's collection. But his great and most useful work, the *Britannia*, is that upon which his fame is chiefly built. The edition above mentioned, to which he put his last hand, was correctly printed in folio, much augmented, amended where it was necessary, and adorned with maps. It was first translated into English, and published in folio at London, in 1611, by the laborious Dr Philemon Holland, a physician of Coventry, who is thought to have consulted our author himself; and therefore great respect has been paid to the additions and explanations that occur

(A) The reign of Queen Elizabeth was so recent when the first volume of the Annals was published, that many of the persons concerned, or their dependents, were still living. It is no wonder, therefore, that the honest historian should offend those whose actions would not bear inquiry. Some of his enemies were clamorous and troublesome; which determined him not to publish the second volume during his life; but, that posterity might be in no danger of disappointment, he deposited one copy in the Cotton library, and transmitted another to his friend Dupuy at Paris. It was first printed at Leyden in 1625.

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occur therein, on a supposition that they may belong to Camden. But in a later edition of the same translation, published in 1636, the doctor has taken liberties which cannot either be defended or excused. A new translation, made with the utmost fidelity from the last edition of our author's work, was published in 1695, by Edmund Gibson of Queen's college in Oxford, afterwards bishop of London; in which, besides the addition of notes, and of all that deserved to be taken notice of in Dr Holland's first edition, which, though thrown out of the text, is preserved at the bottom of the page, there are many other augmentations and improvements, all properly distinguished from the genuine work of the author, as they ought to be: and the same judicious method obtained in the next edition of the same performance, which was justly considered as the very best book of its kind that had been hitherto published. But the public has been recently put in possession of a new translation, and still more improved edition, by that learned and industrious topographer Mr Gough, under whose hands it has been enlarged to near double the size of the last of the preceding editions.

CAMEL, in *Zoology*. See Camelus.

Camel, in *Mechanics*, a kind of machine used in Holland for raising or lifting ships, in order to bring them over the Pampus, which is at the mouth of the river Y, where the shallowness of the water hinders large ships from passing. It is also used in other places, particularly at the dock of Petersburgh, the vessels built here being in their passage to Cronstadt lifted over the bar by means of camels. These machines were originally invented by the celebrated De Wit, for the purpose above mentioned; and were introduced into Russia by Peter the Great, who obtained the model of them when he worked in Holland as a common shipwright. A camel is composed of two separate parts, whose outsides are perpendicular, and whose insides are concave, shaped so as to embrace the hull of a ship on both sides. Each part has a small cabin with sixteen pumps and ten plugs, and contains 20 men. They are braced to a ship underneath by means of cables, and entirely enclose its sides and bottom; being then towed to the bar, the plugs are opened, and the water admitted until the camel sinks with the ship and runs aground. Then, the water being pumped out, the camel rises, lifts up the vessel, and the whole is towed over the bar. This machine can raise the ship eleven feet, or, in other words, make it draw eleven feet less water.

CAMELFORD, a borough town of Cornwall in England, consisting of about 100 houses, badly built; but the streets are broad and well paved. W. Long. 5. 4. N. Lat. 50. 40. It sends two members to parliament; and gives title of baron to Thomas Pitt, elder brother of the great earl of Chatham.

CAMELIA. See Botany *Index*.

CAMELODUNUM. See Camalodunum.

CAMELOPARDALIS, in *Zoology*, the trivial name of a species of Cervus. See Mammalia *Index*.

CAMELUS, or Camel, in *Zoology*, a genus of quadrupeds belonging to the order of pecora. See Mammalia *Index*.

CAMEO. See Camaieu.

CAMERA ÆOLIA, a contrivance for blowing the fire, for the fusion of ores, without bellows, by means of water falling through a funnel into a close vessel, which sends from it so much air or vapour as continually blows the fire: if there be the space of another vessel for it to expatiate in by the way, it there lets fall its humidity, which otherwise might hinder the work. This contrivance was named *camera æolia* by Kircher.

Camera Lucida, a contrivance of Dr Hook for making the image of any thing appear on a wall in a light room, either by day or night. Opposite to the place or wall where the appearance is to be, make a hole of at least a foot in diameter, or if there be a high window with a casement of this dimension in it, this will do much better without such hole or casement opened.

At a convenient distance, to prevent its being perceived by the company in the room, place the object or picture intended to be represented, but in an inverted situation. If the picture be transparent, reflect the sun's rays by means of a looking glass, so as that they may pass through it towards the place of representation; and, to prevent any rays from passing aside it, let the picture be encompassed with some board or cloth. If the object be a statue, or a living creature, it must be much enlightened by casting the sun's rays on it, either by reflection, refraction, or both. Between this object and the place of representation, put a broad convex glass, ground to such a convexity as that it may represent the object distinctly in such place. The nearer this is situated to the object, the more will the image be magnified on the wall, and the further the less: such diversity depending on the difference of the spheres of the glasses. If the object cannot be conveniently inverted, there must be two large glasses of proper spheres, situated at suitable distances, easily found by trial, to make the representations erect. This whole apparatus of object, glasses, &c. with the persons employed in the management of them, are to be placed without the window or hole, so that they may not be perceived by the spectators in the room. Phil. Trans. No. 38. p. 741. seq. See Camera Lucida, Supplement.

Camera Obscura, or *Dark Chamber*, in *Optics*, a machine, or apparatus, representing an artificial eye; whereon the images of external objects, received through a double convex glass, are exhibited distinctly, and in their native colours, on a white matter placed within the machine, in the focus of the glass.

The first invention of this instrument is ascribed to Baptista Porta. See his *Magia Naturalis*, lib. xvii. cap. 6. first published at Frankfort about the year 1589 or 1591; the first four books of this work were published at Antwerp in 1560.

The *camera obscura* affords very diverting spectacles; both by exhibiting images perfectly like their objects, and each clothed in their native colours; and by expressing, at the same time, all their motions; which latter no other art can imitate. By means of this instrument, a person unacquainted with designing will be able to delineate objects with the greatest accuracy and justness, and another well versed in painting will find many things herein to perfect his art. See the construction under Dioptrics.

CAMERARIA.

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CAMERARIA. See Botany *Index*.

CAMERARIUS, Joachim, one of the most learned writers of his time, was born in 1500, at Bamberg, a city of Franconia; and obtained great reputation by his writings. He translated into Latin Herodotus, Demosthenes, Xenophon, Euclid, Homer, Theocritus, Sophocles, Lucian, Theodoret, Nicephorus, &c. He published a catalogue of the bishops of the principal sees; Greek epistles; Accounts of his journeys, in Latin verse; a Commentary on Plautus; the Lives of Helius Eobanus Hessus, and Philip Melancthon, &c. He died in 1574.

Camerarius, *Joachim*, son of the former, and a learned physician, was born at Nuremberg in 1534. After having finished his studies in Germany, he went into Italy, where he obtained the esteem of the learned. At his return he was courted by several princes to live with them; but he was too much devoted to books, and the study of chemistry and botany, to comply. He wrote a Hortus Medicus, and several other works. He died in 1598.

CAMERATED, among builders, the same with vaulted or arched.

CAMERET Bay, in the province of Brittany in France, forms the harbour of Brest. See Brest.

CAMERINO, a town of the Ecclesiastical State in Italy, situated in E. Long. 13. 7. N. Lat. 45. 5.

CAMERLINGO, according to Du Cange, signified formerly the pope's or emperor's treasurer: at present, camerlingo is nowhere used but at Rome, where it denotes the cardinal who governs the Ecclesiastical State, and administers justice. It is the most eminent office at the court of Rome, because he is at the head of the treasury. During a vacation of the papal chair, the cardinal camerlingo publishes edicts, coins money, and exerts every other prerogative of a sovereign prince; he has under him a treasurer-general, auditor-general, and 12 prelates called *clerks of the chamber*.

CAMERON, John, one of the most famous divines among the Protestants of France in the 17th century, was born at Glasgow in Scotland, where he taught the Greek tongue; and having read lectures upon that language for about a year, travelled, and became professor at several universities, and minister at Bourdeaux. He published, 1. Theological lectures; 2. *Icon Johannis Cameronis;* and some miscellaneous pieces. He died in 1625, aged 60.

CAMERONIANS, a sect or party in Scotland, who separated from the Presbyterians in 1666, and continued to hold their religious assemblies in the fields.

The Cameronians took their denomination from Richard Cameron, a famous field preacher, who refusing to accept the indulgences to tender consciences, granted by King Charles II. as such an acceptance seemed an acknowledgment of the king's supremacy, and that he had before a right to silence them, made a defection from his brethren, and even headed a rebellion, in which he was killed. His followers were never entirely reduced till the Revolution, when they voluntarily submitted to King William.

The Cameronians adhered rigidly to the form of government established in 1648.

Cameronians, or *Cameronites*, is also the denomination of a party of Calvinists in France, who asserted that the will of a man is only determined by the practical judgment of the mind; that the cause of men's doing good or evil proceeds from the knowledge which God infuses into them; and that God does not move the will physically, but only morally, in virtue of its dependence on the judgment of the mind. They had this name from John Cameron, a famous professor, first at Glasgow, where he was born, in 1580, and afterwards at Bourdeaux, Sedan, and Saumur; at which last place he broached his new doctrine of grace and free will, which was formed by Amyraut, Cappel, Bochart, Daille, and others of the more learned among the reformed ministers, who judged Calvin's doctrines on these points too harsh. The Cameronians are a sort of mitigated Calvinists, and approach to the opinion of the Arminians. They are also called *Universalists*, as holding the universality of Christ's death; and sometimes *Amyraldists*. The rigid adherents to the synod of Dort accused them of Pelagianism, and even of Manicheism. The controversy between the parties was carried on with a zeal and subtlety scarce conceivable; yet all the question between them was only, Whether the will of man is determined by the immediate action of God upon it, or by the intervention of a knowledge which God impresses into the mind? The synod of Dort had defined that God not only illuminates the understanding, but gives motion to the will by making an internal change therein. Cameron only admitted the illumination, whereby the mind is morally moved; and explained the sentiment of the synod of Dort so as to make the two opinions consistent.

CAMES, a name given to the small slender rods of cast lead of which the glaziers make their turned lead.

Their lead being cast into slender rods of twelve or fourteen inches long each, is called the *came:* sometimes also they call each of these rods a *came*, which being afterwards drawn through their vice, makes their turned lead.

CAMILLUS, Marcus Furius, was the first who rendered the family of *Furius* illustrious. He triumphed four times, was five times dictator, and was honoured with the title of the *second founder of Rome*. In a word, he acquired all the glory a man can gain in his own country. Lucius Apuleius, one of the tribunes, prosecuted him to make him give an account of the spoils taken at Veii. Camillus anticipated judgment, and banished himself voluntarily. During his banishment, instead of rejoicing at the devastation of Rome by the Gauls, he exerted all his wisdom and bravery to drive away the enemy; and yet kept with the utmost strictness the sacred law of Rome, in refusing to accept the command, which several private persons offered him. The Romans who were besieged in the capitol, created him dictator in the year 363; in which office he acted with so much bravery and conduct, that he entirely drove the army of the Gauls out of the territories of the commonwealth. He died in the 81st year of his age, 365 years before the Christian era.

CAMILLI and Camillæ, in antiquity, boys and girls of ingenuous birth, who ministered in the sacrifices of the gods; and especially those who attended the *flamen dialis*, or priest of Jupiter. The word seems borrowed

Camilli | Camoens.

borrowed from the language of the ancient Hetrurians, where it signified minister, and was changed from *casmillus*. The Tuscans also gave the appellation *Camillus* to Mercury, in quality of minister of the gods.

CAMINHA, a maritime town of Portugal, in the province of Entre-Duero-e-Minho, with the title of a duchy. It is situated at the mouth of the river Minho, in W. Long. 9. 15. N. Lat. 41. 14.

CAMIS, or KAMIS, in the Japanese theology, denote deified souls of ancient heroes, who are supposed still to interest themselves in the welfare of the people whom they anciently commanded.

The camis answer to the heroes in the ancient Greek and Roman theology, and are venerated like the saints in the modern Roman church.

Besides the heroes or camis beatified by the consent of antiquity, the *mikaddos*, or pontiffs, have deified many others, and continue still to grant the apotheosis to new worthies; so that they swarm with *camis*: the principal one is *Tensio Dai Sin*, the common father of Japan, to whom are paid devotions and pilgrimages extraordinary.

CAMISADE, in the art of war, an attack by surprise in the night, or at the break of day, when the enemy is supposed to be a-bed. The word is said to have taken its rise from an attack of this kind; wherein, as a badge or signal to know one another by, they bore a shift, in French called *chemise*, or *chamise*, over their arms.

CAMISARDS, a name given by the French to the Calvinists of the Cevennes, who formed a league, and took up arms in their own defence, in 1688.

CAMLETINE, a slight stuff, made of hair and coarse silk, in the manner of camblet. It is now out of fashion.

CAMMA, and GOBBI, two provinces of the kingdom of Loango in Africa. The inhabitants are continually at war with each other. The weapons they formerly used in their wars were the short pike, bows and arrows, sword and dagger; but since the Europeans have become acquainted with that coast, they have supplied them with fire-arms. The chief town of Gobbi lies about a day's journey from the sea.—Their rivers abound with a variety of fish; but are infested with sea-horses, which do great mischief both by land and water. The principal commerce with the natives is in logwood, elephants teeth and tails, the hair of which is highly valued, and used for several curious purposes.

CAMMIN, a maritime town of Germany, in Brandenburg Pomerania, situated in E. Long. 15°. N. Lat. 54°.

CAMOENS, LOUIS DE, a famous Portuguese poet, the honour of whose birth is claimed by different cities. But according to N. Antonio, and Manual Correa, his intimate friend, this event happened at Lisbon in 1517. His family was of considerable note, and originally Spanish. In 1370, Vasco Perez de Caamans, disgusted at the court of Castile, fled to that of Lisbon, where King Ferdinand immediately admitted him into his council, and gave him the lordships of Sardoal, Punnete, Marano, Amendo, and other considerable lands; a certain proof of the eminence of his rank and abilities. In the war for the succession, which broke out on the death of Ferdinand, Camoens sided with the king of Castile, and was killed in the battle of Aljabarota. But though John I. the victor, seized a great part of his estate, his widow, the daughter of Gonsalo Tereyro, grand master of the order of Christ, and general of the Portuguese army, was not reduced beneath her rank. She had three sons, who took the name of *Camoens*. The family of the eldest intermarried with the first nobility of Portugal; and even, according to Castera, with the blood royal. But the family of the second brother, whose fortune was slender, had the superior honour to produce the author of the Lusiad.

Camoens.

Early in his life the misfortunes of the poet began. In his infancy, Simon Vaz de Camoens, his father, commander of a vessel, was shipwrecked at Goa, where, with his life, the greatest part of his fortune was lost. His mother, however, Anne de Macedo of Santarene, provided for the education of her son Louis at the university of Coimbra. What he acquired there, his works discover; an intimacy with the classics, equal to that of a Scaliger, but directed by the taste of a Milton or a Pope.

When he left the university, he appeared at court. He was handsome; had speaking eyes, it is said, and the finest complexion. Certain it is, however, he was a polished scholar, which, added to the natural ardour and gay vivacity of his disposition, rendered him an accomplished gentleman. Courts are the scenes of intrigue; and intrigue was fashionable at Lisbon. But the particulars of the amours of Camoens rest unknown. This only appears; he had aspired above his rank, for he was banished from the court; and in several of his sonnets he ascribes this misfortune to love.

He now retired to his mother's friends at Santarene. Here he renewed his studies, and began his poem on the discovery of India. John III. at this time prepared an armament against Africa. Camoens, tired of his inactive obscure life, went to Ceuta in this expedition, and greatly distinguished his valour in several rencounters. In a naval engagement with the Moors in the straits of Gibraltar, in the conflict of boarding, he was among the foremost, and lost his right eye. Yet neither hurry of actual service nor the dissipation of the camp could stifle his genius. He continued his *Lusiadas*, and several of his most beautiful sonnets were written in Africa, while, as he expressed it,

One hand the pen, and one the sword, employ'd.

The fame of his valour had now reached the court, and he obtained permission to return to Lisbon. But, while he solicited an establishment which he had merited in the ranks of battle, the malignity of evil tongues, as he calls it in one of his letters, was injuriously poured upon him. Though the bloom of his early youth was effaced by several years residence under the scorching heavens of Africa, and though altered by the loss of an eye, his presence gave uneasiness to the gentlemen of some families of the first rank where he had formerly visited. Jealousy is the characteristic of the Spaniards and Portuguese; its resentment knows no bounds, and Camoens now found it prudent to banish himself from his native country. Accordingly, in 1553, he sailed for India, with a resolution never to return. As the ship left the Tagus, he exclaimed, in the words of the sepulchral monument of Scipio Africanus,

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Camoens. canus, *Ingrata patria, non possidebis ossa mea!* "Ungrateful country, thou shalt not possess my bones!" But he knew not what evils in the east would awake the remembrance of his native fields.

When Camoens arrived in India, an expedition was ready to sail to revenge the king of Cochin on the king of Pimenta. Without any rest on shore after his long voyage, he joined this armament, and in the conquest of the Alagada islands displayed his usual bravery.

In the year following, he attended Manuel de Vasconcello in an expedition to the Red sea. Here, says Faria, as Camoens had no use for his sword, he employed his pen. Nor was his activity confined to the fleet or camp. He visited Mount Felix and the adjacent inhospitable regions of Africa, which he so strongly pictures in the Lusiad, and in one of his little pieces where he laments the absence of his mistress.

When he returned to Goa, he enjoyed a tranquillity which enabled him to bestow his attention on his epic poem. But this serenity was interrupted perhaps by his own imprudence. He wrote some satires which gave offence: and by order of the viceroy Francisco Barreto, he was banished to China.

The accomplishments and manners of Camoens soon found him friends, though under the disgrace of banishment. He was appointed commissary of the defunct in the island of Macao, a Portuguese settlement in the bay of Canton. Here he continued his Lusiad; and here also, after five years residence, he acquired a fortune, though small, yet equal to his wishes. Don Constantine de Braganza was now viceroy of India; and Camoens, desirous to return to Goa, resigned his charge. In a ship, freighted by himself, he set sail; but was shipwrecked in the gulf near the mouth of the river Mehon, on the coast of China. All he had acquired was lost in the waves; his poems, which he held in one hand, while he swimmed with the other, were all he found himself possessed of when he stood friendless on the unknown shore. But the natives gave him a most humane reception: this he has immortalized in the prophetic song in the tenth Lusiad; and in the seventh, he tells us, that here he lost the wealth which satisfied his wishes.

Agora da esparança ja adquirida, &c.
Now blest with all the wealth fond hope could crave,
Soon I beheld that wealth beneath the wave
For ever lost;———
My life, like Judah's heaven-doomed king of yore,
By miracle prolong'd———

On the banks of the Mehon he wrote his beautiful paraphrase of the psalm, where the Jews, in the finest strain of poetry, are represented as hanging their harps on the willows, by the rivers of Babylon, and weeping their exile from their native country. Here Camoens continued some time, till an opportunity offered to carry him to Goa. When he arrived at that city, Don Constantine de Braganza, the viceroy, whose characteristic was politeness, admitted him into intimate friendship, and Camoens was happy till Count Redondo assumed the government. Those who had formerly procured the banishment of the satirist, were silent while Constantine was in power; but now they exerted all their arts against him. Redondo, when he entered on office, pretended to be the friend of Camoens; yet, with all that unfeeling indifference with which he made his most horrible witticism on the Zamorin, he suffered the innocent man to be thrown into the common prison. After all the delay of bringing witnesses, Camoens, in a public trial, fully refuted every accusation of his conduct while commissary at Macao, and his enemies were loaded with ignominy and reproach. But Camoens had some creditors, and these detained him in prison a considerable time, till the gentlemen of Goa began to be ashamed that a man of his singular merit should experience such treatment among them. He was set at liberty; and again he assumed the profession of arms, and received the allowance of a gentleman volunteer, a character at this time common in Portuguese India. Soon after, Pedro Barreto, appointed governor of the fort at Sofala, by high promises, allured the poet to attend him thither. The governor of a distant fort, in a barbarous country, shares in some measure the fate of an exile. Yet, though the only motive of Barreto was, in this unpleasant situation, to retain the conversation of Camoens at his table, it was his least care to render the life of his guest agreeable. Chagrined with his treatment, and a considerable time having elapsed in vain dependence upon Barreto, Camoens resolved to return to his native country. A ship, on the homeward voyage, at this time touched at Sofala, and several gentlemen who were on board were desirous that Camoens should accompany them. But this the governor ungenerously endeavoured to prevent, and charged him with a debt for board. Anthony de Cabra, however, and Hector de Sylveyra, paid the demand; and Camoens, says Faria, and the honour of Barreto, were sold together.

After an absence of 16 years, Camoens, in 1569, returned to Lisbon, unhappy even in his arrival, for the pestilence then raged in that city, and prevented his publication for three years. At last, in 1572, he printed his Lusiad, which, in the opening of the first book, in a most elegant turn of compliment, he addressed to his prince, King Sebastian, then in his 18th year. The king, says the French translator, was so pleased with his merit, that he gave the author a pension of 4000 reals, on condition that he should reside at court. But this salary, says the same writer, was withdrawn by Cardinal Henry, who succeeded to the crown of Portugal, lost by Sebastian at the battle of Alcazar.

Though the great patron of one species of literature, a species the reverse of that of Camoens, certain it is, that the author of the Lusiad was utterly neglected by Henry, under whose inglorious reign he died in all the misery of poverty. By some, it is said, he died in an alms-house. It appears, however, that he had not even the certainty of subsistence which these houses provide. He had a black servant, who had grown old with him, and who had long experienced his master's humanity. This grateful Indian, a native of Java, who, according to some writers, saved his master's life in the unhappy shipwreck where he lost his effects, begged in the streets of Lisbon for the only man in Portugal on whom God had bestowed those talents which have a tendency to erect the spirit of a downward age. To the eye of a faithful observer, the fate of Camoens throws

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throws great light on that of his country, and will appear strictly connected with it. The same ignorance, the same degenerated spirit, which suffered Camoens to depend on his share of the alms begged in the streets by his old hoary servant, the same spirit which caused this, sunk the kingdom of Portugal into the most abject vassalage ever experienced by a conquered nation. While the grandees of Portugal were blind to the ruin which impended over them, Camoens beheld it with a pungency of grief which hastened his exit. In one of his letters he has these remarkable words: *Em fim accaberey à vida, e verram todos que fuy efeicoada a minho patria, &c.* "I am ending the course of my life; the world will witness how I have loved my country. I have returned, not only to die in her bosom, but to die with her."

In this unhappy situation, in 1579, in his 62d year, the year after the fatal defeat of Don Sebastian, died Louis de Camoens, the greatest literary genius ever produced by Portugal; in martial courage and spirit of honour nothing inferior to her greatest heroes. And in a manner suitable to the poverty in which he died, was he buried.

CAMOMILE. See ANTHEMIS, BOTANY *Index*.

CAMP, the ground on which an army pitch their tents. It is marked out by the quartermaster general, who appoints every regiment their ground.

The chief advantages to be minded in choosing a camp for an army, are to have it near the water, in a country of forage, where the soldiers may find wood for dressing their victuals; that it have a free communication with garrisons, and with a country from whence it may be supplied with provisions; and, if possible, that it be situated on a rising ground, in a dry gravelly soil. Besides, the advantages of the ground ought to be considered, as marshes, woods, rivers, and enclosure; and if the camp be near the enemy, with no river or marsh to cover it, the army ought to be intrenched. An army always encamps fronting the enemy; and generally in two lines, running parallel, about 500 yards distance; the horse and dragoons, on the wings; and the foot, in the centre; sometimes a body of two, three, or four brigades, is encamped behind the two lines, and is called the *body of reserve*. The artillery and bread-waggons are generally encamped in the rear of the two lines. A battalion of foot is allowed 80 or 100 paces for its camp; and 30 or 40 for an interval betwixt one battalion and another. A squadron of horse is allowed 30 for its camp, and 30 for an interval, and more if the ground will allow it.

Where the grounds are equally dry, those camps are always the most healthful that are pitched on the banks of large rivers; because, in the hot season, situations of this kind have a stream of fresh air from the water, serving to carry off the moist and putrid exhalations. On the other hand, next to marshes, the worst encampments are on low grounds close beset with trees; for then the air is not only moist and hurtful in itself, but by stagnating becomes more susceptible of corruption. However, let the situation of camps be ever so good, they are frequently rendered infectious by the putrid effluvia of rotten straw, and the privies of the army, more especially if the bloody flux prevails; in which case, the best method of preventing a general infection, is to leave the ground with the privies, foul straw, and other filth of the camp, behind. This must be frequently done, if consistent with the military operations: but when these render it improper to change the ground often, the privies should be made deeper than usual, and once a-day a thick layer of earth thrown into them till the pits are near full; and then they are to be well covered, and supplied by others. It may also be a proper caution to order the pits to be made either in the front or the rear, as the then stationary winds may best carry off their effluvia from the camp. Moreover, it will be necessary to change the straw frequently, as being not only apt to rot, but to retain the infectious steams of the sick. But if fresh straw cannot be procured, more care must be taken in airing the tents, as well as the old straw.

The disposition of the Hebrew encampment was at first laid out by God himself. Their camp was of a quadrangular form, surrounded with an enclosure of the height of 10 hands-breadth. It made a square of 12 miles in compass about the tabernacle; and within this was another called the *Levites camp*.

The Greeks had also their camps, fortified with gates and ditches. The Lacedemonians made their camp of a round figure, looking upon that as the most perfect and defensible of any form: we are not, however, to imagine, that they thought this form so essential to a camp, as never to be dispensed with when the circumstances of the place required it. Of the rest of the Grecian camps, it may be observed, that the most valiant of the soldiers were placed at the extremities, the rest in the middle. Thus we learn from Homer, that Achilles and Ajax were posted at the ends of the camp before Troy, as bulwarks on each side of the rest of the princes.

The figure of the Roman camp was a square divided into two principal parts: in the upper part were the general's pavilion, or prætorium, and the tents of the chief officers; in the lower, those of inferior degree were placed. On one side of the prætorium stood the quæstorium, or apartment of the treasurer of the army: and near this the forum, both for a market place and the assembling of councils. On the other side of the prætorium were lodged the legati; and below it the tribunes had their quarters, opposite to their respective legions. Aside of the tribunes were the præfecti of the foreign troops, over against their respective wings; and behind these were the lodgments of the evocati, then those of the extraordinarii and ablecti equites, which concluded the higher part of the camp. Between the two partitions was a spot of ground called *principia*, for the altars and images of the gods, and probably also for the chief ensigns. The middle of the lower partition was assigned to the Roman horse: next to them were quartered the triarii; then the principes, and close by them the hastati; afterwards the foreign horse, and lastly, the foreign foot. They fortified their camp with a ditch and parapet, which they termed *fossa* and *vallum*: in the latter some distinguish two parts, viz. the *agger* or earth, and the *sudes* or wooden stakes driven in to secure it. The camps were sometimes surrounded by walls made of hewn stone; and the tents themselves formed of the same matter.

In the front of the Turkish camp are quartered the janizaries and other foot, whose tents encompass their aga: in the rear are the quarters of the spahis and other

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other horsemen. The body of the camp is possessed by the stately tents or pavilions of the vizier or general, rais effendi or chancellor, khaija or steward, the testerdar bashaw or lord treasurer, and kapislar kabiaseer or master of the ceremonies. In the middle of these tents is a spacious field, wherein are erected a building for the divan, and a hafna or treasury. When the ground is marked out for a camp, all wait for the pitching of the tent *kailac*, the place where the courts of justice are held; it being the disposition of this that is to regulate all the rest.

The Arabs still live in camps, as the ancient Scenites did. The camp of the Assyne Emir, or king of the country about Tadmor, is described, by a traveller who viewed it, as spread over a very large plain, and possessing so vast a space, that though he had the advantage of a rising ground, he could not see the utmost extent of it. His own tent was near the middle; scarce distinguishable from the rest, except that it was bigger, being made, like the others, of a sort of haircloth.

CAMP, is also used by the Siamese, and some other nations in the East Indies, as the name of the quarters which they assign to foreigners who come to trade with them. In these camps, every nation forms, as it were, a particular town, where they carry on all their trade, not only keeping all their warehouses and shops there, but also living in these camps with their whole families. The Europeans, however, are so far indulged, that at Siam, and almost everywhere else, they may live either in the cities or suburbs, as they shall judge most convenient.

Camp-fight, or *Kamp-fight*, in law writers, denotes the trial of a cause by duel, or a legal combat of two champions in the field, for decision of some controversy.

In the trial by camp-fight, the accuser was, with the peril of his own body, to prove the accused guilty; and, by offering him his glove, to challenge him to this trial, which the other must either accept of, or acknowledge himself guilty of the crime whereof he was accused.

If it were a crime deserving death, the camp-fight was for life and death: if the offence deserved only imprisonment, the camp-fight was accomplished when one combatant had subdued the other, so as either to make him yield or take him prisoner. The accused had liberty to choose another to fight in his stead, but the accuser was obliged to perform it in his own person, and with equality of weapons. No women were permitted to be spectators, nor men under the age of thirteen. The priest and the people who looked on were engaged silently in prayer, that the victory might fall to him who had right. None might cry, shriek, or give the least sign; which in some places was executed with so much strictness, that the executioner stood ready with an axe to cut off the right hand or foot of the party that should offend herein.

He that, being wounded, yielded himself, was at the other's mercy either to be killed or suffered to live. But if life were granted him, he was declared infamous by the judge, and disabled from ever bearing arms, or riding on horseback.

CAMPAGNA. See CAMPANIA.

CAMPAIGN, in the art of war, denotes the space of time that an army keeps the field, or is encamped. The beginning of every campaign is considerably more unhealthy than if the men were to remain in quarters. After the first fortnight or three weeks encampment, the sickness decreases daily; the most infirm being by that time in the hospitals, and the weather daily growing warmer. This healthy state continues throughout the summer, unless the men get wet clothes or wet beds; in which case, a greater or less degree of the dysentery will appear in proportion to the preceding heats. But the most sickly part of the campaign begins about the middle or end of August, whilst the days are still hot, but the nights cool and damp, with fogs and dews: then, and not sooner, the dysentery prevails: and though its violence is over by the beginning of October, yet the remitting fever gaining ground, continues throughout the rest of the campaign, and never entirely ceases, even in winter-quarters, till the frost begin. At the beginning of a campaign the sickness is so uniform, that the number may be nearly predicted; but for the rest of the season, as the diseases are then of a contagious nature, and depend so much upon the heats of summer, it is impossible to foresee how many may fall sick from the beginning to the end of autumn. It is also observed, that the last fortnight of a campaign, if protracted till the beginning of winter, is attended with more sickness than the first two months encampment; so that it is better to take the field a fortnight sooner, in order to return into winter-quarters so much the earlier. As to winter expeditions, though severe in appearance, they are attended with little sickness, if the men have strong shoes, quarters, fuel, and provisions. Long marches in summer are not without danger, unless made in the night, or so early in the morning as to be over before the heat of the day.

CAMPANACEÆ, in *Botany*, an order of plants in the *Fragmenta methodi naturalis* of Linnæus, in which are the following genera, viz. convolvulus, ipomæa, polemonium, campanula, roella, viola, &c.*

* See BOTANY, Natural Orders.

CAMPANELLA, THOMAS, a famous Italian philosopher, born at Stilo in Calabria, in 1568. He distinguished himself by his early proficiency in learning: for at the age of 13 he was a perfect master of the ancient orators and poets. His peculiar inclination was to philosophy, to which he at last confined his whole time and study. In order to arrive at truth, he shook off the yoke of authority: by which means the novelty of some of his opinions exposed him to many inconveniences; for at Naples he was thrown into prison, in which he remained 27 years, and during this confinement wrote his famous work entitled *Atheismus triumphatus*. Being at length set at liberty, he went to Paris, where he was graciously received by Louis XIII. and Cardinal Richelieu; the latter procured him a pension of 2000 livres, and often consulted him on the affairs of Italy. Campanella passed the remainder of his days in a monastery of Dominicans at Paris, and died in 1639.

CAMPANI, MATTHEW, of Spoletto, curate at Rome, wrote a curious treatise on the art of cutting glasses for spectacles, and made several improvements in optics, assisted by his brother and pupil Joseph. He died after 1678.

CAMPANIA, a town of Italy, in the kingdom of Naples,

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Naples, and in the Farther Principato, with a bishop's see. E. Long. 15. 30. N. Lat. 40. 40.

Campania, or *Campagna di Roma*, anciently Latium, a province of Italy, bounded on the west by the Tiber and the sea, on the south-west by the sea, on the south by Terra di Lavoro, on the east by Abruzzo, and on the north by Sabina. Though the soil is good, it produces little or nothing, on account of the heavy duties on corn; and though the waters are good, the air is unwholesome. It is subject to the Pope, and is about 60 miles in length, on the Mediterranean sea.

It has been generally thought that the air of this country hath something in it peculiarly noxious during the summer time; but Mr Condamine is of opinion that it is not more unhealthy than any other marshy country. His account follows. "It was after the invasion of the Goths in the fifth and sixth centuries that this corruption of the air began to manifest itself. The bed of the Tiber being covered by the accumulated ruins of the edifices of ancient Rome, could not but raise itself considerably. But what permits us not to doubt of this fact is, that the ancient and well-preserved pavement of the Pantheon and its portico is overflowed every winter; that the water even rises there sometimes to the height of eight or ten feet: and that it is not possible to suppose that the ancient Romans should have built a temple in a place so low as to be covered with the waters of the Tiber on the least inundation. It is evident, then, that the level of the bed of this river is raised several feet; which could not have happened without forming there a kind of dikes or bars. The choking up of its canal necessarily occasioned the overflow and reflux of its waters in such places as till then had not been subject to inundations: to these overflowings of the Tiber were added all the waters that escaped out of the ancient aqueducts, the ruins of which are still to be seen, and which were entirely broken and destroyed by Totila. What need, therefore, of any thing more to infect the air, in a hot climate, than the exhalations of such a mass of stagnating waters deprived of any discharge, and become the receptacle of a thousand impurities, as well as the grave of several millions both of men and animals? The evil could not but increase from the same causes while Rome was exposed to the incursions and devastations of the Lombards, the Normans, and the Saracens, which lasted for several centuries. The air was become so infectious there at the beginning of the 13th century, that Pope Innocent III. wrote, that few people at Rome arrived at the age of forty years, and that nothing was more uncommon there than to see a person of sixty. A very short time after the popes transferred the seat of their residence to Avignon: during the seventy-two years they remained there, Rome became a desert; the monasteries in it were converted into stables; and Gregory XI. on his return to Rome, in 1376, hardly counted there 30,000 inhabitants. At his death began the troubles of the great schism in the west, which continued for upwards of 50 years. Martin V. in whom this schism ended in the year 1429, and his first successors, were able to make but feeble efforts against so inveterate an evil. It was not till the beginning of the 16th century, that Leo X. under whom Rome began to resume her wonted splendour, gave himself some trouble about re-establishing the salubrity of the air: but the city being shortly after besieged twice successively by the emperor Charles V. saw itself plunged again into all its old calamities; and from 85,000 inhabitants, which it contained under Leo X. it was reduced under Clement VIII. to 32,000. In short, it is only since the time of Pius V. and Sextus V. at the end of the 16th century, that the popes have constantly employed the necessary methods for purifying the air of Rome and its environs, by procuring proper discharges for the waters, drying up the humid and marshy grounds, and covering the banks of the Tiber and other places reputed uninhabitable with superb edifices. Since that time a person may dwell at Rome, and go in or out of it at all seasons of the year. At the beginning, however, of the present century, they were still afraid to lie out of the city in summer, when they had resided there; as they were also to return to it, when once they had quitted it. They never ventured to sleep at Rome, even in broad day, in any other house than their own. They are greatly relaxed at present from these ancient scruples: I have seen cardinals, in the months of July and August, go from Rome to lie at Frascati, Tivoli, Albano, &c. and return the next or the following days to the city, without any detriment to their health: I have myself tried all these experiments, without suffering the least inconvenience from them; we have even seen, in the last war in Italy, two armies encamped under the walls of Rome at the time when the heats were most violent. Yet, notwithstanding all this, the greater part of the country people dare not still venture to lie during that season of the year, nor even so much as sleep in a carriage, in any part of the territory comprehended under the name of the *Campagna of Rome*."

CAMPANIFORM, or Campanulated, an appellation given to flowers resembling a bell.

CAMPANINI, a name given to an Italian marble dug out of the mountains of Carrara, because, when it is worked, it sounds like a bell.

CAMPANULA, or Bell-flower. See Botany *Index*.

CAMPBELL, Archibald, Earl and Marquis of Argyle, was the son of Archibald earl of Argyle, by the Lady Anne Douglas, daughter of William earl of Morton. He was born in the year 1598; and educated in the profession of the Protestant religion, according to the strictest rules of the church of Scotland, as it was established immediately after the Reformation. During the commonwealth he was induced to submit to its authority. Upon the Restoration, he was tried for his compliance; a crime common to him with the whole nation, and such a one as the most loyal and affectionate subject might frequently by violence be induced to commit. To make this compliance appear the more voluntary and hearty, there were produced in court letters which he had wrote to Albemarle, while that general governed Scotland, and which contained expressions of the most cordial attachment to the established government. But, besides the general indignation excited by Albemarle's discovery of this private correspondence, men thought, that even the highest demonstrations of affection might, during jealous times, be exacted as a necessary mark of compliance from a person of such distinction as Argyle; and could not, by any equitable construction, imply the crime of treason.

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Campbell. son. The parliament, however, scrupled not to pass sentence upon him, and he suffered with great constancy and courage.

Campbell, *Archibald*, earl of Argyle, son to the former, had from his youth distinguished himself by his loyalty and his attachment to the royal family. Though his father was head of the covenanters, he himself refused to concur in any of their measures; and when a commission of colonel was given him by the convention of states, he forbore to act upon it till it should be ratified by the king. By his respectful behaviour, as well as by his services, he made himself acceptable to Charles when that prince was in Scotland; and even after the battle of Worcester, all the misfortunes which attended the royal cause could not engage him to desert it. Under Middleton he obstinately persevered to harass and infest the victorious English; and it was not till he received orders from that general, that he would submit to accept of a capitulation. Such jealousy of his loyal attachments was entertained by the commonwealth and protector, that a pretence was soon after fallen upon to commit him to prison; and his confinement was rigorously continued till the Restoration. The king, sensible of his services, had remitted to him his father's forfeiture, and created him earl of Argyle; and when a most unjust sentence was passed upon him by the Scots parliament, Charles had anew remitted it. In the subsequent part of this reign Argyle behaved himself dutifully; and though he seemed not disposed to go all lengths with the court, he always appeared, even in his opposition, a man of mild dispositions and peaceable deportment.

A parliament was summoned at Edinburgh in summer 1681, and the duke was appointed commissioner. Besides granting money to the king, and voting the indefeasible right of succession, this parliament enacted a test, which all persons possessed of offices, civil, military, or ecclesiastical, were bound to take. In this test the king's supremacy was asserted, the covenant renounced, passive obedience assented to, and all obligations disclaimed of endeavouring any alteration in civil or ecclesiastical establishments. This was the state of the test as proposed by the courtiers; but the country party proposed also a clause of adherence to the Protestant religion, which could not with decency be rejected. The whole was of an enormous length, considered as an oath; and, what was worse, a confession of faith was there ratified which had been imposed a little after the Reformation, and which contained many articles altogether forged by the parliament and nation. Among others, the doctrine of resistance was inculcated; so that the test being voted in a hurry, was found on examination to be a medley of absurdity and contradiction. Though the courtiers could not reject the clause of adhering to the Protestant religion, they proposed, as a requisite mark of respect, that all princes of the blood should be exempted from taking that oath. This exception was zealously opposed by Argyle: who observed that the sole danger to be dreaded for the Protestant religion must proceed from the perversion of the royal family. By insisting on such topics, he drew on himself the secret indignation of the duke of York, of which he soon felt the fatal consequences.

When Argyle took the test as a privy counsellor, he subjoined, in the duke's presence, an explanation which he had beforehand communicated to that prince, and which he believed to have been approved by him. It was in these words. "I have considered the test, and am very desirous of giving obedience as far as I can. I am confident that the parliament never intended to impose contradictory oaths: therefore I think no man can explain it but for himself. Accordingly I take it as far as it is consistent with itself and the Protestant religion. And I do declare that I mean not to bind myself, in my station, and in a lawful way, from wishing and endeavouring any alteration, which I think to the advantage of church or state, and not repugnant to the Protestant religion and my loyalty; and this I understand as a part of my oath." The duke, as was natural, heard it with great tranquillity: no one took the least offence: Argyle was admitted to sit that day in council; and it was impossible to imagine that a capital offence had been committed where occasion seemed not to have been given so much as for a frown or reprimand.

Argyle was much surprised a few days after, to find that a warrant was issued for committing him to prison; that he was indicted for high treason, leasing-making, and perjury; and that from the innocent words above mentioned an accusation was extracted, by which he was to forfeit life, honours, and fortune. It is needless to enter into particulars, where the iniquity of the whole is so evidently apparent. Though the sword of justice was displayed, even her semblance was not put on; and the forms of law were preserved to sanctify, or rather aggravate, the oppression. Of five judges, three did not scruple to find the guilt of treason and leasing-making to be incurred by the prisoner: a jury of 15 noblemen gave verdict against him; and the king being consulted, ordered the sentence to be pronounced, but the execution of it to be suspended till further orders. Argyle, however, saw no reason to trust to the justice or mercy of such enemies: He made his escape from prison, and till he could find a ship for Holland he concealed himself during some time in London. The king heard of his lurking place, but would not suffer him to be arrested. All the parts, however, of his sentence, so far as the government in Scotland had power, were rigorously executed; his estate confiscated, his arms reversed and torn. Having got over to Holland, he remained there during the remaining part of the reign of Charles II. But thinking himself at liberty, before the coronation of James II. to exert himself in order to recover the constitution by force of arms, he concerted measures with the duke of Monmouth, and went into Scotland, to assemble his friends: but not meeting with the success he expected, he was taken prisoner; and being carried to Edinburgh, was beheaded upon his former unjust sentence, June 30. 1685. He showed great constancy and courage under his misfortunes; on the day of his death he ate his dinner very cheerfully; and, according to custom, slept after it a quarter of an hour or more, very soundly. At the place of execution, he made a short, grave, and religious speech; and, after solemnly declaring that he forgave all his enemies, submitted to death with great firmness.

Campbell, *Archibald*, first duke of Argyle, son to the preceding, was an active promoter of the revolution.

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Campbell. lution. He came over with the prince of Orange; was admitted into the convention as earl of Argyle, though his father's attainder was not reversed; and in the claim of rights the sentence against him was declared to be, what most certainly it was, a reproach upon the nation. The establishment of the crown upon the prince and princess of Orange being carried by a great majority in the Scotish convention, the earl was sent from the nobility, with Sir James Montgomery and Sir John Dalrymple from the barons and boroughs, to offer the crown, in the name of the convention, to their majesties, and tendered them the coronation oath; for which, and many other eminent services, he was admitted a member of the privy council, and, in 1690, made one of the lords of the treasury. He was afterwards made a colonel of the Scots horse guards; and, in 1694, one of the extraordinary lords of session. He was likewise created duke of Argyle, marquis of Kintyre and Lorn, earl of Campbell and Cowall, viscount of Lochow and Glenila, Lord Inverary, Mull, Morvern, and Terrey, by letters-patent, bearing date at Kensington the 23d of June, 1701. He sent over a regiment to Flanders for King William's service, the officers of which were chiefly of his own name and family, who bravely distinguished themselves through the whole course of the war. He married Elizabeth, daughter of Sir Lionel Talmash of Helmingham in the county of Suffolk, by Elizabeth, duchess of Lauderdale, his wife, daughter and heiress of William Murray, earl of Dysart, by whom he left issue two sons and a daughter; namely, John, duke of Argyle, the subject of the next article; Archibald, who succeeded his brother as duke of Argyle; and Lady Anne, married to James Stuart, second earl of Bute, by whom she had a son, afterwards earl of Bute.

CAMPBELL, *John*, second duke of Argyle, and also duke of Greenwich and baron of Chatham, son to the subject of the preceding article, was born on the 10th of October, 1680; and, on the very day when his grandfather suffered at Edinburgh, fell out of a window three pair of stairs high without receiving any hurt. At the age of 15, he had made a considerable progress in classical learning. His father then perceived and encouraged his military disposition, and introduced him to King William, who appointed him to the command of a regiment. In this situation he remained till the death of his father in 1703; when becoming duke of Argyle, he was soon after sworn of Queen Anne's privy council, made captain of the Scots horse guards, and appointed one of the extraordinary lords of session. In 1704, her majesty reviving the Scotish order of the Thistle, his grace was installed one of the knights of that order, and was soon after appointed high-commissioner to the Scotch parliament; where, being of great service in promoting the intended union, he was on his return created a peer of England, by the titles of *baron of Chatham* and *earl of Greenwich*, and in 1710 was made knight of the Garter. His grace first distinguished himself in his military capacity at the battle of Oudenarde; where he commanded as brigadier-general, with all the bravery of youth and the conduct of a veteran officer. He was present under the duke of Marlborough at the siege of Ghent, and took possession of the town. He had also a considerable share in the victory obtained over the French at the battle of Malplaquet, by dislodging them from the wood of Sart, and gaining a post of great consequence. Campbell. In this sharp engagement, several musket-balls passed through the duke's clothes, hat, and peruke. Soon after this hot action, he was sent to take the command in Spain; and after the reduction of Port Mahon he returned to England. His grace having now a seat in the house of lords, he censured the measures of the ministry with such freedom, that all his places were disposed of to other noblemen: but at the accession of George I. he recovered his influence. At the breaking out of the rebellion in 1715, he was made commander-in-chief of his majesty's forces in North Britain; and was the principal means and cause of the total extinction, at that time, of the rebellion in Scotland, without much bloodshed. In direct opposition to him, or that part of the army he commanded, at the head of all his Campbells was placed Campbell, earl of Braidalbin, of the same family and kindred, by some fatal error that ever misguided and misled that unhappy family of the Stuarts and all its adherents. The consequence was, that both sets of Campbells, from family affection, refused to strike a stroke, and retired out of the battle. He arrived at London March 6th, 1716, and was in high favour: but, to the surprise of people of all ranks, he was in a few months divested of all his employments; and from this period to the year 1718, he signalized himself in a civil capacity, by his uncorrupted patriotism and manly eloquence. In the beginning of the year 1719, he was again admitted into favour, appointed lord-steward of the household, and in April following was created duke of Greenwich. He continued in the administration during all the remaining part of that reign; and, after his late majesty's accession, till April 1740; when he delivered a speech with such warmth, that the ministry being highly offended, he was again dismissed from his employments. To these, however, on the change of the ministry, he was soon restored; but not approving of the measures of the new ministry more than those of the old, he gave up all his posts for the last time, and never after engaged in affairs of state. He now enjoyed privacy and retirement; and died of a paralytic disorder on the 4th of October 1743. To the memory of his grace a very noble monument was erected in Westminster Abbey, executed by the ingenious Roubilliac.

The duke of Argyle, though never first minister, was a very able statesman and politician, most steadily fixed in those principles he believed to be right, and not to be shaken or changed. His delicacy and honour were so great, that it hurt him to be even suspected; witness that application said to be made to him by one of the adherents of the Stuart family before the last rebellion in order to gain his interest, which was considerable both in Scotland and England. He immediately sent the letter to the secretary of state; and it vexed him much even to have an application made him, lest any person should think him capable of acting a double part. When be thought measures wrong or corrupt, he cared not who was the author, however great or powerful he might be; witness his boldly attacking the great duke of Marlborough in the house of lords, about his forage and army contracts in Flanders, in the very zenith of his power and popularity,

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Campbell. popularity, though in all other respects he was the most able general of his time. The duke of Argyle on all occasions spoke well, with a firm, manly, and noble eloquence; and seems to deserve the character given of him by Pope:

> Argyle the state's whole thunder born to wield,
> And shake alike the senate and the field.

In private life, the duke's conduct was highly exemplary. He was an affectionate husband and an indulgent master. He seldom parted with his servants till age had rendered them incapable of their employments; and then he made provision for their subsistence. He was liberal to the poor, and particularly to persons of merit in distress: but though he was ready to patronise deserving persons, he was extremely cautious not to deceive any by lavish promises or leading them to form vain expectations. He was a strict economist, and paid his tradesmen punctually every month; and though he maintained the dignity of his rank, he took care that no part of his income should be wasted in empty pomp or unnecessary expences. He was twice married, and left five daughters, but no male issue. The titles of duke and earl of Greenwich and baron of Chatham became extinct at his death; but in his other titles he was succeeded by his brother Archibald earl of Isla, the subject of the next article.

Campbell, *Archibald*, third duke of Argyle, brother to the subject of the preceding article, was born at Hamhouse, in England, in June 1682, and was educated at the university of Glasgow. He afterwards applied himself to the study of the law at Utrecht; but, upon his father's being created a duke, he betook himself to a military life, and served some time under the duke of Marlborough. Upon quitting the army, in which he did not long remain, he applied to the acquisition of that knowledge which would enable him to make a figure in the political world. In 1705, he was constituted treasurer of Scotland, and made a considerable figure in parliament, though he was not more than 23 years of age. In 1706, he was appointed one of the commissioners for treating of the Union; and the same year was created Lord Oronsay, Dunoon, and Arrois, viscount and earl of Isla. In 1708, he was made an extraordinary lord of session; and when the Union was effected, he was chosen one of the Sixteen Peers for Scotland, in the first parliament of Great Britain; and was constantly elected to every future parliament till his death, except the fourth. In 1710, he was made justice-general of Scotland. In 1711, he was called to the privy council; and upon the accession of George I. he was nominated lord register of Scotland. When the rebellion broke out in 1715, he again betook himself to arms, in defence of the house of Hanover, and by his prudent conduct in the West Highlands, he prevented General Gordon, at the head of three thousand men, from penetrating into the country and raising levies. He afterwards joined his brother at Stirling, and was wounded at the battle of Dumblain. In 1725, he was appointed keeper of the privy seal; and from this time, he was entrusted with the management of Scotish affairs. In 1734, upon his resigning the privy seal, he was made keeper of the great seal, which office he enjoyed till his death. Upon the decease of his brother, he became duke of Argyle, hereditary justice-general, lieutenant, sheriff, and commissary of Argyleshire and the Western Isles, hereditary great master of the household, hereditary keeper of Dunstaffnage, Carrick, and several other castles. He was also chancellor of the university of Aberdeen; and laboured to promote the interest of that, as well as of the other universities of Scotland. He particularly encouraged the school of physic at Edinburgh, which has now acquired so high a reputation. Having the chief management of Scotch affairs, he was also extremely attentive to promote the trade, manufactures, and improvements of his country. It was by his advice that, after the rebellion in 1745, the Highlanders were employed in the royal army. He was a man of great endowments, both natural and acquired, well versed in the laws of his country, and possessed considerable parliamentary abilities. He was likewise eminent for his skill in human nature, had great talents for conversation, and had collected one of the most valuable private libraries in Great Britain. He built himself a very magnificent seat at Inverary. The faculties of his mind continued sound and vigorous till his death, which happened suddenly on the 15th of April 1761, in the 79th year of his age. He was married, but had no issue; and was succeeded in his titles and the estates of the family by John Campbell, fourth duke of Argyle, son of the honourable John Campbell of Mammore, who was the second son of Archibald the ninth earl of Argyle. Campbell.

The family of Argyle were heritable justice generals for Scotland till abolished by the jurisdiction act. They are still heritable masters of the king's household in Scotland, and keepers of Dunstaffnage and Carrick.

Campbell, *John*, an eminent historical, biographical, and political writer, was born at Edinburgh, March 8. 1707-8. His father, Robert Campbell of Glenlyon, Esq. was captain of horse in a regiment commanded by the then earl of Hyndford; and his mother, Elizabeth, daughter of —— Smith, Esq. of Windsor in Berkshire, had the honour of claiming a descent from the poet Waller. Our author, their fourth son, was at the age of five years carried from Scotland to Windsor, where he received the first principles of his education; and at a proper age, he was placed out as clerk to an attorney, being intended for the law. This profession, however, he never followed; but by a close application to the acquisition of knowledge of various kinds, became qualified to appear with great advantage in the literary world. In 1736, before he had completed his 30th year, he gave to the public, in two volumes folio, "the Military History of Prince Eugene and the duke of Marlborough," enriched with maps, plans, and cuts. The reputation hence acquired, occasioned him soon after to be solicited to take a part in the "Ancient Universal History." Whilst employed in this capital work, Mr Campbell found leisure to entertain the world with other productions. In 1739, he published the "Travels and Adventures of Edward Brown, Esq." 8vo. In the same year appeared his "Memoirs of the Bashaw Duke de Ripperda," 8vo. reprinted, with improvements, in 1740. These memoirs were followed, Campbell. followed, in 1741, by the "Concise History of Spanish America," 8vo. In 1742, he was the author of "A Letter to a friend in the Country, on the Publication of Thurloe's State Papers;" giving an account of their discovery, importance, and utility. The same year was distinguished by the appearance of the 1st and 2d volumes of his "Lives of the English Admirals, and other eminent British Seamen." The two remaining volumes were completed in 1744; and the whole, not long after, was translated into German. This was the first of Mr Campbell's works to which he prefixed his name; and it is a performance of great and acknowledged merit. In 1743, he published "Hermippus revived;" a second edition of which, much improved and enlarged, came out in 1749, under the following title: "Hermippus Redivivus: or, the Sage's Triumph over Old Age and the Grave. Wherein a method is laid down for prolonging the life and vigour of man. Including a Commentary upon an ancient inscription, in which this great secret is revealed; supported by numerous authorities. The whole interspersed with a great variety of remarkable and well attested relations." This extraordinary tract had its origin in a foreign publication; but it was wrought up to perfection by the additional ingenuity and learning of Mr Campbell. In 1744 he gave to the public, in two volumes folio, his "Voyages and Travels," on Dr Harris's plan, being a very distinguished improvement of that collection which had appeared in 1705. The time and care employed by Mr Campbell in this important undertaking did not prevent his engaging in another great work, the "Biographia Britannica," which began to be published in weekly numbers in 1745, and extended to seven volumes folio: but our author's articles were only in the first four volumes; of which Dr Kippis observes, they constitute the prime merit.

When the late Mr Dodsley formed the design of "The Preceptor," which appeared in 1748, Mr Campbell was to assist in the undertaking; and the parts written by him were the Introduction to Chronology, and the Discourse on Trade and Commerce, both of which displayed an extensive fund of knowledge upon these subjects. In 1750 he published the first separate edition of his "Present State of Europe;" a work which had been originally begun in 1746, in the "Museum," a very valuable periodical performance, printed for Dodsley. There is no production of our author's that hath met with a better reception. It has gone through six editions, and fully deserved this encouragement. The next great undertaking which called for the exertion of our author's abilities and learning, was "The Modern Universal History." This extensive work was published, from time to time, in detached parts, till it amounted to 16 volumes folio; and a second edition of it, in 8vo. began to make its appearance in 1759. The parts of it written by Mr Campbell were, the histories of the Portuguese, Dutch, Spanish, French, Swedish, Danish, and Ostend Settlements in the East Indies; and the histories of the Kingdoms of Spain, Portugal, Algarve, Navarre, and that of France, from Clovis to 1656. As our author had thus distinguished himself in the literary world, the degree of LL.D. was very properly and honourably conferred upon him, June 18. 1754, by the university of Glasgow. Campbell.

His principal and favourite work was, "A Political Survey of Great Britain," 2 vol. 4to, published a short time before his death; in which the extent of his knowledge, and his patriotic spirit, are equally conspicuous. Dr Campbell's reputation was not confined to his own country, but extended to the remotest parts of Europe. As a striking instance of this, it may be mentioned, that in the spring of 1774, the empress of Russia was pleased to honour him with the present of her picture, drawn in the robes worn in that country in the days of John Bassiliowitz, grand duke of Muscovy, who was contemporary with Queen Elizabeth. To manifest the doctor's sense of her imperial majesty's goodness, a set of the "Political Survey of Britain," bound in Morocco, highly ornamented, and accompanied with a letter descriptive of the triumphs and felicities of her reign, was forwarded to St Petersburgh, and conveyed into her hands by Prince Orloff, who had resided some months in this kingdom.

Dr Campbell in 1736 married Elizabeth, daughter of Benjamin Vobe, of Leominster, in the county of Hereford, gentleman, with whom he lived nearly 40 years in the greatest conjugal harmony and happiness. So wholly did he dedicate his time to books, that he seldom went abroad: but to relieve himself as much as possible from the inconveniences incident to a sedentary life, it was his custom, when the weather would admit, to walk in his garden; or otherwise in some room of his house, by way of exercise. By this method, united with the strictest temperance in eating, and an equal abstemiousness in drinking, he enjoyed a good state of health, though his constitution was delicate. His domestic manner of living did not preclude him from a very extensive and honourable acquaintance. His house, especially on a Sunday evening, was the resort of the most distinguished persons of all ranks, and particularly of such as had rendered themselves eminent by their knowledge or love of literature. He received foreigners, who were fond of learning, with an affability and kindness which excited in them the highest respect and veneration; and his instructive and cheerful conversation made him the delight of his friends in general. He was, during the latter part of his life, agent for the province of Georgia in North America; and died at the close of the year 1775, in the 67th year of his age. The doctor's literary knowledge was by no means confined to the subjects on which he more particularly treated as an author; he was well acquainted with the mathematics, and had read much in medicine. It hath been with great reason believed, that if he had dedicated his studies to this last science, he would have made a very conspicuous figure in the medical profession. He was eminently versed in the different parts of sacred literature; and his acquaintance with the languages extended not only to the Hebrew, Greek, and Latin, among the ancient, and to the French, Italian, Spanish, Portuguese, and Dutch, among the modern; but likewise to the oriental tongues. He was particularly fond of the Greek language. His attainment of such a variety of knowledge was exceedingly assisted by a memory surprisingly retentive, and which indeed astonished

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Campbell. nished every person with whom he was conversant. In communicating his ideas, he had an uncommon readiness and facility; and the style of his works, which had been formed upon the model of that of the celebrated Bishop Sprat, was perspicuous, easy, flowing, and harmonious. To all these accomplishments of the understanding, Dr Campbell joined the more important virtues of a moral and pious character. His disposition was gentle and humane, and his manners kind and obliging. He was the tenderest of husbands, a most indulgent parent, a kind master, a firm and sincere friend. To his great Creator he paid the constant and ardent tribute of devotion, duty, and reverence; and in his correspondences he showed that a sense of piety was always nearest his heart.

CAMPBELL, *George*, D. D. was born at Aberdeen in December 1719. He was educated at the grammar school in the same town, and intended for the employment of signet-writer, an occupation similar to that of an English attorney, in which he was bound an apprentice. The love of study, however, prevailed over every opposition: in 1741 he attended divinity lectures at Edinburgh before the term of his apprenticeship was fully completed, and soon after became a regular student in the university of Aberdeen, attending the lectures of Professor Lumsden in King's, and Professor Chalmers in Marischal college. In 1746 he was licensed to preach by the presbytery of Aberdeen. In 1748 he obtained the living of Banchory Ternan, in which situation he became a married man, and was fortunate in possessing a lady "remarkable for the sagacity of her understanding, the integrity of her heart, the general propriety of her conduct, and her skill in the management of domestic economy." Mutual happiness was the consequence of this union, which was not terminated till her death in 1792. In 1757 he was translated to Aberdeen, to be one of the ministers of that town, and in 1759 was presented to the office of principal of Marischal college.

Mr Hume's Treatise on Miracles gave the new principal an opportunity of evincing that he was not unworthy of his office. He opposed it in a sermon preached before the provincial synod of Aberdeen, in 1760, which he was requested to publish; but he preferred the form of a dissertation, and in that state sent the manuscript to Dr Blair, to be by him communicated to the metaphysician. Availing himself then of the remarks of his friends, and his opponent, he gave it to the world in 1763, with a dedication to Lord Bute: but however desirable the patronage of the minister might be in other respects, it was of very little assistance in giving circulation, in the literary world, to an essay which, from the favourable impressions of Blair and Hume, was eagerly read, and universally admired.

In 1771 he was elected professor of divinity in Marischal college, on which he resigned his office as one of the ministers of Aberdeen: but as "minister of Gray Friars, an office conjoined to the professorship about a century ago, he was obliged to preach once every Sunday in one of the established churches." Few persons seem to have entertained truer notions of the office of a teacher in an university than our new professor; and the plan he had in view, on entering upon his lectures, though expressed in rather too strong language, may be recommended to every one who undertakes a similar employment. Campbell.

"Gentlemen (he thus addresses his pupils), the nature of my office has been much misunderstood. It is supposed, that I am to teach you every thing connected with the study of divinity. I tell you honestly, that I am to teach you nothing. Ye are not school-boys. Ye are young men, who have finished your courses of philosophy, and ye are no longer to be treated as if ye were at school. Therefore, I repeat it, I am to teach you nothing; but, by the grace of God, I will assist you to teach yourselves every thing." In 1771 he published his excellent sermon on the Spirit of the Gospel; and, in 1776, his Philosophy of Rhetoric. In this latter year, also, he acquired the friendship of Dr Tucker by a sermon, then much admired, and very generally read, on the Duty of Allegiance, in which he endeavours to show "that the British colonies in America had no right, either from reason or from Scripture, to throw off their allegiance;" and he uses those vulgar arguments, which, as being purely political, and more especially adapted to the sentiments of the majority of that day, were very improper topics for the pulpit. It is so much the fashion for divines to make the varying politics of the hour the subject of their discourses, and in them to follow the sentiments of those whose patronage is deemed most advantageous, that we must not be very severe in our animadversions on the present occasion. In 1777 he chose a better subject for a discourse, which he published at the request of the Society for propagating Christian Knowledge, and in which the success of the first publishers of the Gospel is ably treated as a proof of its truth. In 1779, when many of his countrymen, led away by the madness of enthusiasm and fanaticism, were rushing headlong into the most antichristian practice of persecution, he published a very seasonable address to the people of Scotland, on the alarms which had been raised by the bill in favour of the Roman Catholics.

In the same year, also, he published a sermon on the Happy Influence of Religion on Civil Society. The last work which he lived to bring before the public was his Translation of the Four Gospels, with preliminary dissertations, and explanatory notes, of which it is unnecessary to say any thing further in this place than that it is worthy of his talents and character.

In 1795 he resigned his professorship, in a letter to the moderator of the presbytery of Aberdeen, which they voted to be inserted in their records. Soon after the resignation of his professorship, he resigned also the principalship, on a pension of 300l. a-year being conferred on him by government; but this pension he possessed for a very short time; for, on the 31st of March, 1796, his last illness seized him, and on the next morning it was followed by a paroxysm of the palsy, which destroyed his faculty of speech, and under which he languished till he died. His funeral sermon was preached on the 17th of April by Dr Brown, who had succeeded him in the offices of principal and professor.

His character, very justly drawn by the same gentleman, we shall now lay before our readers. "Dr Campbell, as a public teacher, was long admired for the clearness and copiousness with which he illustrat-ed

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Campbell. ed the great doctrines and precepts of religion, and the strength and energy with which he enforced them. Intimately persuaded of the truth and infinite consequence of what revelation teaches, he was strongly desirous of carrying the same conviction to the minds of his hearers, and delivered his discourses with that zeal which flows from strong impressions, and that power of persuasion which is the result of sincerity of heart, combined with clearness of understanding. He was satisfied, that the more the pure dictates of the gospel were studied, the more they would approve themselves to the mind, and bring forth, in the affections and conduct, all the peaceable fruits of righteousness. The unadulterated dictates of Christianity, he was, therefore, only studious to recommend and inculcate; and knew perfectly to discriminate them from the inventions and traditions of men. His chief study ever was, to direct belief to the great objects of practice; and, without these, he viewed the most orthodox profession as "a sounding brass, and a tinkling cymbal." But, besides the character of a preacher of righteousness, he had also that of a teacher of the science of divinity to sustain. How admirably he discharged this duty, and with what effect he conveyed the soundest and most profitable instruction to the minds of his scholars, let those declare who are now in various congregations of this country, communicating to their fellow Christians the fruits of their studies under so able and judicious a teacher. Discarding all attachment to human systems, merely considered as such, he tied his faith to the Word of God alone, possessed the happiest talent in investigating its meaning, and communicated to his hearers the result of his own inquiries, with a precision and perspicuity which brought light out of obscurity, and rendered clear and simple what appeared intricate and perplexed. He exposed, without reserve, the corruptions which ignorance, craft, and hypocrisy had introduced into religion, and applied his talent for ridicule to the best of all purposes, to hold up to contempt the absurdities with which the purest and sublimest truths had been loaded.

"Placed at the head of a public seminary of learning, he felt all the importance of such a situation, and uniformly directed his influence to public utility. His enlarged and enlightened mind justly appreciated the extensive consequence of the education of youth. He anticipated all the effects resulting to the great community of mankind, from numbers of young men issuing, in regular succession, from the university over which he presided, and occupying the different departments of social life.

"His benevolent heart delighted to represent to itself the students under his direction usefully and honourably discharging the respective duties of their different professions, and some of them, perhaps, filling the most distinguished stations of civil society. With these prospects before him, he constantly directed his public conduct to their attainment. He never suffered his judgment to be warped by prejudice or partiality, or his heart to be seduced by passion or private interest. Those mean and ignoble motives by which many are actuated in the discharge of important trusts, approached not his mind. A certain honourable pride, if pride it may be called, diffused an uniform dignity over the whole of his behaviour. He felt the man degraded by the perversion of public character. His understanding also clearly shewed him even personal advantage attached to such principles and practice, as he adopted from a sense of obligation, and those elevated conceptions of real worth which were so congenial to his soul. He saw, he experienced, esteem, respect, and influence, following in the train of integrity and beneficence; but contempt, disgrace, aversion, and complete insignificance, closely linked to corruption and selfishness. Little minds are seduced and overpowered by selfish considerations, because they have not the capacity to look beyond the present advantage, and to extend to the misery that stands on the other side of it. The same circumstance that betrays the perversity of their hearts, also evinces the weakness of their judgments.

"His reputation as a writer is as extensive as the present intercourse of letters; not confined to his own country, but spread through every civilized nation. In his literary pursuits, he aimed not, as is very often the case, with men of distinguished literary abilities, merely at establishing his own celebrity, or increasing his fortune; but had chiefly at heart the defence of the great cause of Religion, or the elucidation of her dictates.

"At an early period he entered the lists as a champion for Christianity against one of its acutest opponents. He not only triumphantly refuted his arguments, but even conciliated his respect by the handsome and dexterous manner in which his defence was conducted. While he refuted the infidel, he spared the man, and exhibited the uncommon spectacle of a polemical writer possessing all the moderation of a Christian. But while he defended Christianity against its enemies, he was desirous of contributing his endeavours to increase, among its professors, the knowledge of the sacred writings. Accordingly, in the latter part of his life, he favoured the world with a work, the fruit of copious erudition, of unwearied application for almost thirty years, and of a clear and comprehensive judgment. We have only to regret, that the other writings of the New Testament have not been elucidated by the same pen that translated the Gospels. Nor were his literary merits confined to theology, and the studies more immediately connected with it. Philosophy, and the fine arts, are also indebted to his genius and labours; and in him the polite scholar was eminently joined to the deep and liberal divine.

"Political principles will always be much affected by general character. This was also the case with Dr Campbell. In politics, he maintained that moderation which is the surest criterion of truth and rectitude, and was equally distant from those extremes into which men are so apt to run in great political questions. He cherished that patriotism which consists in wishing and endeavouring to promote, the greatest happiness of his country, and is always subordinate to universal benevolence. Firmly attached to the British constitution, he was animated with that genuine love of liberty which it inspires and invigorates. He was equally averse to despotism and to popular anarchy; the two evils into which political parties are so frequently hurried, to the destruction of all that is valuable to government. Party-spirit, of whatever description, he considered as having an unhappy tendency to pervert, to the most pernicious purposes, the best principles of the human mind, and

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and to clothe the most iniquitous actions with the most specious appearances. Although tenacious of those sentiments, whether in religion or politics, which he was convinced to be rational and just, he never suffered mere difference of opinion to impair his good will, to obstruct his good offices, or to cloud the cheerfulness of conversation. His own conversation was enlivened by a vein of the most agreeable pleasantry."

CAMPBELTOWN, a parliament town of Argyleshire in Scotland, seated on the eastern shore of the peninsula of Kintyre or Cantyre, of which it is the capital. It hath a good harbour; and is now a very considerable place, though within these 50 years only a petty fishing town. It has in fact been created by the fishery: for it was appointed the place of rendezvous for the busses; and above 260 have been seen in the harbour at once. The inhabitants amounted to 6000 in 1811. W. Long. 5. 10. N. Lat. 54.

CAMPDEN, a small town of Gloucestershire in England, containing 1214 inhabitants in 1811. It gives title of Viscount, by courtesy, to the earl of Gainsborough, his son. W. Long. 1. 50. N. Lat. 52.

CAMPEACHY, a town of Mexico in South America, seated on the east coast of a bay of the same name, on the west of the province of Yucatan. It is defended by a good wall and strong forts; but is neither so rich, nor carries on such a trade, as formerly; it having been the port for the sale of logwood, the place where it is cut being about 30 miles distant. It was taken by the English in 1596; by the Bucaneers in 1678; and by the Flibusters of St Domingo in 1685, who set it on fire and blew up the citadel. W. Long. 93. 7. N. Lat. 19. 20.

Campeachy-Wood. See HÆMATOXYLUM, BOTANY *Index*.

CAMPEN, a strong town in Overyssel in the United Provinces. It hath a citadel and a harbour; but the latter is almost choked up with sand. It was taken by the Dutch in 1578, and by the French in 1672. E. Long. 5. 35. N. Lat. 52. 38.

CAMPER, PETER, an eminent Dutch writer on medicine and physiology. See SUPPLEMENT.

CAMPESTRE, in antiquity, a sort of cover for the privities, worn by the Roman soldiers in their field exercises; being girt under the navel, and hanging down to the knees. The name is supposed to be formed from *campus*, the field or place where the Roman soldiers performed their exercises.

CAMPHORA, or CAMPHIRE, a solid concrete substance extracted from the wood of the laurus camphora. See CHEMISTRY, and MATERIA MEDICA *Index*.

Pure camphire is very white, pellucid, somewhat unctuous to the touch; of a bitterish aromatic taste, yet accompanied with a sense of coolness; of a very fragrant smell, somewhat like that of rosemary, but much stronger. It has been very long esteemed one of the most efficacious diaphoretics; and has been celebrated in fevers, malignant and epidemical distempers. In deliria, also, where opiates could not procure sleep, but rather aggravated the symptoms, this medicine has often been observed to procure it. All these effects, however, Dr Cullen attributes to its sedative property, and denies that camphire has any other medicinal virtues than those of an antispasmodic and sedative. He allows it to be very powerful, and capable of doing much good or much harm. From experiments made on different brute creatures, camphire appears to be poisonous to every one of them. In some it produced sleep followed by death, without any other symptom. In others, before death, they were awakened into convulsions and rage. It seems, too, to act chiefly on the stomach; for an entire piece swallowed, produced the above-mentioned effects with very little diminution of weight.

CAMPHUYSEN, DIRK THEODORE RAPHAEL, an eminent painter, was born at Gorcum in 1586. He learned the art of painting from Diederic Govertze; and by a studious application to it, he very soon not only equalled, but far surpassed his master. He had an uncommon genius, and studied nature with care, judgment, and assiduity. His subjects were landscapes, mostly small, with ruinous buildings, huts of peasants, or views of villages on the banks of rivers, with boats and hoys, and generally he represented them by moonlight. His pencil is remarkably tender and soft, his colouring true nature and very transparent, and his expertness in perspective is seen in the proportional distances of his objects, which are excellently contrived, and have a surprising degree of nature and truth. As he left off painting at an age when others are scarcely qualified to commence artists, few of his works are to be met with, and they bring considerable prices: as they cannot but give pleasure to the eye of every observer. He painted his pictures with a thin body of colour, but they are handled with singular neatness and spirit. He practised in his profession only till he was 18 years of age, and being then recommended as a tutor to the sons of the Lord of Nieuport, he undertook the employment, and discharged it with so much credit, that he was appointed secretary to that nobleman. He excelled in drawing with a pen; and the designs which he finished in that manner are exceedingly valued.

CAMPIAN, EDMUND, an English Jesuit, was born at London, of indigent parents, in the year 1540, and educated at Christ's hospital, where he had the honour to speak an oration before Queen Mary on her accession to the throne. He was admitted a scholar of St John's college in Oxford at its foundation, and took the degree of master of arts in 1564. About the same time he was ordained by a bishop of the church of England, and became an eloquent Protestant preacher. In 1566, when Queen Elizabeth was entertained by the university of Oxford, he spoke an elegant oration before her majesty, and was also respondent in the philosophy act in St Mary's church. In 1568, he was junior proctor of the university. In the following year, he went over to Ireland, where he wrote a history of that kingdom, and turned Papist; but being found rather too assiduous in persuading others to follow his example, he was committed to prison. He soon, however, found means to make his escape. He landed in England in 1571; and thence proceeded to Douay in Flanders, where he publicly recanted his former heresy, and was created bachelor of divinity. He went soon after to Rome, where, in 1573, he was admitted of the society of Jesus, and was sent by the general of that order to Vienna, where he wrote his tragedy called

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led *Nectar et Ambrosia*, which was acted before the emperor with great applause.

From Vienna he went to Prague in Bohemia, where he resided in the Jesuits college about six years, and then returned to Rome. From thence, in 1580, he was sent by Pope Gregory XIII. with the celebrated Father Parsons, to convert the people of England. From Pitts we learn, that, some time before, several English priests, inspired by the Holy Ghost, had undertaken to convert their countrymen; that 80 of these from foreign seminaries, besides several others who, by God's grace, had been converted in England, were actually engaged in the pious work with great success; that some of them had suffered imprisonment, chains, tortures, and ignominious death, with becoming constancy and resolution; but seeing at last that the labour was abundant, and the labourers few, they solicited the assistance of the Jesuits, requesting, that though not early in the morning, they would at least in the third, sixth, or ninth hour, send labourers into the Lord's vineyard. In consequence of this solicitation, the above two were sent to England. They arrived in an evil hour for Campian, at Dover; and were next day joyfully received by their friends at London. He had not been long in England, before Walsingham, the secretary of state, being informed of his uncommon assiduity, in the cause of the church of Rome, used every means in his power to have him apprehended, but for a long time without success. However, he was at last taken by one Elliot, a noted *priest-taker*, who found him in the house of Edward Yates, Esq. at Lyford, in Berkshire, and conducted him in triumph to London, with a paper on his hat, on which was written *Campian the Jesuit*. He was imprisoned in the Tower, where Wood says, "he did undergo many examinations, abuses, wrackings, tortures:" *exquisitissimis cruciatibus tortus*, says Pitts. It is hoped, for the credit of our reformers, this torturing part of the story is not true. The poor wretch, however, was condemned on the statute 25 Ed. III. for high treason; and butchered at Tyburn, with two or three of his fraternity. Howsoever criminal in the eye of the law, or of the English gospel, might be the zeal of this Jesuit for the salvation of the poor heretics of this kingdom, biographers of each persuasion unite in giving him a great and amiable character. "All writers (says the Oxford antiquary), whether Protestants or Popish, say, that he was a man of admirable parts; an elegant orator, a subtile philosopher and disputant, and an exact preacher whether in English or the Latin tongue; of a sweet disposition, and a well-polished man." Fuller, in his church history, says, "he was of a sweet nature, constantly carrying about him the charms of a plausible behaviour, of a fluent tongue, and good parts." His History of Ireland, in two books, was written in 1570; and published, by Sir James Ware, from a manuscript in the Cotton library, Dublin, 1633, folio. He wrote also *Chronologia Universalis*, a very learned work, and various other tracts.

CAMPICURSIO, in the ancient military art, a march of armed men for several miles, from and back again to the camp, to instruct them in the military pace. This exercise was nearly akin to the *decursio*, from which it only differed, in that the latter was performed by horsemen, the former also by foot.

CAMPIDOCTORES, or CAMPIDUCTORES, in the Roman army, were officers who instructed the soldiery in the discipline and exercises of war, and the art of handling their weapons to advantage. These are also sometimes called *campigeni* and *armidoctores*.

CAMPIDUCTOR, in middle-age writers, signifies the leader or commander of an army, or party.

CAMPION, in *Botany*, the English name of the LYCHNIS.

CAMPION, a town of the kingdom of Tangut in Tartary. It was formerly remarkable for being a place through which the caravans passed in the road from Bukharia to China. E. Long. 104. 53. N. Lat. 40. 25.

CAMPISTRON, a celebrated French dramatic author, was born in 1656. Racine directed his poetical talents to the theatre, and assisted him in his first pieces. He died in 1723.

CAMPITÆ, in church history, an appellation given to the Donatists, on account of their assembling in the fields for want of churches. For a similar reason, they were also denominated *Montenses* and *Rupitani*.

CAMPLI, or CAMPOLI, a town of Italy, in the kingdom of Naples, and in the farther Abruzzo, situated in E. Long. 13. 55. N. Lat. 42. 38.

CAMPOMANES, D. P. R. COMTE DE, a Spanish political writer. See SUPPLEMENT.

CAMPREDON, a town of Catalonia in Spain, seated at the foot of the Pyrenean mountains. The fortifications were demolished by the French in 1691. W. Long. 1. 56. N. Lat. 42. 20.

CAMPS, FRANCIS DE, abbot of Notre Dame at Sigi, was born at Amiens in 1643; and distinguished himself by his knowledge of medals, by writing a history of France, and several other works. He died at Paris in 1723.

CAMPVERE. See VEER.

CAMPUS, in antiquity, a field or vacant plain in a city, not built upon, left vacant on account of shows, combats, exercises, or other uses of the citizens.

CAMPUS Maii, in ancient customs, an anniversary assembly of our ancestors held on May-day, when they confederated together for the defence of the kingdom against all its enemies.

CAMPUS Martius, a large plain in the suburbs of ancient Rome, lying between the Quirinal and Capitoline mounts and the Tiber; thus called because consecrated to the god Mars, and set apart for military sports and exercises to which the Roman youth were trained, as the use and handling of arms, and all manner of feats of activity. Here were the races run, either with chariots or single horses; here also stood the villa publica, or palace for the reception of ambassadors, who were not permitted to enter the city. Many of the public comitia were held in the same field, part of which was for that purpose cantoned out. The place was also nobly decorated with statues, arches, columns, porticoes, and the like structures.

CAMPUS Sceleratus, a place without the walls of ancient Rome, where the Vestals who had violated their vows of virginity were buried alive.

CAMUL, a town of Asia, on the eastern extremity of the kingdom of Cialus, on the frontiers of Tangut. E. Long. 98. 5. N. Lat. 37. 15.

CAMUS, a person with a low flat nose, hollowed in the middle.

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The Tartars are great admirers of camus beauties. Rubruquis observes, that the wife of the great Jenghiz Khan, a celebrated beauty, had only two holes for a nose.

Camus, *John Peter*, a French prelate, born in 1582. He was author of a number of pious romances (the taste of his time), and other theological works, to the amount of 200 vols. His definition of politics is remarkable; *Ars non tam regendi, quam fallendi, homines:* "The art not so much of governing, as of deceiving mankind." He died in 1652.

CAN, in the sea-language, as can-pump, a vessel wherewith seamen pour water into the pump to make it go.

Can-Buoy. See Buoy.

Can-Hook, an instrument used to sling a cask by the end of the staves: it is formed by fixing a broad and flat hook at each end of a short rope; and the tackle by which the cask so slung may be hoisted or lowered, is hooked to the middle of the rope.

CANA, in *Ancient Geography*, a town on the confines of the Upper and Lower Galilee: memorable for the turning water into wine (John). The birthplace of Simeon, called the *Canaanite* from this place, and of Nathanael.

CANAAN, the fourth son of Ham. The irreverence of Ham towards his father Noah is recorded in Gen. ix. Upon that occasion the patriarch cursed him in a branch of his posterity: "Cursed," says he, "be Canaan; a servant of servants shall he be unto his brethren." This curse being pronounced, not against Ham the immediate transgressor, but against his son, who does not appear, from the words of Moses, to have been anywise concerned in the crime, hath occasioned several conjectures. Some have believed that Noah cursed Canaan, because he could not well have cursed Ham himself, whom God had not long before blessed. Others think Moses's chief intent in recording this prediction was to raise the spirits of the Israelites, then entering on a terrible war with the children of Canaan, by the assurance, that, in consequence of the curse, that people were destined by God to be subdued by them. For the opinion of those who imagine all Ham's race were here accursed, seems repugnant to the plain words of Scripture, which confines the malediction to Canaan and his posterity: and is also contrary to fact. Indeed the prophecy of Noah that "Canaan should be a servant of servants to his brethren," seems to have been wholly completed in him. It was completed with regard to Shem, not only in that a considerable part of the seven nations of the Canaanites were made slaves to the Israelites, when they took possession of their land, as part of the remainder of them were afterwards enslaved by Solomon; but also by the subsequent expeditions of the Assyrians and Persians, who were both descended from Shem; and under whom the Canaanites suffered subjection, as well as the Israelites; not to mention the conquest of part of Canaan by the Elamites, or Persians, under Chedorlaomer, prior to them all. With regard to Japhet, we find a completion of the prophecy, in the successive conquests of the Greeks and Romans in Palestine and Phœnicia, where the Canaanites were settled; but especially in the total subversion of the Carthaginian power by the Romans; besides some invasions of the northern nations, as the posterity of Thogarma and Magog; wherein many of them, probably, were carried away captive.

The posterity of Canaan were very numerous. His eldest son was Sidon, who at least founded and peopled the city of Sidon, and was the father of the Sidonians and Phœnicians. Canaan had besides ten sons, who were the fathers of so many peoples, dwelling in Palestine, and in part of Syria; namely, the Hittites, the Jebusites, the Amorites, the Girgasites, the Hivites, the Arkites, the Sinites, the Arvadites, the Zemarites, and Hamathites.

Land of Canaan, the country so named from Canaan the son of Ham. It lies between the Mediterranean sea and the mountains of Arabia, and extends from Egypt to Phœnicia. It is bounded to the east by the mountains of Arabia; to the south by the wilderness of Paran, Idumea, and Egypt; to the west by the Mediterranean, called in Hebrew the Great Sea; to the north by the mountains of Libanus. Its length from the city of Dan (since called Cæsarea Philippi, or Paneadis, which stands at the foot of these mountains) to Beersheba, is about 70 leagues; and its breadth from the Mediterranean sea to the eastern borders, is in some places 30. This country, which was first called Canaan, from Canaan the son of Ham, whose posterity possessed it, was afterwards called Palestine, from the people which the Hebrews call Philistines, and the Greeks and Romans corruptly Palestines, who inhabited the sea coasts, and were first known to them. It likewise had the name of the *Land of Promise*, from the promise God made to Abraham of giving it to him; that of the *Land of Israel*, from the Israelites having made themselves masters of it; that of *Judah*, from the tribe of Judah, which was the most considerable of the twelve; and lastly, the happiness it had of being sanctified by the presence, actions, miracles, and death of Jesus Christ, has given it the name of the *Holy Land*, which it retains to this day.

The first inhabitants of this land therefore were the Canaanites, who were descended from Canaan, and the eleven sons of that patriarch. Here they multiplied extremely: trade and war were their first occupations; these gave rise to their riches, and the several colonies scattered by them over almost all the islands and maritime provinces of the Mediterranean. The measure of their idolatry and abominations was completed, when God delivered their country into the hands of the Israelites. In St Athanasius's time, the Africans still said they were descended from the Canaanites; and it is said, that the Punic tongue was almost entirely the same with the Canaanitish and Hebrew language. The colonies which Cadmus carried into Thebes in Bœotia, and his brother Cilix into Cilicia, came from the stock of Canaan. The isles of Sicily, Sardinia, Malta, Cyprus, Corfu, Majorca and Minorca, Gades and Ebusus, are thought to have been peopled by the Canaanites. Bochart, in his large work entitled *Canaan*, has set all this matter in a good light.

Many of the old inhabitants of the north-west of the land of Canaan, however, particularly on the coast or territories of Tyre and Sidon, were not driven out by the children of Israel, whence this tract seems to have retained the name of Canaan a great while after those

those other parts of the country, which were better inhabited by the Israelites, had lost the said name. The Greeks called this tract, inhabited by the old Canaanites along the Mediterranean sea, Phœnicia; the more inland parts, as being inhabited partly by Canaanites, and partly by Syrians, Syrophœnicia: and hence the woman said by St Matthew (xv. 22.) to be a woman of Canaan, whose daughter Jesus cured, is said by St Mark (vii. 26.) to be a Syrophœnician by nation as she was a Greek by religion and language.'

CANABAC, an island which lies contiguous to BULAM on the western coast of Africa, and is inhabited by a fierce people, governed by two kings or chiefs. It would appear that the Canabacs had been very troublesome to their neighbours; for the inhabitants of some other islands in that cluster rejoiced at the settlement of the English in Bulam, hoping to find in them a defence against the usurpations of this people.

CANADA, an extensive country of North America, bounded on the north-east by the gulf of St Lawrence, and St John's river; on the south-west, by the great line of lakes, Erie, Huron, and Superior; on the south, by the province of Nova Scotia, and the territories of the United States; and on the north-west, by Indian nations. Under the name of *Canada*, the French comprehended a very large territory; taking into their claim part of New Scotland, New England, and New York on the east; and extending it on the west as far as the Pacific ocean. That part, however, which is occupied or claimed by the British at present lies between 61 and 92 of west longitude, and 42 and 52 of north latitude, and is divided into Upper and Lower Canada. The climate is not very different from that of the United States; but as it is much further from the sea, and more to the northward, than most of those provinces, it has a much severer winter, though the air is generally clear; and, like most of those American tracts that do not lie too far to the northward, the summers are very hot, and exceeding pleasant. The soil in general is very good, and in many parts extremely fertile; producing many different sorts of grains, fruits, and vegetables. The meadow grounds, which are well watered, yield excellent grass, and breed vast numbers of great and small cattle. The uncultivated parts are a continued wood, composed of prodigiously large and lofty trees, of which there is such a variety of species, that even of those who have taken most pains to know them, there is not perhaps one that can tell half the number. Canada produces, among others, two sorts of pines, the white and the red; four sorts of firs; two sorts of cedar and oak, the white and the red; the male and female maple; three sorts of ash trees, the free, the mungrel, and the bastard; three sorts of walnut-trees, the hard, the soft, and the smooth; vast numbers of beech-trees and white wood; white and red elms, and poplars. The Indians hollow the red elms into canoes, some of which made out of one piece will contain 20 persons: others are made of the bark; the different pieces of which they sew together with the inner rind, and daub over the seams with pitch, or rather a bituminous matter resembling pitch, to prevent their leaking; the ribs of these canoes are made of boughs of trees. In the hollow elms, the bears and wild cats take up their lodging from November to April. The country produces also a vast variety of other vegetables, particularly tobacco, which thrives well. Near Quebec is a fine lead mine, and many excellent ones of iron have been discovered. It hath also been reported that silver is found in some of the mountains. The rivers are extremely numerous, and many of them very large and deep. The principal are, the Ouattauais, St John's, Seguinay, Despaires, and Trois Rivieres; but all these are swallowed up by the great river St Lawrence. This river issues from Lake Ontario; and, taking its course north-east, washes Montreal, where it receives the Ouattauais, and forms many fertile islands. It continues the same course, and meets the tide upwards of 400 miles from the sea, where it is navigable for large vessels; and below Quebec, 320 miles from the sea, it becomes so broad and so deep, that ships of the line contributed in the last war to reduce that city. After receiving in its progress innumerable streams, it at last falls into the ocean at Cape Rosiers, where it is 90 miles broad, and where the cold is intense and the sea boisterous. The most considerable settlements are upon the river and its smaller branches, and upon Lake Ontario, though a few settlers have fixed themselves also on Lake Erie, and the fur traders have stations far beyond Lake Superior. Here are five lakes, the least of which is of greater extent than the fresh-water lakes to be found in any other part of the world: these are Lake Ontario, which is not less than 200 leagues in circumference; Erie, or Oswego, longer, but not so broad, is about the same extent. That of the Huron spreads greatly in width, and is about 300 leagues in circuit; as also is that of Michigan, though, like Lake Erie, it is rather long, and comparatively narrow. But Lake Superior is larger than any of these, being not less than 500 leagues in circumference. All these are navigable by any vessels, and they all communicate with each other; but the passage between Erie and Ontario is interrupted by a most stupendous fall or cataract, called the *falls of Niagara* *. The river St Lawrence, as already observed, is the outlet of these lakes, by which they discharge themselves into the ocean. The French built forts at these several straits, by which the lakes communicate with one another, and on that where the last of them communicates with the river. By these, while the country was in their possession, they effectually secured to themselves the trade of the lakes, and preserved an influence over all the Indian nations that lie near them.

* See Niagara.

The most curious and interesting part of the natural history of Canada is the animals there produced. These are stags, elks, deer, bears, foxes, martens, wild cats, ferrets, weasels, large squirrels of a grayish hue, hares and rabbits. The southern parts, in particular, breed great numbers of wild bulls, divers sorts of roebucks, goats, wolves, &c. The marshes, lakes, and pools, with which this country abounds, swarm with otters and beavers, of which the white are highly valued, as well as the right black kind. A vast variety of birds are also to be found in the woods; and the river St Lawrence abounds with such quantities of fish, that it is affirmed by some writers, this would be a more profitable article than even the fur-trade.—There are in

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Canada. in Canada a multitude of different Indian tribes: but these are observed to decrease in number where the Europeans are most numerous; owing chiefly to the immoderate use of spirituous liquors, of which they are excessively fond. Their manners and way of living we have already particularly described*. The principal towns are Quebec, Trois Rivieres, Montreal, and York. The commodities required by the Canadians from Europe are, wine, or rather rum; cloths, chiefly coarse; linens, and wrought iron. The Indian trade requires rum, tobacco, a sort of duffle blankets, guns, powder, balls, and flints, kettles, hatchets, toys, and trinkets of all kinds. While the country was in possession of the French, the Indians supplied them with poultry; and the French had traders, who, like the original inhabitants, traversed the vast lakes and rivers in canoes, with incredible industry and patience, carrying their goods into the remotest parts of America, and among nations entirely unknown to us. These again brought the furs, &c. home to them, as the Indians were thereby habituated to trade with them. For this purpose, people from all parts, even from the distance of 1000 miles, came to the French fair at Montreal, which began in June, and sometimes lasted three months. Since Canada came into the possession of Great Britain, its progress has been extremely rapid. Its population in 1759, when the French lost it, amounted to 70,000. In 1814 the inhabitants of Lower Canada amounted to 335,000, and those of Upper Canada to 95,000; but a part of this increase may be attributed to the great influx of emigrants from Britain. The agriculture and commerce of Canada have also been vastly extended. In 1769 the value of the produce exported amounted to 163,105l. and it employed 70 vessels belonging to Britain and the colonies. But in 1812 the value of the goods imported into Britain, from Canada, Nova Scotia, and Newfoundland, amounted to 1,909,689l. Since heavy duties were laid on Baltic timber, a vast quantity has been imported from Canada; but its quality is found to be very inferior to what is procured from Norway.

* See *America*.

The greatest obstruction to the trade of Canada arises from the rigour of the climate. This is so excessive from December to April, that the broadest rivers are frozen over, and the snow lies commonly from four to six feet deep on the ground, even in those parts of the country which lie three degrees south of London, and in the temperate latitude of Paris. Our communication therefore with Canada, and the immense regions beyond it, will always be interrupted during the winter season, until roads are formed that can be travelled without danger from the Indians. For these savage people often commit hostilities against us without any previous notice; and frequently, without any provocation, they commit the most horrid ravages for a long time with impunity.

Canada was undoubtedly discovered by Sebastian Cabot, the famous Italian adventurer, who sailed under a commission from Henry VII. But though the English monarch did not think proper to make any use of this discovery, the French quickly attempted it; we have an account of their fishing for cod on the banks of Newfoundland, and along the sea-coast of Canada, in the beginning of the 16th century. About the year 1506, one Denys, a Frenchman, drew a map of the gulf of St Lawrence; and two years after, one Aubort, a shipmaster of Dieppe, carried over to France some of the natives of Canada. As the new country, however, did not promise the same amazing quantities of gold and silver produced by Mexico and Peru, the French for some years neglected the discovery. At last, in the year 1523, Francis I. a sensible and enterprising prince, sent four ships, under the command of Verazani, a Florentine, to prosecute discoveries in that country. The particulars of this man's first expedition are not known. All we can learn is, that he returned to France, and next year he undertook a second. As he approached the coast, he met with a violent storm; however, he came so near as to perceive the natives on the shore, making friendly signs to him to land. This being found impracticable by reason of the surf upon the coast, one of the sailors threw himself into the sea; but, endeavouring to swim back to the ship, a surge threw him on shore without signs of life. He was, however, treated by the natives with such care and humanity, that he recovered his strength, and was allowed to swim back to the ship, which immediately returned to France. This is all we know of Verazani's second expedition. He undertook a third, but was no more heard of, and it is thought that he and all his company perished before he could form any colony. In 1534, one Jaques Cartier of St Malo's set sail under a commission from the French king, and on the 10th of May arrived at Cape Bonavista in Newfoundland. He had with him two small ships besides the one in which he sailed. He cruised along the coast of that island, on which he discovered inhabitants, probably the Eskimaux. He landed in several places along the coast of the gulf, and took possession of the country in the king's name. On his return, he was again sent out with a commission, and a pretty large force; he returned in 1535, and passed the winter at St Croix; but the season proved so severe, that he and his companions must have died of the scurvy, had they not, by the advice of the natives, made use of the decoction of the tops and bark of the white pines. As Cartier, however, could produce neither gold nor silver, all that he could say about the utility of the settlement was disregarded; and in 1540, he was obliged to become pilot to one M. Roberval, who was by the French king appointed viceroy of Canada, and who sailed from France with five vessels. Arriving at the gulf of St Lawrence, they built a fort; and Cartier was left to command the garrison in it, while Roberval returned to France for additional recruits to his new settlement. At last, having embarked in 1549, with a great number of adventurers, neither he nor any of his followers were heard of more.

This fatal accident so greatly discouraged the court of France, that for 50 years, no measures were taken for supplying with necessaries the settlers that were left. At last, Henry IV. appointed the marquis de la Roche lieutenant-general of Canada and the neighbouring countries. In 1598, he landed on the isle of Sable, which he absurdly thought to be a proper place for a settlement, though it was without any port, and without product except briars. Here he left about 40 malefactors, the refuse of the French jails. After cruizing

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Canada, Canal.

for some time on the coast of Nova Scotia, without being able to relieve these poor wretches, he returned to France, where he died of a broken heart. His colony must have perished, had not a French ship been wrecked on the island, and a few sheep driven upon it at the same time. With the boards of the ship they erected huts; and while the sheep lasted they lived on them, feeding afterwards on fish. Their clothes wearing out, they made coats of seal-skin; and in this miserable condition they spent seven years, when Henry ordered them to be brought to France. The king had the curiosity to see them in their seal-skin dresses, and was so moved with their appearance, that he forgave them all their offences, and gave each of them 50 crowns to begin the world anew.

In 1600, one Chauvin, a commander in the French navy, attended by a merchant of St Malo, called *Pontgrave*, made a voyage to Canada, from whence he returned with a very profitable quantity of furs. Next year he repeated the voyage with the same good fortune, but died while he was preparing for a third. The many specimens of profit to be made by the Canadian trade, at last induced the public to think favourably of it. An armament was equipped, and the command of it given to Pontgrave, with powers to extend his discoveries up the river St Laurence. He sailed in 1603, having in his company Samuel Champlain, who had been a captain in the navy, and was a man of parts and spirit. It was not, however, till the year 1608, that the colony was fully established. This was accomplished by founding the city of Quebec, which from that time commenced the capital of all the settlements in Canada. The colony, however, for many years continued in a low way, and was often in danger of being totally exterminated by the Indians. As the particulars of these wars, however, could neither be entertaining, nor indeed intelligible to many of our readers, we choose to omit them, and in general observe, that the French not only concluded a permanent peace with the Indians, but so much ingratiated themselves with them, that they could with the greatest ease prevail upon them at any time to murder and scalp the English in their settlements. These practices had a considerable share in bringing about the last war with France, when the whole country was conquered by the British in 1761. The most remarkable transaction in this conquest was the siege of Quebec. See QUEBEC; see also CANADA, SUPPLEMENT. And for the transactions here during the late American war, see AMERICA (*United States of*).

CANAL *of* COMMUNICATION, an artifical cut in the ground, supplied with water from rivers, springs, &c. in order to make a navigable communication betwixt one place and another.

The particular operations necessary for making artificial navigations depend upon a number of circumstances. The situation of the ground; the vicinity or connection with rivers; the ease or difficulty with which a proper quantity of water can be obtained: these and many other circumstances necessarily produce great variety in the structure of artificial navigations, and augment or diminish the labour and expence of executing them. When the ground is naturally level, and unconnected with rivers, the execution is easy, and the navigation is not liable to be disturbed with floods; but, when the ground rises and falls, and cannot be reduced to a level, artificial methods of raising and lowering vessels must be employed; which likewise vary according to circumstances.

Canal.

A kind of temporary sluices are sometimes employed for raising boats over falls or shoals in rivers by a very simple operation. Two posts or pillars of mason-work, with grooves, are fixed, one on each bank of the river, at some distance below the shoal. The boat having passed these posts, planks are let down across the river by pulleys into the grooves, by which the water is dammed up to a proper height for allowing the boat to pass up the river over the shoal.

The Dutch and Flemings at this day sometimes, when obstructed by cascades, form an inclined plane or rolling-bridge upon dry land, alongst which their vessels are drawn from the river below the cascade into the river above it. This, it is said, was the only method employed by the ancients, and is still used by the Chinese, who are said to be entirely ignorant of the nature and utility of locks. These rolling-bridges consist of a number of cylindrical rollers which turn easily on pivots, and a mill is commonly built near by, so that the same machinery may serve the double purpose of working the mill and drawing up vessels.

A LOCK is a bason placed lengthwise in a river or canal, lined with walls of masonry on each side, and terminated by two gates, placed where there is a cascade or natural fall of the country; and so constructed, that the bason being filled with water by an upper sluice to the level of the waters above, a vessel may ascend through the upper gate; or the water in the lock being reduced to the level of the water at the bottom of the cascade, the vessel may descend through the lower gate; for when the waters are brought to a level on either side, the gate on that side may be easily opened. But, as the lower gate is strained in proportion to the depth of water it supports, when the perpendicular height of the water exceeds 12 or 13 feet, more locks than one become necessary. Thus, if the fall be 17 feet, two locks are required, each having 8½ feet fall; and if the fall be 26 feet, three locks are necessary, each having 8 feet 8 inches fall. The side walls of a lock ought to be very strong. Where the natural foundation is bad, they should be founded on piles and platforms of wood: they should likewise slope outwards, in order to resist the pressure of the earth from behind.

Plate CXXXIV. fig. 1. A perspective view of part of a canal: the vessel L, within the lock AC.—Fig. 2. Section of an open lock; the vessel L about to enter.—Fig. 3. Section of a lock full of water; the vessel L raised to a level with the water in the superior canal.—Fig. 4. Ground section of a lock. L, a vessel in the inferior canal. C, the under gate. A, the upper gate. GH, a subterraneous passage for letting water from the superior canal run into the lock. KF, a subterraneous passage for water from the lock to the inferior canal.

X and Y, (fig. 1.) are the two floodgates, each of which consists of two leaves, resting upon one another, so as to form an obtuse angle, in order the better to resist the pressure of the water. The first (X) prevents the water of the superior canal from falling into the lock; and the second (Y) dams up and sustains

stains the water in the lock. These flood-gates ought to be very strong, and to turn freely upon their hinges. In order to make them open and shut with ease, each leaf is furnished with a long lever A *b*, A *b*; C *b*, C *b*. They should be made very tight and close, that as little water as possible may be lost.

By the subterraneous passage GH (fig. 2, 3, and 4.) which descends obliquely, by opening the sluice G, the water is let down from the superior canal D into the lock, where it is stopt and retained by the gate C when shut, till the water in the lock comes to be on a level with the water in the superior canal D; as represented, fig. 3. When, on the other hand, the water contained by the lock is to be let out, the passage GH must be shut by letting down the sluice G; the gate A must be also shut, and the passage KF opened by raising the sluice K: a free passage being thus given to the water, it descends through KF, into the inferior canal, until the water in the lock is on a level with the water in the inferior canal B; as represented, fig. 2.

Now, let it be required to raise the vessel L (fig. 2.) from the inferior canal B to the superior one D; if the lock happens to be full of water, the sluice G must be shut, and also the gate A, and the sluice K opened, so that the water in the lock may run out till it is on a level with the water in the inferior canal B. When the water in the lock comes to be on a level with the water at B, the leaves of the gate C are opened by the levers C *b*, which is easily performed, the water on each side of the gate being in equilibrio; the vessel then sails into the lock. After this the gate C and the sluice K are shut, and the sluice G opened, in order to fill the lock, till the water in the lock, and consequently the vessel, be upon a level with the water in the superior canal D; as is represented in fig. 3. The gate A is then opened, and the vessel passes into the canal D.

Again let it be required to make a vessel descend from the canal D into the inferior canal B. If the lock is empty, as in fig. 2. the gate C and sluice K must be shut, and the upper sluice G opened, so that the water in the lock may rise to a level with the water in the upper canal D. Then open the gate A, and let the vessel pass through into the lock. Shut the gate A and the sluice G; then open the sluice K, till the water in the lock be on a level with the water in the inferior canal; then the gate C is opened, and the vessel passes along into the canal B, as was required.

Scarcity of water becomes a very serious inconvenience to navigation in those places where locks are necessary, as without a sufficient supply, it must be frequently interrupted. To save water, therefore, has been an important consideration in the construction of locks. Various attempts have been made for this purpose. We shall here give an account of one which has been proposed by Mr Playfair, architect in London. "The nature and principle of this manner of saving water (says the inventor), consists in letting the water which has served to raise or fall a boat or barge from the lock, pass into reservoirs or cisterns, whose apertures of communication with the lock are upon different levels, and which may be placed or constructed at the side or sides of the lock with much they communicate, or in any other contiguous situation that circumstances may render eligible; which apertures may be opened or shut at plesure, so that the water may pass from the lock to each reservoir of the canal, or from each reservoir to the lock, in the following manner: The water which fills the lock, when a boat is to ascend or descend, instead of being passed immediately into the lower part of the canal, is let pass into these cisterns or reservoirs, upon different levels; then their communications with the lock being shut, they remain full until another vessel is wanted to pass; then, again, the cisterns are emptied into the lock, which is thereby nearly filled, so that only the remainder which is not filled is supplied from the higher part of the canal. Each of these cisterns must have a surface not less than that of the lock, and must contain half as much water as is meant to be expended for the passing of each vessel. The cistern the most elevated is placed twice its own depth (measuring by the aperture, or communicating opening of the cisterns) under the level of the water in the higher part of the canal. The second cistern is placed once its own depth under the first, and so on are the others, to the lowest; which last is placed once its own depth above the level of the water in the lower part of the canal. The apertures of the intermediate cisterns, whatever their number may be, must all be equally divided into different levels; the surface of the water in the one being always on the level of the bottom of the aperture of the cistern which is immediately above. As an example of the manner and rule for constructing these cisterns, suppose that a lock is to be constructed twelve feet deep, that is, that the vessel may ascend or descend twelve feet in passing. Suppose the lock sixty feet long and six feet wide, the quantity of water required to fill the lock, and to pass a boat, is 4320 cubic feet; and suppose that, in calculating the quantity of water that can be procured for supplying the canal, after allowing for waste, it is found (according to the number of boats that may be expected to pass) that there will not be above 800 cubic feet for each; then it will be necessary to save five sixths of the whole quantity that in the common case would be necessary: to do which ten cisterns must be made (the mode of placing which is expressed in the drawing, fig. 5. Plate CXXXIV.) each of which must be one foot deep, or deeper at pleasure, and each must have a surface of 360 feet square, equal to the surface of the lock. The bottom of the aperture of the lowest cistern must be placed one foot above the level of the water in the lower part of the canal, or eleven feet under the level of the high water; the second cistern must be two feet above the level of the low water; the third three feet, and so on of the others; the bottom of the tenth, or uppermost cistern, being ten feet above the low water, and two feet lower than the high water; and, as each cistern must be twelve inches in depth, the surface of the water in the higher cistern will be one foot under the level of the water in the upper part of the canal. The cisterns being thus constructed, when the lock is full, and the boat to be let down, the communications between the lock and the cisterns, which until then have all been shut, are to be opened in the following manner; first, the communication with the higher cistern is opened, which, being at bottom two feet under the level of the water in the lock,

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lock, is filled to the depth of one foot, the water in the lock descending one foot also at the same time: that communication is then shut, and the communication between the lock and the second cistern is opened; one foot more of the water then passes into that cistern from the lock, and fills it; the opening is then shut: the same is done with the third, fourth, fifth, sixth, seventh, eighth, ninth, and tenth cisterns, one by one, until they are all filled; and, when the tenth, or lowermost cistern, is filled, there remains but two feet depth of water in the lock. The communication between the lock and the lower part of the canal is then opened, and the last two feet depth of water is emptied into the lower part of the canal. By this means, it is evident, that, instead of twelve feet depth of water being let descend into the lower part of the canal, there is only two feet depth that descends, or one-sixth of the whole; therefore, instead of 4320 cubic feet being used, there are only 720 cubic feet used: the remainder of the water in the cisterns being used as follows. When another boat is to mount, the sluices being then shut, and the boat in the lock, the tenth or lowermost cistern is emptied into the lock, which it fills one foot; the communication being then shut, the next lower cistern, or the ninth, is emptied into the lock, which is thereby filled another foot; and so in like manner, all the other cisterns are emptied, one after another, until the higher cistern being emptied, which fills the tenth foot of water in the lock, there remains but two feet of water to fill, which is done from the upper part of the canal, by opening the higher sluice to pass the boat; by that means the same quantity of water descends from the upper part of the canal into the lock, that in the other case descended from the lock into the lower part of the canal; so that, in both cases, the same quantity of water is saved, that is, five-sixths of what would be necessary were there no cisterns. Suppose again that, upon the same canal, and immediately after the twelve feet lock, it would be advantageous to construct one of eighteen feet; then, in order not to use any greater quantity of water, it will be necessary to have sixteen cisterns, upon different levels, communicating with the lock in the same manner. Should, again, a lock of only six feet be wanted, after that of eighteen, then it will only be necessary to have four cisterns on different levels, and so of any other height of lock. The rule is this: for finding the number and size of the cisterns, each cistern being the same in superficies with the lock, its depth must be such as to contain one half the quantity of water meant to be used in the passing of one boat. The depth of the lock, divided by the depth necessary for such a cistern, will give, in all cases, the whole number of cisterns, and two more: deduct the number two, therefore, from the number which you find by dividing the depth of the lock by the depth of one cistern, and you have always the number of cisterns required; which are to be placed upon different levels, according to the rule already given. The above is the principle and manner of using the lock, for saving water in canals, and for enabling engineers to construct locks of different depths upon the same canal, without using more water for the deep locks than for the shallow ones. With regard to the manner of disposing the cisterns, the circumstance of the ground, the declivity, &c. will be the best guide for the engineer."

But even when water is abundant, if the declivity of a country be such as to require numerous locks, navigation suffers great interruption from them. A method by which boats could be raised and lowered with greater facility, or in a shorter time than can be done by means of locks, is still a very desirable object of improvement in inland navigation. For this purpose the inclined plane has been often resorted to, and particularly in China, where water carriage is more generally employed than in any country of Europe. But this method requires very powerful machinery or a great number of hands, which has prevented it from being much practised in this country. Other contrivances to obviate the use of locks have been proposed. Dr Anderson, in his Agricultural Survey of the County of Aberdeen, has described one, of which we shall give an account in his own words. This contrivance, he observes, "in the opinion of very good judges of matters of this sort, to whom the plan has been shewn, has been deemed fully adequate to the purpose of raising and lowering boats of a moderate size, that is, of 20 tons, or downwards; and it is the opinion of most men with whom I have conversed, who are best acquainted with the inland navigations, that a boat of from 10 to 15 tons is better than those of a larger size. When several are wanted to be sent at once, they may be affixed to one another, as many as the towing-horse can conveniently draw. Were boats of this size adopted, and were all the boats on one canal to be of the same dimensions, it would prove a great convenience to a country in a state of beginning improvements; because the expence of such a boat would be so trifling, that every farmer could have one for himself, and might of course make use of it when he pleased, by the aid of his own horse, without being obliged to have any dependence on the time that might suit the convenience of his neighbour; and if two or more boats were going from the same neighbourhood, one horse could serve the whole.

"You are to suppose that fig. 6. Plate CXXXIV. represents a bird's eye view of this simple apparatus, as seen from above. A is supposed to be the upper reach of the canal, and B the lower reach, with the apparatus between the two. This consists of three divisions; the middle one, extending from C to D, is a solid piece of masonry, raised from a firm foundation below the level of the bottom of the second reach; this is again divided into five parts, viz. *d d d*, where the wall rises only to the height of the water in the upper reach, and *e e*, two pillars, raised high enough to support the pivots of a wheel or pulley *g*, placed in the position there marked.

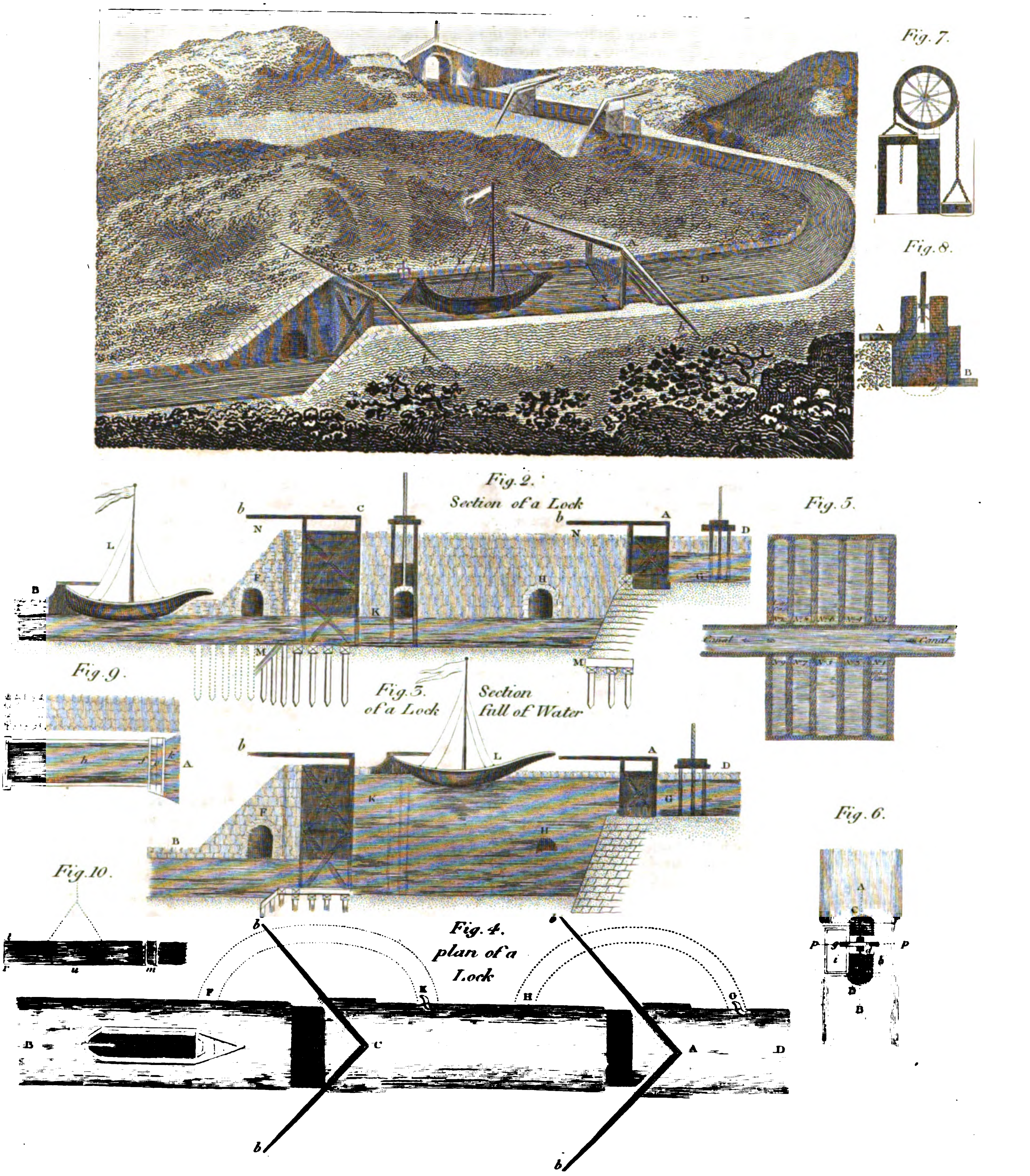
"The second division *h* consists of a wooden coffer, of the same depth nearly as the water in the upper reach, and of a size exactly fitted to contain one of the boats. This communicates directly with the upper reach, and being upon the same plane with it, and so connected with it as to be water-tight, it is evident, from inspection, that nothing can be more easy than to float a boat into this coffer from the upper reach, the part of the wheel that projects over it being at a sufficient height above it, so as to occasion no sort of interruption.

"Third

CANAL.

Fig 1

Perspective View of part of a CANAL with Locks



F. Mitchell sculp.

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Canal.

"Third division. At *i* is represented another coffer, precisely of the same dimensions with the first. But here two sluices, which were open in the former, and only represented by dotted lines, are supposed to be shut, so as to cut off all communication between the water in the canal and that in the coffer. As it was impossible to represent this part of the apparatus on so small a scale, for the sake of illustration it is represented more at large in fig. 9. where A, as before, represents the upper reach of the canal, and *h* one of the coffers. The sluice *k* goes into two cheeks of wood, joined to the masonry of the dam of the canal, so as to fit perfectly close; and the sluice *f* fits, equally close, into cheeks made in the side of the coffer for that purpose; between these two sluices is a small space *o*. The coffer, and this division *o*, are to be supposed full of water, and it will be easy to see that these sluices may be let down, or drawn up at pleasure, with much facility.

"Fig. 10. represents a perpendicular section of these parts in the same direction as in fig. 9. and in which the same letters represent the same parts.

"Things being thus arranged, you are to suppose the coffer *h* to be suspended, by means of a chain passed over the pulley, and balanced by a weight that is sufficient to counterpoise it, suspended at the opposite end of the chain. Suppose, then, that the counterpoise be made somewhat lighter than the coffer with its contents, and that the line *m n* (fig. 10.) represents a division between the solid sides of the dam of separation, which terminates the upper reach and the wooden coffer, which had been closed only by the pressure of its own weight (being pushed a very little from A towards B, beyond its precise perpendicular swing), and that the joining all round is covered with lists of cloth put upon it for that purpose; it is evident that, so long as the coffer is suspended to this height, the joining must be water-tight; but no sooner is it lowered down a little than this joining opens, the water in the small division *o* is allowed to run out, and an entire separation is made between the fixed dam and this moveable coffer, which may be lowered down at pleasure without losing any part of the water it contained.

"Suppose the coffer now perfectly detached, turn to fig. 7. which represents a perpendicular section of this apparatus, in the direction of the dotted line *pp* (fig. 6.). In fig. 7. *h* represents an end view of the coffer, indicated by the same letter as in fig. 6. suspended by its chain, and now perfectly detached from all other objects, and balanced by a counterpoise *i*, which is another coffer exactly of the same size, as low down as the level of the lower reach. From inspection only it is evident, that, in proportion as the one of these weights rises, the other must descend. For the present, then, suppose that the coffer *h* is by some means rendered more weighty than *i*, it is plain it will descend while the other rises; and they will thus continue till *h* comes down to the level of the lower reach, and *i* rises to the level of the higher one.

"Fig. 8. represents a section in the direction AB (fig. 6.), in which the coffer *i* (seen in both situations) is supposed to have been gradually raised from the level of the lower reach B to that of the higher one where it now remains stationary; while the coffer *h* (which is concealed behind the masonry) has descended in the mean time to the level of the lower reach, where it closes by means of the juncture *rs*, fig. 10. (which juncture is covered with lists of cloth, as before explained at *m n*, and is of course become water-tight), when, by lifting the sluice *t*, and the corresponding sluice at the end of the canal, a perfect communication by water is established between them. If then, instead of water only, this coffer had contained a boat, floated into it from the upper reach, and then lowered down, it is very plain, that when these sluices were removed, after it had reached the level of the lower reach, that boat might have been floated out of the coffer with as much facility as it was let into it above. Here then we have a boat taken from the higher into the lower canal; and, by reversing this movement, it is very obvious that it might be, with equal ease, raised from the lower into the higher one. It now only remains that I should explain by what means the equilibrium between these counter-balancing weights can be destroyed at pleasure, and the motion, of course, produced.

"It is very evident, that if the two corresponding coffers be precisely of the same dimensions, their weight will be exactly the same when they are both filled to the same depth of water. It is equally plain, that should a boat be floated into either or both of them, whatever its dimensions or weight may be, so that it can be contained afloat in the coffer, the weight of the coffer and its contents will continue precisely the same as when it was filled with water only: hence, then, supposing one boat is to be lowered, or one to be raised at a time, or supposing one to be raised and another lowered at the same time—they remain perfectly in equilibrium in either place, till it is your pleasure to destroy that equilibrium. Suppose, then, for the present, that both coffers are loaded with a boat in each, the double sluices both above and below closed; and suppose also that a stop-cock *u*, in the under edge of the side of the lower coffer (fig. 8. and 10), is opened, some of the water which served to float the boat in the coffer will flow out of it, and consequently that coffer will become lighter than the higher one; the upper coffer will of course descend, while the other mounts upwards. When a gentle motion has been thus communicated, it may be prevented from accelerating, merely by turning the stop-cock so as to prevent the loss of more water, and thus one coffer will continue to ascend, and the other to descend, till they have assumed their stations respectively; when, in consequence of a stop below, and another above, they are rendered stationary at the level of the respective canals (A).

"Precisely the same effect will be produced when the coffers are filled entirely with water.

"It is unnecessary to add more to this explanation, except to observe, that the space for the coffer to descend into must be deeper than the bottom of the lower canal,

(A) "It does not seem necessary to adopt any other contrivance than the above for regulating the motions; but if it should be found necessary, it would be easy to put a ratch-wheel on the same axle."

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canal, in order to allow a free descent for the coffer to the requisite depth; and of course it will be necessary to have a small conduit to allow the water to get out of it. Two or three inches free, below the bottom of the canal, is all that would be necessary.

"Where the height is inconsiderable, there will be no occasion for providing any counterpoise for the chain, as that will give only a small addition to the weight of the undermost coffer, so as to make it preponderate, in circumstances where the two coffers would otherwise be in perfect equilibrium; but, where the height is considerable, there will be a necessity for providing such a counterpoise; as, without it, the chain, by becoming more weighty every foot it descended, would tend to destroy the equilibrium too much, and accelerate the motion to an inconvenient degree. To guard against this inconvenience, let a chain of the same weight per foot, be appended at the bottom of each coffer, of such a length as to reach within a few yards of the ground where the coffer is at its greatest height (see fig. 7.); it will act with its whole weight upon the highest coffer while in this position; but, as that gradually descended, the chain would reach the ground, and, being there supported, its weight would be diminished in proportion to its descent; while the weight of the chain on the opposite side would be augmented in the same proportion, so as to counterpoise each other exactly, in every situation, until the uppermost chain was raised from the ground. After which it would increase its weight no more; and, of course, would then give the under coffer that preponderance which is necessary for preserving the machine steady. The under coffer, when it reached its lowest position, would touch the bottom on its edges, which would then support it, and keep every thing in the same position, till it was made lighter for the purpose of ascending.

"What constitutes one particular excellence of the apparatus here proposed is, that it is not only unlimited as to the system of the rise or depression of which it is susceptible (for it would not require the expenditure of one drop more water to lower it 100 feet than one foot); but it would also be easy so to augment the number of pulleys at any one place as to admit of two, three, four, or any greater number of boats being lowered or elevated at the same time; so that let the succession of boats on such a canal be nearly as rapid as that of carriages upon a highway, none of them need be delayed one moment to wait an opportunity of passing: a thing that is totally impracticable where water-locks are employed; for the intercourse, on every canal constructed with water-locks, is necessarily limited to a certain degree, beyond which it is impossible to force it.

"For example: suppose a hundred boats are following each other, in such a rapid succession as to be only half a minute behind each other. By the apparatus here proposed, they would all be elevated precisely as they came; in the other, let it be supposed that the lock is so well constructed as that it takes no more than five minutes to close and open it; that is, ten minutes in the whole to each boat (for the lock, being once filled, must be again emptied before it can receive another in the same direction); at this rate, six boats only could be passed in an hour, and of course it would take sixteen hours and forty minutes to pass the whole hundred; and as the last boat would reach the lock in the space of fifty minutes after the first, it would be detained fifteen hours and fifty minutes before its turn would come to be raised. This is an immense detention; but if a succession of boats, at the same rate, were to follow continually, they never could pass at all. In short, in a canal constructed with water-locks, not more than six boats, on an average, can be passed in an hour, so that beyond that extent all commerce must be stopped; but, on the plan here proposed, sixty, or six hundred, might be passed in an hour, if necessary, so as to occasion no sort of interruption whatever. These are advantages of a very important nature, and ought not to be overlooked in a commercial country.

"This apparatus might be employed for innumerable other uses as a moving power, which it would be foreign to our present purpose here to specify. Nor does its power admit of any limitation, but that of the strength of the chain, and of the coffers which are to support the weights. All the other parts admit of being made so immoveably firm as to be capable of supporting almost any assignable weight.

"I will not enlarge on the benefits that may be derived from this very simple apparatus: its cheapness, when compared with any other mode of raising and lowering vessels that has ever yet been practised, is very obvious; the waste of water it would occasion is next to nothing; and when it is considered that a boat might be raised or lowered fifty feet nearly with the same ease as five, it is evident that the interruptions which arise from frequent locks would be avoided, and an immense saving be made in the original expence of the canal, and in the annual repairs.

"It is also evident, that an apparatus, on the same principle, might be easily applied for raising coals or metals from a great depth in mines, wherever a very small stream of water could be commanded, and where the mine was level-free."

It is almost needless to spend time in enumerating the many advantages which necessarily result from artificial navigations. Their utility is now so apparent, that most nations in Europe give the highest encouragement to undertakings of this kind wherever they are practicable. The advantages of navigable canals did not escape the observation of the ancients. From the most early accounts of society we read of attempts to cut through large isthmuses, in order to make a communication by water, either between different nations, or distant parts of the same nation, where land-carriage was long and expensive. Herodotus relates, that the Cnidians, a people of Caria in Asia Minor, designed to cut the isthmus which joins that peninsula to the continent; but were superstitious enough to give up the undertaking, because they were interdicted by an oracle. Several kings of Egypt attempted to join the Red sea to the Mediterranean by a canal. It was begun by Necos the son of Psammeticus, and completed by Ptolemy II. After his reign it was neglected, till it was opened in 635 under the caliphate of Omar, but was again allowed to fall into disrepair: so that it is now difficult to discover any traces of it. Both the Greeks and Romans intended to make a canal across the isthmus of Corinth, which joins the Morea and Achaia, in order to make a navigable passage by the Ionian sea into the Archipelago. Demetrius,

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Canal. metrius, Julius Cæsar, Caligula, and Nero, made several unsuccessful efforts to open this passage. But, as the ancients were entirely ignorant of the use of water-locks, their whole attention was employed in making level cuts, which is probably the principal reason why they so often failed in their attempts. Charlemagne formed a design of joining the Rhine and the Danube, in order to make a communication between the ocean and the Black sea, by a canal from the river Almutz which discharges itself into the Danube, to the Reditz, which falls into the Main, and this last falls into the Rhine near Mayence; for this purpose he employed a prodigious number of workmen; but he met with so many obstacles from different quarters, that he was obliged to give up the attempt.

The French at present have many fine canals: that of Briare was begun under Henry IV. and finished under the direction of Cardinal Richelieu in the reign of Louis XIII. This canal makes a communication betwixt the Loire and the Seine by the river Loing. It extends 11 French great leagues from Briare to Montargis. It enters the Loire a little above Briare, and terminates in the Loing at Cepoi. There are 42 locks on this canal.

The canal of Orleans, for making another communication between the Seine and the Loire, was begun in 1675, and finished by Philip of Orleans, regent of France, during the minority of Louis XV. and is furnished with 20 locks. It goes by the name of the *canal of Orleans;* but it begins at the village of Combleux, which is a short French league from the town of Orleans.

But the greatest and most useful work of this kind is the junction of the ocean with the Mediterranean by the canal of Languedoc. It was proposed in the reigns of Francis I. and Henry IV. and was undertaken and finished under Louis XIV. It begins with a large reservoir 4000 paces in circumference, and 24 feet deep, which receives many springs from the mountain Noire. This canal is about 64 leagues in length, is supplied by a number of rivulets, and is furnished with 104 locks, of about eight feet rise each. In some places it passes over bridges of vast height; and in others it cuts through solid rocks for 1000 paces. At one end it joins the river Garonne near Thoulouse, and terminates at the other in the lake Tau, which extends to the port of Cette. It was planned by Francis Riquet in the 1666, and finished before his death, which happened in the 1680.

In the Dutch, Austrian, and French Netherlands, there is a very great number of canals; that from Bruges to Ostend carries vessels of 200 tons.

The Chinese have also a great number of canals; that which runs from Canton to Pekin extends about 825 miles in length, and was executed about 800 years ago.

It would be an endless task to describe the numberless canals in Holland, Russia, Germany, &c. We shall therefore confine ourselves to some of the more important in our own country.

As the promoting of commerce is the principal intention of making canals, it is natural to expect that their frequency in any nation should bear some proportion to the trade carried on in it, providing the situation of the country will admit of them. The present state of England and Scotland confirms this observation. Though the Romans made a canal between the Nyne, a little below Peterborough, and the Witham, three miles below Lincoln, which is now almost entirely filled up, yet it is not long since canals were revived in England. They are now however become very numerous, particularly in the counties of York, Lincoln, and Cheshire. Most of the counties betwixt the mouth of the Thames and the Bristol channel are connected together either by natural or artificial navigation; those upon the Thames and Isis being now connected with those upon the Severn. The duke of Bridgewater's canal in Cheshire runs 27 miles on a perfect level; but at Barton it is carried by a very high aqueduct bridge over the Irwell, a navigable river; so that it is common for vessels to be passing at the same time both under and above the bridge. It is likewise cut some miles into the hills, where the duke's coal-mines are wrought.

A navigable canal betwixt the Forth and Clyde in Scotland, and which divides the kingdom in two parts, was first thought of by Charles II. for transports and small ships of war; the expence of which was to have been 500,000l. a sum far beyond the abilities of his reign. It was again projected in the year 1722, and a survey made; but nothing more done till 1761, when the then Lord Napier, at his own expence, caused a survey, plan, and estimate, on a small scale, to be made. In 1764, the trustees for fisheries, &c. in Scotland, caused make another survey, plan, and estimate, of a canal five feet deep, which was to cost 79,000l. In 1766, a subscription was obtained by a number of the most respectable merchants in Glasgow, for making a canal four feet deep and twenty four feet in breadth; but when the bill was nearly obtained in parliament, it was given up on account of the smallness of the scale, and a new subscription set on foot for a canal seven feet deep, estimated at 150,000l. This obtained the sanction of parliament; and the work was begun in 1768 by Mr Smeaton the engineer. The extreme length of the canal from the Forth to the Clyde is 35 miles, beginning at the mouth of the Carron, and ending at Dalmuir Burnfoot on the Clyde, six miles below Glasgow, rising and falling 160 feet by means of 39 locks, 20 on the east side of the summit, and 19 on the west, as the tide does not ebb so low in Clyde as in the Forth by nine feet. Vessels drawing eight feet water, not exceeding nineteen feet beam and seventy-three feet in length, pass with ease, the canal having afterwards been deepened to upwards of eight feet. The whole enterprise displays the art of man in a high degree. The carrying the canal through moss, quicksand, gravel, and rocks, up precipices and over valleys, was attended with inconceivable difficulties. There are eighteen draw-bridges and fifteen aqueduct bridges of note, besides small ones and tunnels. In the first three miles there are only six locks: but in the fourth mile there are no less than ten locks, and a very fine aqueduct bridge over the great road to the west of Falkirk. In the next six miles there are only four locks which carry you to the summit. The canal then runs eighteen miles on a level, and terminates by one branch about a mile from Glasgow. In this course, for a considerable way, the ground is banked about twenty feet high, and the water is sixteen feet deep,

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and two miles of it is made through a deep moss. At Kirkintilloch, the canal is carried over the water of Logie on an aqueduct arch of ninety feet broad. This arch was thrown over in three stretches, having only a centre of thirty feet, which was shifted on small rollers from one stretch to another: a thing new, and never attempted before with an arch of this size; yet the joinings are as fairly equal as any other part, and admired as a very fine piece of masonry. On each side there is a very considerable banking over the valley. This work was carried on till it came within six miles of its junction with the Clyde; when the subscription and a subsequent loan being exhausted, the work was stopt in 1775. The city of Glasgow, however, by means of a collateral branch, opened a communication with the Forth, which has produced a revenue of about 6000l. annually; and, in order to finish the remaining six miles, the government in 1784 gave 50,000l. out of the forfeited estates, the dividends arising from this sum to be applied to making and repairing roads in the Highlands of Scotland. The work was accordingly resumed; and by contract, under a high penalty, was to be entirely completed in November 1789. The aqueduct bridge over the Kelvin, which is supposed the greatest of the kind in the world, consists of four arches, and carries the canal over a valley 65 feet high, and 420 in length, exhibiting a very singular effort of human ingenuity and labour. To supply the canal with water was of itself a very great work. There is one reservoir of 50 acres 24 feet deep, and another of 70 acres 22 feet deep, in which many rivers and springs terminate, which it is thought will afford a sufficient supply of water at all times. This whole undertaking when finished cost about 200,000l. It is the greatest of the kind in Britain, and of great national utility; though it is to be regretted that it had not been executed on a still larger scale, the locks being too short for transporting large masts.

This canal was completed in July 1790. On the 28th of this month, a tract barge, belonging to the company of proprietors, sailed from the bason, near the city of Glasgow, to Bowling bay, where the canal joins the river Clyde. The committee of management, accompanied by the magistrates of Glasgow, were the first voyagers on the new canal. On the arrival of the vessel at Bowling bay, after descending from the last lock into the Clyde, the ceremony of the junction of the Forth and Clyde was performed by discharging into the river Clyde a hogshead of water taken up from the river Forth, as a symbol of joining the western and eastern seas together.

About the year 1801, a canal was finished between Loch Gilp to Loch Crinan in Argyleshire. The distance is about nine miles. This canal, which is called the Crinan canal, is intended to accommodate the trade of the Western islands and fisheries. The vessels employed in this trade will, by means of this canal, avoid the circuitous and dangerous navigation round the Mull of Cantire.

Another canal was begun in 1803, which is intended to open a communication between the Western sea, and the Murray frith, through Loch Ness. This canal, which is by far the most magnificent work of the kind in Britain, is expected to be finished in 1821. See Caledonian Canal, Supplement.

Canal, in *Anatomy*, a duct or passage through which any of the juices flow.

CANANORE, a maritime town of Hindostan, on the coast of Malabar, in a district of the same name, with a large and safe harbour. It formerly belonged to the Portuguese, and had a strong fort to guard it; but in 1683, the Dutch, together with the natives, drove them away; and after they became masters of the town, enlarged the fortifications. The Dutch sold the place to a native family, now represented by a female, and also sovereign of the Lacadive islands, but paying an annual tribute of 14,000 rupees to the English East India Company. The town was taken by the British in 1790 from Tippo Saib, who had previously made himself master of it. E. Long. 78. 10. N. Lat. 12. 0.

Cananore, a small district of Hindostan, on the coast of Malabar, now subject to the British. The natives are generally Mahometans; and the country produces pepper, cardamoms, ginger, mirobolans, and tamarinds, in which they drive a considerable trade, their vessels sailing to Arabia and Sumatra.

CANARA, a province of Hindostan, on the coast of Malabar. The inhabitants are Gentoos, or Pagans; and there is a pagod or temple, called *Ramtrut*, which is visited every year by a great number of pilgrims. Here the custom of burning the wives with their husbands had its beginning, and is practised to this day. The country, before it fell into the hands of the British, was generally governed by a woman, who kept her court at a town called *Baydor*, two days journey from the sea. She might marry whom she pleased; and was not obliged to burn with her husband, like her female subjects. They are so good observers of their laws, that a robbery or murder is scarce ever heard of among them. The lower grounds yield every year two crops of corn or rice; and the higher produce pepper, betel-nuts, sanders wood, iron, and steel. The climate is fine, though subject to heavy rains during a great portion of the year. The surface is rocky and uneven, but produces a great abundance of vegetables. The inhabitants live in ease and comfort, though they are subjected to an enormous land tax of 60 per cent.

CANARIA, in *Ancient Geography*, one of the Fortunate islands, a proof that these were what are now called the *Canaries*. Canaria had its name from its abounding with dogs of an enormous size, two of which were brought to Juba, king of Mauritania. See the following article.

Canaria, or the *Grand Canary*, an island in the Atlantic ocean, about 180 miles from the coast of Africa. It is about 100 miles in circumference, and 33 in diameter. It is a fruitful island, and famous for the wine that bears its name. It also abounds with apples, melons, oranges, citrons, pomegranates, figs, olives, peaches, and plantains. The fir and palm trees are the most common. The towns are, Canary the capital, Gualdera, and Geria.

CANARY, or Cividad de Palmas, is the capital of the island of Canaria, with an indifferent castle, and a bishop's see. It has also a court of inquisition, and the supreme council of the rest of the Canary islands; as also four convents, two for men and two for women. The town is about three miles in compass, and contains

Canary. contains 12,000 inhabitants. The houses are only one story high, and flat at the top; but they are well built. The cathedral is a handsome structure. W. Long. 15. 20. N. Lat. 28. 4.

Canary Islands, are situated in the Atlantic ocean, over against the empire of Morocco in Africa. They were formerly called the *Fortunate Islands*, on account of the temperate healthy air, and excellent fruits. The land is very fruitful, for both wheat and barley produce 130 for one. The cattle thrive well, and the woods are full of all sorts of game. The Canary singing birds are well known all over Europe. There are here sugar-canes in great abundance; but the Spaniards first planted vines here, from whence we have the wine called *Canary* or *Sack*.

These islands were not entirely unknown to the ancients; but they were a long while forgot, till John de Batencourt discovered them in 1402. It is said they were first inhabited by the Phœnicians, or Carthaginians, but on no certain foundation; nor could the inhabitants themselves tell from whence they were derived; on the contrary, they did not know there was any other country in the world. Their language, manners, and customs, had no resemblance to those of their neighbours. However, they were like the people on the coast of Barbary in complexion. They had no iron. After the discovery, the Spaniards soon got possession of them all, under whose dominion they are to this day, except Madeira, which belongs to the Portuguese. The inhabitants are chiefly Spaniards; though there are some of the first people remaining, whom they call *Guanches*, who are somewhat civilized by their intercourse with the Spaniards. Their chief food is goat's milk. Their complexion is tawny, and their noses flat. The population, according to Humboldt, in 1790, was 174,000. The Spanish vessels, when they sail for the West Indies, always rendezvous at these islands, going and coming. Their number is 12. 1. Alegranza; 2. Canaria; 3. Ferro; 4. Fuerteventura; 5. Gomera; 6. Gratiosa; 7. Lancerotta; 8. Madeira; 9. Palma; 10. Rocca; 11. Salvages; 12. Teneriff. West longitude from 12. to 21. north latitude from 27. 30. to 29. 30. See Canary Islands, Supplement.

Canary-Bird. See Fringilla. These birds are much admired for their singing, and take their name from the place from whence they originally came, viz. the Canary islands; but of late years there is a sort of birds brought from Germany, and especially from Tirol, and therefore called *German birds*, which are much better than the others; though both are supposed to have originally come from the same place. The cocks never grow fat, and by some country people cannot be distinguished from common green-birds; though the Canary-birds are much lustier, have a longer tail, and differ much in the heaving of the passages in the throat when they sing. These birds being so much esteemed for their song, are sometimes sold at a high price, according to the goodness and excellency of their notes; so that it will always be advisable to hear one sing before he is bought. In order to know whether he is in good health, take him out of the store-cage, and put him in a clean cage by himself; if he stand up boldly, without crouching or shrinking in his feathers, look with a brisk eye, and is not subject to clap his head under his wing, it is a sign that he is in good health; but the greatest matter is to observe his dunging: if he bolts his tail like a nightingale, after he has dunged, it is a sign he is not in good health, or at least that he will soon be sick; but if his dung be very thin like water, or of a slimy white without any blackness in it, it is a sign of approaching death. When in perfect health, his dung lies round and hard, with a fine white on the outside, dark within, and dries quickly; though a seed-bird seldom dungs so hard, unless he is very young.

Canary-birds are subject to many diseases, particularly imposthumes, which affect the head, cause them to fall suddenly from the perch, and die in a short time, if not speedily cured. The most approved medicine is an ointment made of fresh butter and capon's grease melted together. With this the top of the bird's head is to be anointed for two or three days, and it will dissolve the imposthume: but if the medicine has been too long delayed, then, after three or four times anointing, see whether the place of his head be soft; and if so, open it gently, and let out the matter, which will be like the yolk of an egg; when this is done, anoint the place, and the bird will be cured. At the same time he must have figs with his other food, and in his water a slice or two of liquorice, with white sugar-candy.

Canary-birds are distinguished by different names at different times and ages: such as are about three years old are called *runts*; those above two are named *criffs*; those of the first year under the care of the old ones, are termed *branchers*; those that are new-flown, and cannot feed themselves, *pushers*; and those brought up by hand, *nestlings*.

The Canary-birds may be bred with us; and, if treated with proper care, they will become as vigorous and healthful as in the country from whence they have their name. The cages in which these birds are kept are to be made either of walnut-tree or oak, with bars of wire; because these, being woods of strength, do not require to be used in large pieces. The common shape of cages, which is cylindric, is very improper for these birds; for this allows little room to walk, and without that the birds usually become melancholy. The most proper of all shapes is the high and long, but narrow.

If these birds eat too much, they grow over-fat, lose their shape, and their singing is spoiled; or at least they become so idle, that they will scarce ever sing. In this case their victuals are to be given them in a much smaller quantity, and they will by this means be recovered by degrees to all their beauty, and will sing as at first.

At the time that they are about to build their nests, there must be put into their cages some hay, dried thoroughly in the sun; with this must be mixed some moss dried in the same manner, and some stag's hair; and great care is to be taken of breeding the young, in the article of food. As soon as the young birds are eight days old, or somewhat more, and are able to eat and pick up food of themselves, they are to be taken out of the cage in which they were hatched, and each put separately into another cage, and hung up in a room where it may never have an opportunity of hearing the voice of any other bird. After they have been kept thus about eight days, they are to be excited;

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cited to sing by a bird-pipe; but this is not to be blowed too much, or in too shrill a manner, lest they sing themselves to death.

For the first fifteen days the cages are to be covered with a black cloth, and for the fifteen days following with a green one. Five lessons in a day from the pipe are sufficient for these young creatures; and they must not be disturbed with several sounds at the same time, lest they confound and puzzle them; two lessons should be given them early in the morning, one about the middle of the day, and two more at night.

The genius and temper of the several birds of this kind are very different. The males are almost always melancholy, and will not sing unless they are excited to it by hearing others continually singing about them. The male bird of this kind will often kill the female put to him for breeding; and when there are several females together with the males, they will often do the same to one another from jealousy. It is therefore not easy to manage the article of their breeding well in this particular, unless in this manner: let two female birds be put into one cage, and when they have lived together some time, they will have contracted a sort of love for one another, which will not easily be dissolved. Put a male bird into the cage with these two, and every thing will go well; their friendship will keep them from quarrelling about his favours, and from danger of his mischievous disposition; for if he attacks one of them, in order to kill her, the other will immediately take her part; and after a few of these battles, the male will find that they are together an overmatch for him at fighting, and will then distribute his favours to them, and there will not fail of being a young breed or two, which are to be taken away from their parents, and educated as before directed. Some males watch the time of the females laying, and devour the eggs as fast as she deposits them; and others take the young ones in their beak as soon as hatched, and crush them to death against the sides of the cage, or some other way destroy them. When a male has been known once to have been guilty of this, he is to be shut up in a small cage, in the middle of the large one in which the female is breeding her young, and thus he will often comfort her with singing all day long, while she sits upon the eggs or takes care of the young ones; and when the time of taking away, to put them into separate cages, is come, the male is to be let out, and he will always after this live in friendship with the female.

If the male become sick during the time of the female's sitting or bringing up her young, he must be removed immediately, and only brought to the side of her cage at certain times that she may see him, till he is perfectly cured; and then he is to be shut up again in his cage in the middle.

Canary-birds are various in their notes; some having a sweet song, others a lowish note, others a long song, which is best, as having the greatest variety of notes; but they sing chiefly either the titlark or nightingale notes. See *Song of Birds*.

CANCALLE, a town of France, in the department of Ille and Vilaine, by the sea-side, where there is a road. Here the British landed in 1758, in their way to St Maloes, where they burnt a great number of ships in the harbour, and then retired without loss. This town was in their power; but they acted like generous enemies, and did no hurt to this nor any other on the coast. W. Long. 0. 13. N. Lat. 48. 41.

CANCELIER, in falconry, is when a light brown hawk, in her stooping, turns two or three times upon the wing, to recover herself before she seizes.

CANCELLI, a term used to denote lattice windows, or those made of cross bars disposed latticewise; it is also used for rails or ballusters inclosing the communion-table, a court of justice, or the like, and for the network in the inside of hollow bones.

CANCELLING, in the civil law, an act whereby a person consents that some former deed be rendered null and void. This is otherwise called *rescision*. The word comes from the Latin *cancellare*, to encompass or pale a thing round. In the proper sense of the word, *to cancel*, is to deface an obligation, by passing the pen from top to bottom, or across it; which makes a kind of chequer lattice, which the Latins call *cancelli*.

CANCER, in *Zoology*, a genus of insects belonging to the order of insecta aptera. This genus includes the lobster, the crab, the prawn, the shrimp, and the craw-fish. See ENTOMOLOGY *Index*.

CANCER, in *Medicine*, a roundish, unequal, hard, and livid tumour, generally seated in the glandulous parts of the body, supposed to be so called, because it appears at length with turgid veins shooting out from it, so as to resemble, as it is thought, the figure of a crab-fish, or others say, because, like that fish, where it has once got, it is scarce possible to drive it away. See MEDICINE *Index*.

CANCER, in *Astronomy*, one of the twelve signs, represented on the globe in the form of a crab, and thus marked (♋) in books. It is the fourth constellation in the starry zodiac, and that from which one quadrant of the ecliptic takes its denomination. The reason generally assigned for its name as well as figure, is a supposed resemblance which the sun's motion in this sign bears to the crab-fish. As the latter walks backwards, so the former, in this part of his course, begins to go backwards, or recede from us; though the disposition of stars in this sign is by others supposed to have given the first hint to the representation of a crab.

Tropic of CANCER, in *Astronomy*, a lesser circle of the sphere parallel to the equator, and passing through the beginning of the sign Cancer.

CANCHERIZANTE, or CANCHERIZATO, in the Italian music, a term signifying a piece of music that begins at the end, being the retrograde motion from the end of a song, &c. to the beginning.

CANCROMA, or BOAT-BILL. See ORNITHOLOGY *Index*.

CANDAHAR, a province of Afghanistan, bounded on the north by the province of Balk; on the east, by that of Cabul; on the south, by Buchor and Sablestan; and on the west, by Sigestan. There have been bloody wars between the Indians and Persians on account of this province. In 1650 it fell to the Persians, but is now independent. The inhabitants, who are known by the name of *Aghuans*, or *Afghans*, are chiefly a migratory race of shepherds. The country is fertile. See PERSIA.

CANDAHAR, the capital of the above province, is seated on a mountain; and being a place of great trade

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trade has a considerable fortress. The caravans that travel from Persia and the parts about the Caspian sea to the East Indies, choose to pass through Candahar, because there is no danger of being robbed on this road, and provisions are very reasonable. The religion is Mahometanism, but there are many Banians and Guebres. E. Long. 65. 45. N. Lat. 32. 40.

CANDAULES, the last king of Lydia, of the family of the Heraclidæ. See LYDIA.

CANDELARES, (from *candela*, a candle), the name of an order in the former editions of Linnæus's Fragments of a Natural Method, consisting of these three genera, *rhizophora*, *nyssa*, and *mimusops*. They are removed, in the later editions, into the order HOLORACEÆ.

CANDIA, the modern name of the island of Crete (see CRETE). The word is a variation of *Khunda*, which was originally the Arabian name of the metropolis only, but in time came to be applied to the whole island.

Candia came into the possession of the Venetians, by purchase, in the year 1194, as related under the article CRETE; and soon began to flourish under the laws of that wise republic. The inhabitants, living under the protection of a moderate government, and being encouraged by their masters, engaged in commerce and agriculture. The Venetian commandants readily afforded to those travellers who visited the island, that assistance which is necessary to enable them to extend and improve useful knowledge. Belon, the naturalist, is lavish in praise of their good offices, and describes, in an interesting manner, the flourishing state of that part of the island which he visited.

The seat of government was established at Candia. The magistrates and officers, who composed the council, resided there. The provisor-general was president. He possessed the chief authority; and his power extended over the whole principality. It continued in the possession of the Venetians for five centuries and a half. Cornaro held the chief command at the time when it was threatened with a storm, on the side of Constantinople. The Turks, for the space of a year, had been employed in preparing a vast armament. They deceived the Venetian, by assuring him that it was intended against Malta. In the year 1645, in the midst of a solemn peace, they appeared unexpectedly before Crete with a fleet of 400 sail, having on board 60,000 land forces, under the command of four pachas. The emperor Ibrahim, under whom this expedition was undertaken, had no fair pretext to offer in justification of his enterprise. He made use of all that perfidy which characterizes the people of the east, to impose on the Venetian senate. He loaded their ambassador with presents, directed his fleet to bear for Cape Matapan, as if they had been going beyond the Archipelago; and caused the governors of Tina and Cerigna to be solemnly assured that the republic had nothing to fear for her possessions. At the very instant when he was making those assurances, his naval armament entered the gulf of Canea; and, passing between that city and St Theodore, anchored at the mouth of Platania.

The Venetians, not expecting this sudden attack, had made no preparations to repel it. The Turks landed without opposition. The isle of St Theodore is but a league and a half from Canea. It is only three quarters of a league in compass. The Venetians had erected two forts there; one of which, standing on the summit of the highest eminence, on the coast of that little isle, was called Turluru; the other, on a lower situation, was named St Theodore. It was an important object to the Mussulmans to make themselves masters of that rock, which might annoy their ships. They immediately attacked it with ardour. The first of these fortresses, being destitute of soldiers and cannon, was taken without striking a blow. The garrison of the other consisted of no more than 60 men. They made a gallant defence, and stood out till the last extremity; and when the Turks at last prevailed, their number was diminished to ten, whom the captain-pacha cruelly caused to be beheaded.

Being now masters of that important post, as well as of Lazaret, an elevated rock, standing about half a league from Canea, the Turks invested the city by sea and land. General Cornaro was struck, as with a thunder-clap, when he learned the descent of the enemy. In the whole island there were no more than a body of 3500 infantry, and a small number of cavalry. The besieged city was defended only by 1000 regular troops, and a few citizens, who were able to bear arms. He made haste to give the republic notice of his distress; and posted himself off the road, that he might the more readily succour the besieged city. He threw a body of 250 men into the town before the lines of the enemy were completed. He afterwards made several attempts to strengthen the besieged with other reinforcements; but in vain. The Turks had advanced in bodies close to the town, had carried a half-moon battery, which covered the gate of Retimo; and were battering the walls night and day with their numerous artillery. The besieged defended themselves with resolute valour, and the smallest advantage which the besiegers gained cost them dear. General Cornaro made an attempt to arm the Greeks, particularly the Spachlots, who boasted loudly of their valour. He formed a battalion of these. But the æra of their valour was long past. When they beheld the enemy, and heard the thunder of the cannon, they took to flight; not one of them would stand fire.

When the senate of Venice were deliberating on the means to be used for relieving Canea, and endeavouring to equip a fleet, the Mahometan generals were sacrificing the lives of their soldiers to bring their enterprise to a glorious termination. In different engagements they had already lost 20,000 warriors; but, descending into the ditches, they had undermined the walls, and blown up the most impregnable forts with explosions of powder. They sprung one of those mines beneath the bastion of St Demetri. It overturned a considerable part of the wall, which crushed all the defenders of the bastion. That instant the besiegers sprung up with their sabres in their hands, and taking advantage of the general consternation of the besieged on that quarter, made themselves masters of the post. The besieged, recovering from their terror, attacked them with unequalled intrepidity. About 400 men assailed 2000 Turks already firmly posted on the wall, and pressed upon them with such obstinate and dauntless valour, that they killed a great number, and drove the rest down into the ditch. In this extremity, every person

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Candia. person in the city was in arms. The Greek monks took up muskets; and the women, forgetting the delicacy of their sex, appeared on the walls among the defenders, either supplying the men with ammunition and arms, or fighting themselves; and several of those daring heroines lost their lives.

For 50 days the city held out against all the forces of the Turks. If, even at the end of that time, the Venetians had sent a naval armament to its relief, the kingdom of Candia might have been saved. Doubtless, they were not ignorant of this well-known fact. The north wind blows straight into the harbour of Canea. When it blows a little briskly, the sea rages. It is then impossible for any squadron of ships, however numerous, to form in line of battle in the harbour, and to meet an enemy. If the Venetians had set out from Cerigo with a fair wind, they might have reached Canea in five hours, and might have entered the harbour with full sails without being exposed to one cannon-shot; while none of the Turkish ships would have dared to appear before them; or if they had ventured, must have been driven back on the shore, and dashed in pieces among the rocks. But, instead of thus taking advantage of the natural circumstances of the place, they sent a few galleys, which, not daring to double Cape Spada, coasted along the southern shore of the island, and failed of accomplishing the design of their expedition.

At last, the Caneans, despairing of relief from Venice, seeing three breaches made in their walls, through which the infidels might easily advance upon them, exhausted with fatigue, and covered with wounds, and reduced to the number of 500 men, who were obliged to scatter themselves round the walls, which were half a league in extent, and undermined in all quarters, demanded a parley, and offered to capitulate. They obtained very honourable conditions; and after a glorious defence of two months, which cost the Turks 20,000 men, marched out of the city with the honours of war. Those citizens who did not choose to continue in the city were permitted to remove; and the Ottomans, contrary to their usual practice, faithfully observed their stipulations.

The Venetians, after the loss of Canea, retired to Retimo. The captain-pacha laid siege to the citadel of the Sude, situated in the entrance of the bay, on a high rock, of about a quarter of a league in circumference. He raised earthen batteries, and made an ineffectual attempt to level the ramparts. At last, despairing of taking it by assault, he left some forces to block it up from all communication, and advanced towards Retimo. That city, being unwalled, was defended by a citadel, standing on an eminence which overlooks the harbour. General Cornaro had retired thither. At the approach of the enemy, he advanced from the city, and waited for them in the open field. In the action, inattentive to his own safety, he encouraged the soldiers, by fighting in the ranks. A glorious death was the reward of his valour; but his fall determined the fate of Retimo.

The Turks having landed additional forces on the island, they introduced the plague, which was almost a constant attendant on their armies. This dreadful pest rapidly advanced, and, like a devouring fire, wasting all before it, destroyed most part of the inhabitants. The rest, flying in terror before its ravages, escaped into the Venetian territories, and the island was left almost desolate. Candia.

The siege of the capital commenced in 1646, and was protracted much longer than that of Troy. Till the year 1648, the Turks scarce gained any advantages before that city. They were often routed by the Venetians, and sometimes compelled to retire to Retimo. At that period Ibrahim was solemnly deposed, and his eldest son, at the age of nine years, was raised to the throne, under the name of Mahomet IV. Not satisfied with confining the sultan to the horrors and obscurity of a dungeon, the partizans of his son strangled him on the 19th of August, in the same year. That young prince, who mounted the throne by the death of his father, was afterwards expelled from it, and condemned to pass the remainder of his life in confinement.

In the year 1649, Ussein Pacha, who blockaded Candia, receiving no supplies from the Porte, was compelled to raise the siege, and retreat to Canea. The Venetians were then on the sea with a strong squadron. They attacked the Turkish fleet in the bay of Smyrna, burnt 12 of their ships and two galleys, and killed 6000 of their men. Some time after, the Mahometans having found means to land an army on Candia, renewed the siege of the city with great vigour, and made themselves masters of an advanced fort that was very troublesome to the besieged; which obliged them to blow it up.

From the year 1650 till 1658, the Venetians, continuing masters of the sea, intercepted the Ottomans every year in the straits of the Dardanelles, and fought them in four naval engagements; in which they defeated their numerous fleets, sunk a number of their caravels, took others, and extended the terror of their arms even to the walls of Constantinople. That capital became a scene of tumult and disorder. The Grand Signior, alarmed, and trembling for his safety, left the city with precipitation.

Such glorious success revived the hopes of the Venetians, and depressed the courage of the Turks. They converted the siege of Candia into a blockade, and suffered considerable losses. The sultan, in order to exclude the Venetian fleet from the Dardanelles, and to open to his own navy a free and safe passage, caused two fortresses to be built at the entrance of the straits. He gave orders to the pacha of Canea to appear again before the walls of Candia, and to make every possible effort to gain the city. In the mean time, the republic of Venice, to improve the advantages which they had gained, made several attempts on Canea. In 1660, that city was about to surrender to their arms, when the pacha of Rhodes, hastening to its relief, reinforced the defenders with a body of 2000 men. He happily doubled the extremity of Cape Melec, though within sight of the Venetian fleet, which was becalmed off Cape Spada, and could not advance one fathom to oppose an enemy considerably weaker than themselves.

Kiopruli, son and successor to the vizier of that name, who had long been the support of the Ottoman empire, knowing that the murmurs of the people against the long continuance of the siege of Candia were rising to a height, and fearing a general revolt, which would

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Candia. would be fatal to himself and his master, set out from Byzantium about the end of the year 1666 at the head of a formidable army. Having escaped the Venetian fleet, which was lying off Canea with a view to intercept him, he landed at *Palio Castro*, and formed his lines around Candia. Under his command were four pachas, and the flower of the Ottoman forces. Those troops, being encouraged by the presence and the promises of their chiefs, and supported by a great quantity of artillery, performed prodigies of valour. All the exterior forts were destroyed. Nothing now remained to the besieged but the bare line of the walls, unprotected by fortresses; and these being battered by an incessant discharge of artillery, soon gave way on all quarters. Still, however, what posterity may perhaps regard as incredible, the Candians held out three years against all the force of the Ottoman empire. At last they were going to capitulate, when the hope of assistance from France re-animated their valour, and rendered them invincible. The expected succours arrived on the 26th of June 1669. They were conducted by the duke of Noailles. Under his command were a great number of French noblemen, who came to make trial of their skill in arms against the Turks.

Next day after their arrival, the ardour of the French prompted them to make a general sally. The duke of Beaufort, admiral of France, assumed the command of the forlorn hope. He was the first to advance against the Mussulmans, and was followed by a numerous body of infantry and cavalry. They advanced furiously upon the enemy, attacked them within their trenches, forced the trenches, and would have compelled them to abandon their lines and artillery, had not an unforeseen accident damped their courage. In the midst of the engagement a magazine of powder was set on fire; the foremost of the combatants lost their lives; the French ranks were broken; several of their leaders, among whom was the duke of Beaufort, disappeared for ever; the soldiers fled in disorder; and the duke of Noailles, with difficulty, effected a retreat within the walls of Candia. The French accused the Italians of having betrayed them; and on that pretext prepared to set off sooner than the time agreed upon. No intreaties of the commandant could prevail with them to delay their departure; so they re-embarked. Their departure determined the fate of the city. There were now no more than five hundred men to defend it. Morosini capitulated with Kiopruli, to whom he surrendered the kingdom of Crete, excepting only the Sude, Grabusa, and Spina-Longua. The grand-vizier made his entrance into Candia on the 4th of October 1670, and staid eight months in that city, inspecting the reparation of its walls and fortresses.

The three fortresses left in the hands of the Venetians by the treaty of capitulation remained long after in their possession. At last they were all taken, one after another. In short, after a war of 30 years continuance, in the course of which more than 200,000 men fell in the island, and it was deluged with streams of Christian and Mahometan blood, Candia was entirely subdued by the Turks, in whose hands it still continues.

Of the climate of Candia travellers speak with rapture. The heat is never excessive; and in the plains violent cold is never felt. In the warmest days of summer the atmosphere is cooled by breezes from the sea. Winter properly begins here with December and ends with January; and during that short period snow never falls on the lower grounds, and the surface of the water is rarely frozen over. Most frequently the weather is as fine then as it is in Britain at the beginning of June. These two months have received the name of *winter*, because in them there is a copious fall of rain, the sky is obscured with clouds, and the north winds blow violently; but the rains are favourable to agriculture, the winds chase the clouds towards the summits of the mountains, where a repository is formed for those waters which are to fertilize the fields; and the inhabitants of the plain suffer no inconvenience from these transient blasts. In the month of February, the ground is overspread with flowers and rising crops. The rest of the year is almost one continued fine day. The inhabitants of Crete never experience any of those mortifying returns of piercing cold, which are so frequently felt in Britain and even more southern countries; and which, succeeding suddenly after the cherishing heats of spring, nip the blossoming flowers, wither the open buds, destroy half the fruits of the year, and are fatal to delicate constitutions. The sky is always unclouded and serene; the winds are mild and refreshing breezes. The radiant sun proceeds in smiling majesty along the azure vault, and ripens the fruits on the lofty mountains, the rising hills, and the plains. The nights are no less beautiful; their coolness is delicious. The atmosphere not being overloaded with vapours, the sky unfolds to the observer's view a countless profusion of stars; those numerous stars sparkle with the most vivid rays, and strew the azure vault in which they appear fixed, with gold, with diamonds, and with rubies. Nothing can be more magnificent than this sight, and the Cretans enjoy it for six months in the year.

To the charms of the climate other advantages are joined which augment their value: There are scarce any morasses in the island; the waters here are never in a state of stagnation; they flow in numberless streams from the tops of the mountains, and form here and there large fountains or small rivers that empty themselves into the sea; the elevated situation of their springs causes them to dash down with such rapidity, that they never lose themselves in pools or lakes; consequently insects cannot deposit their eggs upon them, as they would be immediately hurried down into the sea; and Crete is not infested like Egypt with these clouds of insects which swarm in the houses, and whose sting is insufferably painful; nor is the atmosphere here loaded with those noxious vapours which rise from marshy grounds.

The mountains and hills are overspread with various kinds of thyme, savoury, wild thyme, and with a multitude of odoriferous and balsamic plants; the rivulets which flow down the valleys are overhung with myrtles, laurel, and roses; clumps of orange, citron, and almond trees, are plentifully scattered over the fields; the gardens are adorned with tufts of Arabian jasmine. In spring, they are bestrewed with beds of violets; some extensive plains are arrayed in saffron; the cavities of the rocks are fringed with sweet smelling dittany. In a word, from the hills, the vales, and the plains,

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Candia. plains, on all hands, there arise clouds of exquisite perfumes, which embalm the air, and render it a luxury to breathe it.

As to the inhabitants, the Mahometan men are generally from five feet and a half to six feet tall. They bear a strong resemblance to ancient statues; and it must have been after such models that the ancient artists wrought. The women also are generally beautiful. Their dress does not restrain the growth of any part of their bodies, and their shape therefore assumes those admirable proportions with which the hand of the Creator has graced his fairest workmanship on earth. They are not all handsome or charming; but some of them are beautiful, particularly the Turkish ladies. In general, the Cretan women have a rising throat, a neck gracefully rounded, black eyes sparkling with animation, a small mouth, a fine nose, and cheeks delicately coloured with the fresh vermilion of health. But the oval of their form is different from that of Europeans, and the character of their beauty is peculiar to their own nation.

The quadrupeds belonging to the island are not of a ferocious temper. There are no lions, tigers, bears, wolves, foxes, or indeed any dangerous animal here. Wild goats are the only inhabitants of the forests that overspread the lofty mountains; and these have nothing to fear but the ball of the hunter: hares inhabit the hills and the plain; sheep graze in security on the thyme and the heath; they are folded every night, and the shepherd sleeps soundly without being disturbed with the fear that wild animals may invade and ravage his folds.

The Cretans are very happy in not being exposed to the troublesome bite of noxious insects, the poison of serpents, or the rapacity of the wild beasts of the desert. The ancients believed that the island enjoyed these singular advantages, on account of its having been the birth-place of Jupiter. "The Cretans (says Ælian) celebrate in their songs the beneficence of Jupiter, and the favour which he conferred on their island, which was the place of his birth and education, by freeing it from every noxious animal, and even rendering it unfit for nourishing those noxious animals that are introduced into it from foreign countries."

Dittany holds the first rank among the medicinal plants which are produced in Crete. The praises bestowed on the virtues of this plant by the ancients are altogether extravagant; yet we perhaps treat the medicinal virtues of this plant with too much contempt. Its leaf is very balsamic, and its flower diffuses around it a delicious odour. At present the inhabitants of the island apply it with success on various occasions. The leaf, when dried and taken in an infusion with a little sugar, makes a very pleasant drink, of a finer flavour than tea. It is there an immediate cure for a weak stomach, and enables it to recover its tone after a bad digestion.

Diseases are very rare in a country whose atmosphere is exceedingly pure; and in Candia, epidemical diseases are unknown. Fevers prevail here in summer, but are not dangerous; and the plague would be wholly unknown, had not the Turks destroyed the lazarets that were established by the Venetians, for strangers to do quarantine in. Since the period when these were demolished, it is occasionally introduced by ships from Smyrna and Constantinople. As no precautions are taken against it, it gains ground, and spreads over the island from one province to another; and as the colds and heats are never intemperate, it sometimes continues its ravages for six months at a time.

This fine country is infested with a disease somewhat less dangerous than the plague, but whose symptoms are somewhat more hideous; that disease is the leprosy. In ancient times, Syria was the focus in which it raged with most fury: and from Syria it was carried into several of the islands of the Archipelago. It is infectious, and is instantaneously communicated by contact. The victims who are attacked by it, are driven from society, and confined to little ruinous houses on the highway. They are strictly forbidden to leave these miserable dwellings, or hold intercourse with any person. Those poor wretches have generally beside their huts a small garden producing pulse, and feeding poultry; and with that support, and what they obtain from passengers, they find means to drag out a painful life in circumstances of shocking bodily distress. Their bloated skin is covered with a scaly crust, speckled with red and white spots: which afflict them with intolerable itchings. A hoarse and tremulous voice issues from the bottom of their breasts. Their words are scarce articulated; because their distemper inwardly preys upon the organs of speech. These frightful spectres gradually lose the use of their limbs. They continue to breathe till such time as the whole mass of their blood is corrupted, and their bodies entirely in a state of putrefaction: The rich are not attacked by this distemper: it confines itself to the poor, chiefly to the Greeks. But those Greeks observe strictly their four lents; and eat nothing during that time but salt fish, botargo salted and smoked, pickled olives, and cheese. They drink plentifully of the hot and muddy wines of the island. The natural tendency of such a regimen must be, to fire the blood, to thicken the fluid part of it, and thus at length to bring on a leprosy.

Candia is at present governed by three pachas, who reside respectively at Candia, Canea, and Retimo. The first, who is always a pacha of three tails, may be considered as viceroy of the island. He enjoys more extensive powers than the others. To him the inspection of the forts and arsenals is intrusted. He nominates to such military employments as fall vacant, as well as to the governments of the Sude, Grabusa, Spina Longua, and Gira-petra. The governors of these forts are denominated *beys*. Each of them has a constable and three general officers under him; one of whom is commander of the artillery, another of the cavalry, and the third of the janissaries.

The council of the pacha consists of a kyaia, who is the channel through which all orders are issued, and all favours bestowed; an aga of the janissaries, colonel-general of the troops, who has the chief care of the regulation of the police; two topigi bachi; a defterdar, who is treasurer-general for the imperial revenues; a keeper of the imperial treasury; and the chief officers of the army. This government is entirely military, and the power of the pacha serasquier is absolute. The justice of his sentences is never called in question; they are instantly carried into execution.

The

Candia.

The people of the law are the mufti, who is the religious head, and the cadi. The first interprets those laws which regard the division of the patrimony among the children of a family, successions, and marriages,—in a word, all that are contained in the Koran; and he also decides on every thing that relates to the ceremonies of the Mussulman religion. The cadi cannot pronounce sentence on affairs connected with these laws, without first taking the opinion of the mufti in writing, which is named *Faitfa*. It is his business to receive the declarations, complaints, and donations of private persons; and to decide on such differences as arise among them. The pacha is obliged to consult those judges when he puts a Turk legally to death; but the pacha, who is dignified with three tails, sets himself above all laws, condemns to death, and sees his sentence executed, of his own proper authority. All the mosques have their itam, a kind of curate, whose duty is to perform the service. There are schoolmasters in the different quarters of the city. These persons are much respected in Turkey, and are honoured with the title of *effendi*.

The garrison of Candia consists of 46 companies, composing a military force of about ten thousand men. All these forces do not reside constantly in the city, but they may be mustered in a very short time. They are all regularly paid every three months, excepting the janissaries, none of whom but the officers receive pay. The different gradations of this military body do not depend on the pacha. The council of each company, consisting of veterans, and of officers in actual service, has the power of naming to them. A person can occupy the same post for no longer than two years; but the post of *sorbagi*, or captain, which is purchased at Constantinople, is held for life. The *ousta*, or cook, is also continued in his employment as long as the company to which he belongs is satisfied with him. Each company has its almoner, denominated *imam*.

The garrisons of Canea and Retimo, formed on a similar plan, are much less numerous. The first consists of about 3000 men, the other of 500; but as all the male children of the Turks are enrolled among the janissaries as soon as born, the number of these troops might be greatly augmented in time of war: but, to say the truth, they are far from formidable. Most of them have never seen fire, nor are they ever exercised in military evolutions.

The pachas of Canea and Retimo are no less absolute, within the bounds of their respective provinces, than the pacha of Candia. They enjoy the same privileges with him, and their council consists of the same officers. These governors chief object is to get rich as speedily as possible; and in order to accomplish that end, they practise all the arts and cruelties of oppression, to squeeze money from the Greeks. In truth, those poor wretches run to meet the chains with which they are loaded. Envy, which always preys upon them, continually prompts them to take up arms. If some one among them happen to enjoy a decent fortune, the rest assiduously seek some pretence for accusing him before the pacha, who takes advantage of these dissensions, to seize the property of both the parties. It is by no means astonishing, that under so barbarous a government, the number of the Greeks is daily diminished.

There are scarcely in the island, 65,000 of whom pay the carach.	150,000 Greeks
The Turks have not possessed the island for more than 120 years; yet as they are not exposed to the same oppression, they have multiplied in it, and raised themselves upon the ruin of the ancient inhabitants. Their number amounts to	200,000 Turks.
The Jews, of whom there are not many in the island, amount only to	200
Total is	350,200 souls.

This fertile country is in want of nothing but industrious husbandmen, secure of enjoying the fruit of their labours. It might maintain four times its present number of inhabitants.

Antiquity has celebrated the island of Crete as containing 100 populous cities; and the industry of geographers has preserved their names and situations. Many of these cities contained no fewer than 30,000 inhabitants; and by reckoning them, on an average, at 6000 each, we shall in all probability be rather within than beyond the truth. This calculation gives for 100 cities	600,000
By allowing the same number as inhabitants of the towns, villages, and all the rest of the island,	600,000
the whole number of the inhabitants of ancient Crete will amount to	1,200,000

This number cannot be exaggerated. When Candia was in the hands of the Venetians, it was reckoned to contain nine hundred fourscore and sixteen villages.

It appears, therefore, that when the island of Crete enjoyed the blessing of liberty, it maintained to the number of 849,800 more inhabitants than it does at present. But since those happier times, she has been deprived of her laws by the tyranny of the Romans; has groaned under the destructive sway of the monarchs of the lower empire; has been exposed for a period of 120 years to the ravages of the Arabians; has next passed under the dominion of the Venetians; and has at last been subjected to the despotism of the Turks, who have produced a dreadful depopulation in all the countries which have been subdued by their arms.

The Turks allow the Greeks the free exercise of their religion, but forbid them to repair their churches or monasteries; and accordingly they cannot obtain permission to repair their places of worship, or religious houses, but by the powerful influence of gold. From this article the pachas derive very considerable sums. They have 12 bishops as formerly, the first of whom assumes the title of archbishop of Gortynia. He resides at Candia; in which city the metropolitan church of the island stanes. He is appointed by the patriarch of Constantinople; and has the right of nominating to all the other bishoprics of the island; the names of which are, Gortynia, Cnosson, Mirabella, Hyera, Gira-petra, Arcadia, Cherronese, Lambis, Milopotamo, Retimo, Canea, Cisamo. These bishoprics are nearly the same as under the reign of the Greek emperors

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The patriarch wears a triple tiara, writes his signature in red ink, and answers for all the debts of the clergy. To enable him to fulfil his engagements, he lays impositions on the rest of the bishops, and particularly on the monasteries, from which he draws very handsome contributions. He is considered as the head of the Greeks, whom he protects, as far as his slender credit goes. The orders of government are directed to him on important occasions; and he is the only one of all the Greeks in the island who enjoys the privilege of entering the city on horseback.

CANDIA, is the capital of the above island, situated on its northern coast, in E. Long. 25. 0. N. Lat. 35. 30. It stands on the same situation which was formerly occupied by Heraclea, and is the seat of government under the Turks. Its walls, which are more than a league in compass, are in good repair, and defended by deep ditches, but not protected by any exterior fort. Towards the sea, it has no attacks to fear; because the shallowness of the harbour renders it inaccessible to ships of war.

The Porte generally commits the government of this island to a pacha of three tails. The principal officers, and several bodies of the Ottoman soldiery, are stationed here. This city, when under the Venetians, was opulent, commercial, and populous; but it has now lost much of its former strength and grandeur. The harbour, naturally a fine bason, in which ships were securely sheltered from every storm, is every day becoming narrower and shallower. At present it admits only boats, and small ships after they have discharged a part of their freight. Those vessels, which the Turks freight at Candia, are obliged to go almost empty to the port of Standie, whither their cargoes are conveyed to them in barks. Such inconveniences are highly unfavourable to commerce; and as government never thinks of removing them, the trade of Candia is therefore considerably decayed.

Candia, which was embellished by the Venetians with regular streets, handsome houses, a fine square, and a magnificent cistern, contains at present but a small number of inhabitants, notwithstanding the vast extent of the area enclosed within its walls. Several divisions of the city are void of inhabitants. That in which the market-place stands is the only one which discovers any stir of business, or show of affluence. The Mahometans have converted most of the Christian temples into mosques; yet they have left two churches to the Greeks, one to the Armenians, and a synagogue to the Jews. The Capuchins possess a small convent, with a chapel in which the vice-consul of France hears mass. At present he is the only Frenchman who attends it, as the French merchants have taken up their residence at Canea.

West of the city of Candia is an extensive range of hills, which are a continuation of Mount Ida, and of which the extremity forms the promontory of Dion. On the way to Dion, we find Palio Castro, on the shore; a name which the modern Greeks give indifferently to all remains of ancient cities. Its situation corresponds to that of the ancient Panormus, which stood north-west from Heraclea.

The river which runs west of Candia was anciently known by the name of Triton; near the source of which Minerva sprung from the brain of Jove. Loazus is a little farther distant. About a league east of that city, the river Ceratus flows through a delightful vale. According to Strabo, in one part of its course it runs near by Gnossus. A little beyond that, is another river supposed to be Therenus, on the banks of which, fable relates that Jupiter consummated his marriage with Juno. For the space of more than half a league round the walls of Candia there is not a single tree to be seen. The Turks cut them all down in the time of the siege, and laid waste the gardens and orchards. Beyond that extent, the country is plentifully covered with corn and fruit trees. The neighbouring hills are overspread with vineyards, which produce the malmsey of Mount Ida,—worthy of preference at the table of the most exquisite connoisseur in wines. That species of wine, though little known, has a fine flavour, a very pleasant relish, and is highly esteemed in the island.

CANDIAC, John Lewis, a premature genius, born at Candiac in the diocese of Nismes in France, in 1719. In the cradle he distinguished his letters: at 13 months, he knew them perfectly: at three years of age, he read Latin, either printed or in manuscript: at four, he translated from that tongue: at six, he read Greek and Hebrew; was master of the principles of arithmetic, history, geography, heraldry, and the science of medals; and had read the best authors on almost every branch of literature. He died of a complication of disorders, at Paris, in 1726.

CANDIDATE, a person who aspires to some public office.

In the Roman commonwealth, they were obliged to wear a white gown during the two years of their soliciting a place. This garment, according to Plutarch, they wore without any other clothes, that the people might not suspect they concealed money for purchasing votes, and also that they might more easily show to the people the scars of those wounds they had received in fighting for the defence of the commonwealth. The candidates usually declared their pretensions a year before the time of election, which they spent in making interest and gaining friends. Various arts of popularity were practised for this purpose, and frequent circuits made round the city, and visits and compliments to all sorts of persons, the process of which was called *ambitus*. See Ambitus.

CANDIDATI milites, an order of soldiers, among the Romans, who served as the emperor's body-guards to defend him in battle. They were the tallest and strongest of the whole troops, and most proper to inspire terror. They were called *candidati*, because clothed in white, either that they might be more conspicuous, or because they were considered in the way of preferment.

CANDISH, a considerable province of Asia, in the dominions of the Great Mogul, bounded by Chytor and Malva on the north, Orixa on the east, Decan on the south, and Guzerat on the west. It is populous and rich; and abounds in cotton, rice, and indigo. Brampore is the capital town.

CANDLE, a small taper of tallow, wax, or spermaceti; the wick of which is commonly of several threads of cotton, spun and twisted together.

A tallow-candle, to be good, must be half sheep's and half bullock's tallow; for hog's tallow makes the candle

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Candle.

candle gutter, and always gives an offensive smell, with a thick black smoke. The wick ought to be pure, sufficiently dry, and properly twisted; otherwise the candle will emit an inconstant vibratory flame, which is both prejudicial to the eyes and insufficient for the distinct illumination of objects.

There are two sorts of tallow-candles; the one dipped, the other moulded: the former are the common candles; the others are the invention of the Sieur le Brege at Paris.

As to the method of making candles in general: After the tallow has been weighed, and mixed in the due proportions, it is cut into very small pieces, that it may melt the sooner; for the tallow in lumps, as it comes from the butchers, would be in danger of burning or turning black, if it were left too long over the fire. Being perfectly melted and skimmed, they pour a certain quantity of water into it, proportionable to the quantity of tallow. This serves to precipitate to the bottom of the vessel the impurities of the tallow which may have escaped the skimmer. No water, however, must be thrown into the tallow designed for the three first dips; because the wick, being still quite dry, would imbibe the water, which makes the candles crackle in burning, and renders them of bad use. The tallow, thus melted, is poured into a tub, through a coarse sieve of horse-hair, to purify it still more, and may be used after having stood three hours. It will continue fit for use 24 hours in summer and 15 in winter. The wicks are made of spun cotton, which the tallow-chandlers buy in skains, and which they wind up into bottoms or clues; whence they are cut out, with an instrument contrived on purpose, into pieces of the length of the candle required: then put on the sticks or broaches, or else placed in the moulds, as the candles are intended to be either dipped or moulded.

Wax-candles are made of a cotton or flaxen wick, slightly twisted, and covered with white or yellow wax. Of these, there are several kinds: some of a conical figure, used to illuminate churches, and in processions, funeral ceremonies, &c. (see TAPER); others of a cylindrical form, used on ordinary occasions. The first are either made with a ladle or the hand. 1. To make wax-candles with the ladle. The wicks being prepared, a dozen of them are tied by the neck, at equal distances, round an iron circle, suspended over a large bason of copper tinned, and full of melted wax: a large ladle full of this wax is poured gently on the tops of the wicks one after another, and this operation continued till the candle arrive at its destined bigness; with this precaution that the three first ladles be poured on at the top of the wick, the fourth at the height of $\frac{3}{4}$, the fifth at $\frac{1}{2}$, and the sixth at $\frac{1}{4}$, in order to give the candle its pyramidal form. Then the candles are taken down, kept warm, and rolled and smoothed upon a walnut-tree table, with a long square instrument of box, smooth at the bottom. 2. [illegible] the manner of making wax-candles by the b[illegible]gin to soften the wax, by working it se[illegible] hot water, contained in a narrow but [illegible]iece of the wax is then taken out, a[illegible]e and little around the wick, whic[illegible]k in the wall, by the extremity oppos[illegible]; so that they begin with the big end, di[illegible]g still as they descend towards the neck. In other respects the method is nearly the same as in the former case. However, it must be observed, that, in the former case, water is always used to moisten the several instruments, to prevent the wax from sticking; and in the latter, oil of olives, or lard, for the hands, &c. The cylindrical wax-candles are either made as the former, with a ladle, or drawn. Wax-candles drawn, are so called, because actually drawn in the manner of wire, by means of two large rollers of wood, turned by a handle, which turning backwards and forwards several times, pass the wick through melted wax contained in a brass bason, and at the same time through the holes of an instrument like that used for drawing wire fastened at one side of the bason.

If any chandlers mix with their wares any thing deceitfully, &c. the candles shall be forfeited, by stat. 23 Eliz.; and a tax or duty is granted on candles, by 8 and 9 Anne, cap. 6. made for sale, of one penny a pound, besides the duty upon tallow, by 8 Anne, cap. 9. And by 24 Geo. III. cap. 11. an additional duty of a halfpenny a pound: and by the same an additional duty of a halfpenny a pound is laid upon all candles imported (except those of wax and spermaceti, for which see *WAX-Candles*), subject also to the two additional 5 per cents. imposed by 19 and 22 Geo. III. besides the duty of $2\frac{1}{4}$d. formerly imposed by 2 W. sess. 2. cap. 4. 8 Anne, cap. 9. and 9 Anne, cap. 6. And every maker of candles, other than wax-candles, for sale, shall annually take out a licence at 1l. The maker of candles shall, in four weeks within the bills, and elsewhere in six weeks, after entry, clear off the duties on pain of double duty; nor sell any after default in payment, on pain of double value; 8 Anne, cap. 9. The makers of candles are not to use melting houses, without making a true entry, on pain of 100l. and to give notice of making candles to the excise officer for the duties; and of the number, &c. or shall forfeit 50l. stat. 11. Geo. I. cap. 30. See also 23 Geo. II. cap. 21. and 26 Geo. II. cap. 32. No maker of candles for sale shall begin to make candles, without notice first given to the officers, unless, from September 29. to March 25. yearly, between seven in the morning and five in the evening, and from March 25. to September 29. between five in the morning and seven in the evening, on pain of 10l. 10 Anne, cap. 26. The penalty of obstructing the officer is 20l. and of removing candles before they are surveyed 20l. 8 Anne, cap. 9. The penalty of privately making candles is the forfeiture of the same and utensils, and 100l. 5 Geo. III. cap. 43. And the penalty of mingling weighed with unweighed candles, of removing them before they are weighed, or of concealing them, is the forfeiture of 100l. 11 Geo. cap. 30. Candles, for which the duty hath been paid, may be exported, and the duty drawn back; but no drawback shall be allowed on the exportation of any foreign candles imported. 8 Anne, cap. 9. 23 Geo. II. cap. 21.

The Roman candles were at first little strings dipt in pitch, or surrounded with wax; though afterwards they made them of the papyrus, covered likewise with wax; and sometimes also of rushes, by stripping off the outer rind, and only retaining the pith.—For religious offices, wax-candles were used; for vulgar uses, those

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Candle.

those of tallow. Lord Bacon proposes candles of divers compositions and ingredients, as also of different sorts of wicks; with experiments of the degrees of duration, and light of each. Good housewives bury their candles in flour or bran, which it is said increases their lasting almost half.

Experiments to determine the real and comparative value of burning Candles *of different sorts and sizes.*

	Num. of candles in one pound.	Weight of one candle. Oz	Dr.	The time one candle lasted. Hr.	Min.	The time that one pound will last Hr.	Min.	The expence in 12 hours when candles are at 6d per dozen, which also shews the proportion of the expence at any price per dozen. Farthings and 100th parts
Small wick	$18\frac{1}{3}$	0	14	3	15	59	26	4.85
Large wick.	19	0	$13\frac{1}{2}$	2	40	50	34	5.70
	$16\frac{1}{2}$	0	$15\frac{1}{2}$	2	40	44	2	6.54
	12	1	$5\frac{1}{3}$	3	27	41	24	6.96
*	$10\frac{1}{2}$	1	8	3	36	38	24	7.50
*	$7\frac{3}{4}$	2	1	4	9	32	12	8.94
*	8	2	0	4	15	34	0	8.47
	$5\frac{3}{4}$	2	13	5	19	30	15	9.53
	Mould. candles.							Mould. candl. at 7s. per doz.
	$5\frac{7}{8}$	2	12	7	20	42	39	7.87
	4	4	0	9	3	36	20	9.28

N. B. The time that one candle lasted was taken from an average of several trials in each size.

It is observable, in opics, that the flame of two candles joined, gives a much stronger light than both of them separate. The observation was suggested by Dr Franklin. Probably the union of the two flames produces a greater degree of heat, whereby the vapour is attenuated, and the particles of which light consists are more copiously emitted.

Mr Nicholson has made some interesting observations on the light afforded by lamps and candles, which we shall lay before our readers in his own words *. "We are acquainted with no means (says he), unless we may except electricity, of producing light, but by combustion, and this is most probably of the same nature. The rude method of illumination consists in successively burning certain masses of such in the solid state. Common fires answer this purpose in the apartments of houses, and in some lighthouses; small pieces of resinous wood, and the bituminous coal called *kunnel-coal*, are in some countries applied to the same use; but the most general and useful method is that in which fat oil, of an animal or vegetable kind, is burned by means of a wick. These instruments of illumination are either lamps or candles. In the lamp, the oil must be one of those which retains its fluidity in the ordinary temperature of the atmosphere. The candle is formed of an oil, or other material, which is not fusible but at a temperature considerably elevated.

* *Phil. Jour.* vol. i.

"The method of measuring the comparative intensities of light is one of the first requisites in an inquiry concerning the art of illumination. Two methods of considerable accuracy are described in the *Traité d'Optique* of Bouguer, of which an abridged account is given by Dr Priestley in his Optics. The first of these two methods has been used by others since that time, and probably before, from its very obvious nature, but particularly by Count Rumford, who has given a description and drawings of an instrument called the *photometer*, in the Philosophical Transactions for 1794. The principle it is grounded upon is, that if two lights shine upon the same surface at equal obliquities, and an opaque body be interposed, the two shadows it will produce must differ in blackness or intensity in the same degree. For the shadow formed by intercepting the greater light will be illuminated by the smaller light only, and reversely the other shadow will be illuminated by the greater light. That is to say, in short, the stronger light will be attended with a deeper shadow. But it is easy, by removing the greater light to a greater distance, to render the illumination it produces at the common surface equal to that afforded by the less. Experiments of this kind may be conveniently made by fastening a sheet of white paper against the wall of a room. The two lights or candles intended to be compared, must then be placed so that the ray of light from each shall fall with nearly the same angle of incidence upon the middle of the paper. By some experiments made in this way in the year 1785, I was satisfied that the degree of illumination could be thus ascertained to the 80th or 90th part of the whole.

"By experiments of this kind many useful particulars may be shewn. Thus, for example, the light of a candle, which is so exceedingly brilliant when first snuffed, is very speedily diminished to one-half, and is usually not more than one-fifth or one-sixth before the uneasiness of the eye induces us to snuff it. Whence it follows, that if candles could be made so as not to require snuffing, the average quantity of light afforded by the same quantity of combustible matter would be more than doubled. In the same way, likewise, since the cost and duration of candles, and the consumption of oil in lamps, are easily ascertainable, it may be shewn whether more or less of light is obtained at the same expence during a given time, by burning a number of small candles instead of one of greater thickness. From a few experiments already made out of the numerous and useful series that presents itself, I have reason to think that there is very much waste in this expensive article of accommodation.

"In the lamp there are three articles which demand our attention, the oil, the wick, and the supply of air. It is required that the oil should be readily inflammable, without containing any fetid substance which may prove offensive, or mucilage, or other matter, to obtruct the channels of the wick. I do not know of any process for ameliorating oils for this purpose, excepting that of washing with water containing acid or alkali. Either of these is said to render the mucilage of animal oils more soluble in the water; but acid is preferred, because it is less disposed to combine with the oil itself. The office of the wick appears to be chiefly, if not solely, to convey the oil by capillary attraction to the place of combustion. As the oil is consumed and flies off, other oil succeeds, and in this way a continued current of oil and maintenance of the flame are effected. But as the wicks of lamps are commonly formed of

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of combustible matter, it appears to be of some consequence what the nature and structure of this material may be. It is certain that the flame afforded by a wick of rush differs very considerably from that afforded by cotton; though perhaps this difference may, in a great measure, depend on the relative dimensions of each. And if we may judge from the different odour in blowing out a candle of each sort, there is some reason to suspect that the decomposition of the oil is not effected precisely in the same manner in each. We have also some obscure accounts of prepared wicks for lamps, which are stated to possess the property of facilitating the combustion of very impure oils, so that they shall burn for many hours without smoke or smell.

"The access of air is of the last importance in every process of combustion. When a lamp is fitted up with a very slender wick, the flame is small, and of a brilliant white colour: if the wick be larger, the combustion is less perfect, and the flame is brown: a still larger wick not only exhibits a brown flame, but the lower internal part appears dark, and is occupied by a portion of volatilized matter, which does not become ignited until it has ascended towards the point. When the wick is either very large or very long, part of this matter escapes combustion, and shews itself in the form of coal or smoke. The different intensity of the ignition of flame, according to the greater or less supply of air, is remarkably seen by placing a lamp with a small wick beneath a shade of glass not perfectly closed below, and more or less covered above. While the current of air through the glass shade is perfectly free, the flame is white; but in proportion as the aperture above is diminished, the flame becomes brown, long, wavering, and smoky; it instantly recovers its original whiteness when the opening is again enlarged. The inconvenience of a thick wick has been long since observed, and attempts made to remove it: in some instances by substituting a number of small wicks instead of a larger; and in others, by making the wick flat instead of cylindrical. The most scientific improvement of this kind, though perhaps less simple than the ordinary purposes of life demand, is the well-known lamp of Argand. In this the wick forms a hollow cylinder or tube, which slides over another tube of metal, so as to afford an adjustment with regard to its length. When this wick is lighted, the flame itself has the figure of a thin tube, to the inner as well as the outer surface of which the air has access from below. And a cylindrical shade of glass serves to keep the flame steady, and in a certain degree to accelerate the current of air. In this very ingenious apparatus many experiments may be made with the greatest facility. The inconvenience of a long wick, which supplies more oil than the volume of flame is capable of burning, and which consequently emits smoke, is seen at once by raising the wick; and on the other hand, the effect of a short wick, which affords a diminutive flame merely for want of a sufficient supply of combustible matter, is observable by the contrary process.

"The most obvious inconvenience of lamps in general, arises from the fluidity of the combustible material, which requires a vessel adapted to contain it, and even in the best constructed lamps is more or less liable to be spilled. When the wick of a lamp is once adjusted as to its length, the flame continues nearly in the same state for a very considerable time.

"It is almost unnecessary to describe a thing so universally known as a candle. The article is formed of a consistent oil, which envelopes a porous wick of fibrous vegetable matter. The cylindrical form and dimensions of the oil are given, either by casting it in a mould, or by repeatedly dipping the wick into the fused ingredient. Upon comparing a candle with a lamp, two very remarkable particulars are immediately seen. In the first place, the tallow itself, which remains in the unfused state, affords a cup or cavity to hold that portion of melted tallow which is ready to flow into the lighted part of the wick. In the second place, the combustion, instead of being confined, as in the lamp, to a certain determinate portion of the fibrous matter, is carried by a slow succession, through the whole length. Hence arises the greater necessity for frequent snuffing the candle; and hence also the station of the freezing point of the fat oil becomes of great consequence. For it has been shown that the brilliancy of the flame depends very much on the diameter of the wick being as small as possible; and this requisite will be most attainable in candles formed of a material that requires a higher degree of heat to fuse it. The wick of a tallow candle must be made thicker in proportion to the greater fusibility of the material, which would otherwise melt the sides of the cup, and run over in streams. The flame will therefore be yellow, smoky, and obscure, excepting for a short time immediately after snuffing. Tallow melts at the 92d degree of Fahrenheit's thermometer; spermaceti at the 133d degree; the fatty matter formed of flesh after long immersion in water melts at 127°; the *pela* of the Chinese, at 145°; bees wax at 142°; and bleached wax at 155°. Two of these materials are well known in the fabrication of candles. Wax in particular does not afford so brilliant a flame as tallow: but, on account of its fusibility, the wick can be made smaller; which not only affords the advantage of a clear perfect flame, but from its flexibility it is disposed to turn on one side, and come in contact with the external air which completely burns the extremity of the wick to white ashes, and thus performs the office of snuffing. We see, therefore, that the important object to society of rendering tallow candles equal to those of wax, does not at all depend on the combustibility of the respective materials, but upon a mechanical advantage in the cup, which is afforded by the inferior degree of fusibility in the wax; and that to obtain this valuable object, one of the following effects must be produced: Either the tallow must be burned in a lamp, to avoid the gradual progression of the flame along the wick; or some means must be devised to enable the candle to snuff itself, as the wax candle does; or, lastly, the tallow itself must be rendered less fusible by some chemical process. I have no great reason to boast of success in the endeavour to effect these; but my hope is, that the facts and observations here presented may considerably abridge the labour of others in the same pursuit.

"The makers of thermometers and other small articles with the blow-pipe and lamp, give the preference to tallow instead of oil, because its combustion is more complete,

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Candle. complete, and does not blacken the glass. In this operation, the heat of the lamp melts the tallow which is occasionally brought into its vicinity by the workman. But for the usual purposes of illumination, it cannot be supposed that a person can attend to supply the combustible matter. Considerable difficulties arise in the project for affording this gradual supply as it may be wanted. A cylindrical piece of tallow was inserted into a metallic tube, the upper aperture of which was partly closed by a ring, and the central part occupied by a metallic piece nearly resembling that part of the common lamp which carries the wick. In this apparatus the piece last described was intended to answer the same purpose, and was provided with a short wick. The cylinder of tallow was supported beneath in such a manner that the metallic tube and other part of this lamp were left to rest with their whole weight upon the tallow at the ring or contraction of the upper aperture. In this situation the lamp was lighted. It burned for some time with a very bright clear flame, which, when compared with that of a candle, possessed the advantages of uniform intensity, and was much superior to the ordinary flame of a lamp in its colour, and the perfect absence of smell. After some minutes it began to decay, and very soon afterwards went out. Upon examination it was found, that the metallic piece which carried the wick had fused a sufficient quantity of tallow for the supply during the combustion; that part of this tallow had flowed beneath the ring, and to other remote parts of the apparatus, beyond the influence of the flame; in consequence of which, the tube, and the cylinder of tallow, were fastened together, and the expected progression of supply prevented. It seems probable, that in every lamp for burning consistent oils, the material ought to be so disposed that it may descend to the flame upon the principle of the fountain reservoir. I shall not here state the obstacles which present themselves in the prospect of this construction, but shall dismiss the subject by remarking, that a contrivance of this nature would be of the greatest public utility.

"The wick of a candle, being surrounded by the flame, is nearly in the situation of a body exposed to destructive distillation in a close vessel. After losing its volatile products, the carbonaceous residue retains its figure, until, by the descent of the flame, the external air can have access to its upper extremity. But, in this case, the requisite combustion, which might snuff it, is not effected. For the portion of oil emitted by the long wick is not only too large to be perfectly burned, but also carries off much of the heat of the flame while it assumes the elastic state. By this diminished combustion and increased efflux of half-decomposed oil, a portion of coal or soot is deposited on the upper part of the wick, which gradually accumulates, and at length assumes the appearance of a fungus. The candle does not then give more than one-tenth of the light emitted in its best state. Hence it is that a candle of tallow cannot spontaneously snuff itself. It was not probable that the addition of a substance containing vital air or oxygene would supply that principle at the precise period of time required; but, as experiment is the test of every probability of this nature, I soaked a wick of cotton in a solution of nitre, then dried it, and made a candle. When this came to be lighted, nothing remarkable happened for a short time; at the expiration of which a decrepitation followed at the lower extremity of the flame, which completely divided the wick where the blackened part commences. The whole of the matter in combustion therefore fell off, and the candle was of course instantly extinguished. Whether this would have happened in all proportions of the salt or constructions of the candle, I did not try, because the smell of azote was sufficiently strong and unpleasant to forbid the use of nitre in the pursuit. From various considerations I am disposed to think that the spontaneous snuffing of candles made of tallow, or other fusible materials, will scarcely be effected but by the discovery of some material for the wick which shall be voluminous enough to absorb the tallow, and at the same time sufficiently flexible to bend on one side.

"The most promising speculation respecting this most useful article, seems to direct itself to the cup which contains the melted tallow. The imperfection of this part has already been noticed, namely, that it breaks down by fusion, and suffers its fluid contents to escape. The Chinese have a kind of candle about half an inch in diameter, which, in the harbour of Canton, is called *lobchock*; but whether the name be Chinese, or the corruption of some European word, I am ignorant. The wick is of cotton, wrapt round a small stick or match of the bamboo cane. The body of the candle is white tallow; but the external part, to the thickness of perhaps one-thirtieth of an inch, consists of a waxy matter coloured red. This covering gives a considerable degree of solidity to the candle, and prevents its guttering, because less fusible than the tallow itself. I did not observe that the stick in the middle was either advantageous or the contrary; and, as I now write from the recollection of this object at so remote a period as 25 years ago, I can only conjecture that it might be of advantage in throwing up a less quantity of oil into the flame than would have been conveyed by a wick of cotton sufficiently stout to have occupied its place unsupported in the axis of the candle.

"Many years ago I made a candle in imitation of the lobchock. The expedient to which I had recourse consisted in adapting the wick in the usual pewter mould: wax was then poured in, and immediately afterwards poured out: the film of wax which adhered to the inner surface of the mould soon became cool; and the candle was completed by filling the mould with tallow. When it was drawn out, it was found to be cracked longitudinally on its surface, which I attributed to the contraction of the wax, by cooling, being greater than that of the tallow. At present I think it equally probable that the cracking might have been occasioned by too sudden cooling of the wax before the tallow was poured in; but other avocations prevented the experiments from being varied and repeated. It is probable that the Chinese external coating may not be formed of pure hard bleached wax.

"But the most decisive remedy for the imperfection of this cheapest, and in other respects best material for candles, would undoubtedly be to diminish its fusibility. Various substances may be combined with tallow, either in the direct or indirect method. In the latter way, by the decomposition of soap, a number of experiments were made by Berthollet, of which an account

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Candle. count is inserted in the memoirs of the academy at Paris for the year 1780, and copied into the 26th volume of the Journal de Physique. None of these point directly to the present object; besides which, it is probable that the soap made use of by that eminent chemist was formed not of tallow, but oil. I am not aware of any regular series of experiments concerning the mutual action of fat oils and other chemical agents, more especially such as may be directed to this important object of diminishing its solubility; for which reason I shall mention a few experiments made with this view.

"1. Tallow was melted in a small silver vessel. Solid tallow sinks in the fluid, and dissolves without any remarkable appearance. 2. Gum sandarach in tears was not dissolved, but emitted bubbles, swelled up, became brown, emitted fumes, and became crisp or friable. No solution nor improvement of the tallow. 3. Shell-lac swelled up with bubbles, and was more perfectly fused than the gum sandarach in the former experiment. When the tallow was poured off, it was thought to congeal rather more speedily. The lac did not appear to be altered. 4. Benzoin bubbled without much swelling, was fused, and emitted fumes of an agreeable smell, though not resembling the flowers of benzoin. A slight or partial solution seemed to take place. The benzoin was softer and of a darker colour than before, and the tallow less consistent. 5. Common resin unites very readily with melted tallow, and forms a more fusible compound than the tallow itself. 6. Camphor melts easily in tallow, without altering its appearance. When the tallow is near boiling, camphoric fumes fly off. The compound appeared more fusible than tallow. 7. The acid or flowers of benzoin dissolves in great quantities without any ebullition or commotion. Much smoke arises from the compound, which does not smell like the acid of benzoin. Tallow alone does not fume at a low heat, though it emits a smell something like that of oil-olive. When the proportion of the acid was considerable, small needled crystals appeared as the temperature diminished. The appearances of separation are different according to the quantity of acid. The compound has the hardness and consistence of firm soap, and is partially transparent. 8. Vitriolated tartar, nitre, white sugar, cream of tartar, crystallized borax, and the salt sold in the markets under the name of salt of lemons, but which is supposed to be the essential salt of sorrel, or vegetable alkali supersaturated with acid of sugar, were respectively tried without any obvious mutual action or change of properties in the tallow. 9. Calcined magnesia rendered tallow opake and turbid, but did not seem to dissolve. Its effect resembled that of lime.

"It is proposed to try the oxigenated acetous acid, or radical vinegar; the acid of ants, of sugar, of borax, of galls, the tanning principle, the serous and gelatinous animal matter, the fecula of vegetables, vegetable gluten, bird lime, and other principles, either by direct or indirect application. The object, in a commercial point of view, is entitled to an extensive and assiduous investigation. Chemists in general suppose the hardness or less fusibility of wax to arise from oxygen, and to this object it may perhaps be advantageous to direct a certain portion of the inquiry. The metallic salts and calces are the combinations from which this principle is most commonly obtained; but the combinations of these with fat oils have hitherto afforded little promise of the improvement here sought. The subject is however so little known, that experiments of the loosest and most conjectural kind are by no means to be despised." Candle.

Lighting a CANDLE *by a small spark of electricity.* This method, which is an invention of Dr Ingenhousz, is recorded in the Phil. Trans. vol. lxviii. It is done by a small phial, having eight or ten inches of metallic coating, or even less, charged with electricity, which may be done at any time of the night by a person who has an electric machine in his room. "When I have occasion to light a candle," says he, "I charge a small coated phial, whose knob is bent outwards, so as to hang a little over the body of the phial; then I wrap some loose cotton over the extremity of a long brass pin or a wire, so as to stick moderately fast to its substance. I next roll this extremity of the pin wrapped up with cotton in some fine powder of resin, (which I always keep in readiness upon the table for this purpose, either in a wide-mouthed phial or in a loose paper); this being done, I apply the extremity of the pin or wire to the external coating of the charged phial, and bring as quickly as possible the other extremity wrapped round with cotton to the knob; the powder of resin takes fire, and communicates its flame to the cotton, and both together burn long enough to light a candle. As I do not want more than half a minute to light my candle in this way, I find it a readier method than kindling it by a flint and steel, or calling a servant. I have found that powder of white or yellow resin lights easier than that of brown. The *farina lycopodii* may be used for the same purpose; but it is not so good as the powder of resin, because it does not take fire quite so readily, requiring a stronger spark not to miss: besides, it is soon burnt away. By dipping the cotton in oil of turpentine, the same effect may be as readily obtained, if you take a jar somewhat greater in size. This oil will inflame so much the readier if you strew a few fine particles of brass upon it. The pin dust is the best for this purpose: but as this oil is scattered about by the explosion, and when kindled fills the room with much more smoke than the powder of resin, I prefer the last."

CANDLE-*Bombs*, a name given to small glass bubbles, having a neck about an inch long, with a very slender bore, by means of which a small quantity of water is introduced into them, and the orifice afterwards closed up. This stalk being put through the wick of a burning candle, the vicinity of the flame soon rarefies the water into steam, by the elasticity of which the glass is broken with a loud crack.

CANDLE is also a term of medicine, and is reckoned among the instruments of surgery. Thus the *candela fumalis*, or the *candela pro suffitu odorata*, is a mass of an oblong form, consisting of odoriferous powders mixed up with a third or more of the charcoal of willow or lime tree, and reduced to a proper consistence with a mucilage of gum tragacanth, labdanum, or turpentine. It is intended to excite a grateful smell without any flame, to correct the air, to fortify the brain, and to excite the spirits.

Medicated CANDLE, the same with BOUGIE.

CANDLE. Sale or auction by inch of candle, is when a

Candle | Candlestick.

a small piece of candle, being lighted, the bystanders are allowed to bid for the merchandise that is selling; but the moment the candle is out, the commodity is adjudged to the last bidder.

There is also an excommunication by inch of candle; when the sinner is allowed to come to repentance while a candle continues burning; but after it is consumed, he remains excommunicated to all intents and purposes.

Rush CANDLES, used in different parts of England, are made of the pith of a sort of rushes, peeled or stripped of the skin, except on one side, and dipped in melted grease.

CANDLE-Wood, slips of pine about the thickness of a finger, used in New England and other colonies to burn instead of candles, giving a very good light. The French inhabitants of Tortuga use slips of yellow santal-wood for the same purpose, and under the same denomination, which yields a clear flame, though of a green colour.

CANDLEBERRY TREE. See MYRICA, BOTANY *Index*.

CANDLEMAS, a feast of the church held on the second day of February, in honour of the purification of the Virgin Mary. It is borrowed from the practice of the ancient Christians, who on that day used abundance of lights both in their churches and processions, in memory, as is supposed, of our Saviour's being on that day declared by Simon "to be a light to lighten the Gentiles." In imitation of this custom, the Roman Catholics on this day consecrate all the tapers and candles which they use in their churches during the whole year. At Rome, the pope performs that ceremony himself; and distributes wax-candles to the cardinals and others, who carry them in procession through the great hall of the pope's palace. This ceremony was prohibited in England by an order of council in 1548.

CANDLEMAS, (2d Feb.) is made one of the four terms of the year for paying or receiving rents or borrowed money, &c.—In the courts of law, Candlemas term begins 15th January, and ends 3d February.

CANDLESTICK, an instrument to hold a candle, made in different forms, and all sorts of matter.

The golden candlestick was one of the sacred utensils made by Moses to be placed in the Jewish tabernacle. It was made of hammered gold, a talent in weight. It consisted of seven branches supported by a base or foot. These branches were adorned at equal distances with six flowers like lilies, and with as many bowls and knobs placed alternately. Upon the stock and six branches of the candlestick were the golden lamps, which were immoveable, wherein were put oil and cotton.

These seven lamps were lighted every evening, and extinguished every morning. The lamps had their tongs or snuffers to draw the cotton in or out, and dishes underneath them to receive the sparks or droppings of the oil. This candlestick wss placed in the antichamber of the sanctuary on the south side, and served to illuminate the altar of perfume and the tabernacle of the shew-bread. When Solomon had built the temple of the Lord, he placed in it ten golden candlesticks of the same form as that described by Moses, five on the north and five on the south side of the holy: But after the Babylonish captivity, the golden candlestick was again placed in the temple, as it had been before in the tabernacle by Moses. This sacred utensil, upon the destruction of the temple by the Romans, was lodged in the temple of Peace built by Vespasian: and the representation of it is still to be seen on the triumphal arch at the foot of Mount Palatine, on which Vespasian's triumph is delineated.

Candlestick, Candy.

CANDY, a large kingdom of Asia, in the island of Ceylon. It contains about a quarter of the island; and as it is encompassed with high mountains, and covered with thick forests, through which the roads and paths are narrow and difficult, the king had them guarded to prevent his subjects from going into other countries. It is full of hills, from whence rivulets proceed which are full of fish; but as they run among the rocks, they are not fit for boats: however, the inhabitants are very dexterous in turning them to water their land, which is fruitful in rice, pulse, and hemp.

Since the island of Ceylon fell into the hands of the English, we have obtained fuller information respecting it. Mr Percival, who has published an account of this island, mentions the jealousy, both of the Dutch and of the natives, as difficulties which could not have been easily surmounted by travellers while it remained subject to Holland *. "The interior of the island (he says), owing to the jealousy of the Dutch, has been little explored by Europeans; and any traveller who might have obtained the permission of the Dutch to visit it, could not have executed his purpose from the jealousy of the natives. Since the Candians have been driven by their invaders into the mountains of the interior, it has been their policy carefully to prevent any European from seeing those objects which might tempt the avarice of his countrymen, or from observing the approaches by which an army could penetrate their mountains. If an European by any accident was carried into their territories, they took every precaution to prevent him from escaping; and the guards, stationed everywhere at the approaches, joined to the wide and pathless woods which divide the interior from the coast, rendered such an attempt almost completely desperate. When an ambassador was sent from any European government to the king of Candy, he was watched with all that strictness and jealousy which the suspicious temper of uncivilized nations dictates. In an embassy which I attended to the court of that monarch, I had an opportunity of observing how careful the natives were to prevent strangers from making any observations. Mr Boyd, who about twenty years ago went on a similar embassy, was watched with the same particular circumspection; and has therefore been able to add little to our stock of knowledge concerning the interior.

"The dominions of the native prince are completely cut off on all sides from those of the Europeans, by almost impenetrable woods and mountains. The passes which lead through these to the coasts are extremely steep and difficult, and scarcely known even by the natives themselves. As soon as we advance from ten to twenty miles from the coasts, a country presents itself greatly differing from the sea-coast, both in soil, climate, and appearance. After ascending the mountains and passing the woods, we find ourselves in the midst of a country not advanced many stages beyond the

* *Account of Ceylon*, p. 13.

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Candy. the first state of improvement, and which we are astonished to find in the neighbourhood of the highly cultivated fields which surround Columbo. As we advance towards the centre of the island, the country gradually rises, and the woods and mountains which separate the several parts of the country become more steep and impervious.

"It is in the midst of these fastnesses that the native prince still preserves those remains of territory and power which have been left him by successive invaders. His dominions are now much reduced in size: for besides the whole of the sea-coasts which were of any value, the Dutch, in their various attacks during the last century, have contrived to get into their power every tract from which they could derive either emolument or security. Those provinces which still remain to him, are Noureealva and Hotcourly towards the north and north-west; while Matuly, comprehending the districts of Bintana, Velas, and Panoa, with a few others, occupy those parts more to the eastward. To the south-east lies Ouvvah, a province of some note, and giving the king one of his titles. The western parts are chiefly included in the provinces of Cotemal and Hottemoorley. These different provinces are subdivided into corles or districts, and entirely belong to the native prince. It is needless to recount the names of those divisions which stretch towards the sea-coast, and are now chiefly in our possession.

"In the highest and most centrical part of the native king's dominions, lie the corles or counties of Ondanor and Tatanour, in which are situated the two principal cities. These countries take the pre-eminence of all the rest, and are both better cultivated, and more populous, than any of the other districts, and are distinguished by the general name of Condé Udda; *condé* or *candé* in the native language signifying a mountain, and *udda* the greatest or highest.

Ceylon fell into the hands of the British in 1796; and in 1802 a war originated with the Candians. The British took possession of the capital, and placed a new prince on the throne; but the military force being reduced by the climate, and the Candians being in arms, the place was given up by capitulation, in defiance of which, however, the British were massacred. Another British force again reduced the chief town in 1815, and in 1816 the kingdom was annexed to the British dominions. The Candians revolted in 1818, but were subdued after a considerable struggle.

Candy, a town of Asia, and capital of a kingdom of the same name, in the island of Ceylon. It has been often burnt by the Portuguese when they were masters of these coasts. It is situated in E. Long. 79. 12. N. Lat. 7. 35.

We have the following description of Candy by Mr Percival, whom we have already quoted, and who attended an embassy to the king.

"In the district of Tatanour lies Candy, the royal residence and the capital of the native prince's dominions. It is situated at the distance of 80 miles from Columbo, and twice as far from Trincomalee, in the midst of lofty and steep hills covered with thick jungle. The narrow and difficult passes by which it is approached are intersected with thick hedges of thorn; and hedges of the same sort are drawn round the hills in the vicinity of Candy like lines of circumvallation. Through them the only passage is by gates of the same thorny materials, so contrived as to be drawn up and let down by ropes. When the Candians are obliged to retreat within these barriers, they cut the ropes, and then it is impossible to force a passage except by burning down the gates, which, from their green state, and the constant annoyance of the enemy sheltered behind them, would prove an enterprise of time and difficulty. These hedge-rows form the chief fortifications of Candy. The Malivagonga also nearly surrounds the hill on which it stands: that river is here broad, rocky, and rapid; a very strict guard is kept on it, and every one who passes or repasses is closely watched and examined.

"The city itself is a poor miserable-looking place, surrounded by a mud wall of no strength whatever. It has been several times burnt by Europeans, and was once deserted by the king, who retired to a more inaccessible part of his dominions. It is upon occasion of the embassy of General Macdowall, that any information concerning the present state of Candy has been obtained; and even then it could be little more than guessed at, as the ambassador and his suite were admitted only by torch-light, and always retired before break of day. From what could then be observed, the city consists of a long straggling street built on the declivity of a hill; the houses mean and low, but with their foundations raised in such a manner above the level of the street, that they appear quite lofty to passengers. The reason of this extraordinary taste is to enable the king to hold his assemblies of the people, and to have his elephant and buffalo fights in the street, without interfering with the houses. When the king passes along the street, none of the inhabitants are allowed to appear before their houses, or the paths on a level with them, as that would be attended with the heinous indecorum of placing a subject higher than the prince descended of the sun.

"At the upper end of this street, stands the palace, a poor mansion for the abode of a king. It is surrounded with high stone walls, and consists of two squares, one within the other. In the inner of these are the royal apartments, and it is there that the court is held and audiences given. The exterior of the palace and the rest of the city could be but very partially observed by those who attended General Macdowal, owing to the pressure of the crowd, and the dazzling glare of the torches. By every account indeed which I have heard, Candy contains nothing worthy of notice, and from the want of either wealth or industry among the inhabitants, it is not indeed to be expected that any thing could be met with in this straggling village to attract the attention of the traveller."

Candying. Candy, or *Sugar-Candy*, a preparation of sugar made by melting and crystallizing it six or seven times over, to render it hard or transparent. It is of three kinds, white, yellow, and red. The white comes from the loaf-sugar, the yellow from the casonado, and the red from the muscovado.

CANDYING, the act of preserving simples in substance, by boiling them in sugar. The performance

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[illegible] of this originally belonged to the apothecaries, but is now become a part of the business of the confectioner.

CANE. See ARUNDO and CALAMUS, BOTANY *Index*.

CANE, denotes also a walking stick. It is customary to adorn it with a head of gold, silver, agate, &c. Some are without knots, and very smooth and even; others are full of knots about two inches distance from one another. These last have very little elasticity, and will not bend so well as the others.

Canes of Bengal are the most beautiful which the Europeans bring into Europe. Some of them are so fine, that people work them into bowls or vessels, which being varnished over in the inside, with black or yellow lacca, will hold liquors as well as glass or China ware does; and the Indians use them for that purpose.

CANE is also the name of a long measure, which differs according to the several countries where it is used. At Naples the cane is equal to 7 feet $3\frac{1}{2}$ inches English measure: The cane of Thoulouse and the Upper Languedoc, is equal to the varre of Arragon, and contains 5 feet $8\frac{5}{8}$ inches; at Montpellier, Provence, Dauphiny, and the Lower Languedoc, to 6 English feet $5\frac{1}{2}$ inches.

CANEA, a considerable town of the island of Candia, where a bashaw resides. It was built by the Venetians, and occupies part of the site of the ancient CYDONIA. It is but about two miles in compass; encircled on the land side with a single wall, extremely thick; and defended by a broad and deep ditch, cut through a bed of rock, which extends all around the wall. By cutting it still deeper, they might cause the sea to flow round its ramparts; on which they have raised high platforms, that their great guns might command a wider extent of the adjacent plain. The city has only one gate, the gate of Retimo, protected by a half-moon battery, which is the only exterior fort. The side which faces the sea is the best fortified. On the left of the harbour are four batteries, rising one above another, and planted with a number of large cannons of cast metal, marked with the arms of Venice. The first of these batteries stands close on the brink of the sea. The right side of the harbour is defended only by a strong wall, extending along a chain of pointed rocks which it is dangerous for ships to approach. At the extremity of this wall, there is an old castle, falling into ruins. Beneath that castle, the Venetians had immense arsenals, vaulted with stone. Each of these vaults was of sufficient length, breadth, and height, to serve as a work-shop for building a ship of the line. The ground is sloping, and the outermost part of these capacious arsenals is on a level with the sea; so that it was very easy to launch the ships built there into the water. The Turks are suffering that magnificent work to fall into ruins.

The city of Canea is laid out on a fine plan. The streets are large and straight; and the squares adorned with fountains. There are no remarkable buildings in it. Most of the houses are flat-roofed, and have only one story. Those contiguous to the harbour are adorned with galleries, from which you enjoy a delightful prospect. From the windows you discover the large bay formed between Cape Spada and Cape Meleo, and all the ships that are entering in or passing out. The harbour, at present, receives ships of 200 tons burden: and it might be enlarged so as to admit the largest frigates. Its mouth is exposed to the violence of the north winds, which sometimes swell the billows above the ramparts. But, as it is narrow, and the bottom is good, ships that are well moored run no danger. At the time when Tournefort visited Crete, Canea did not contain more than five or six thousand inhabitants. But, at present, when the gates of Gira-Petra, Candi, and Retimo, are chocked up, the merchants have retired to Canea; and it is reckoned to contain 16,000 souls. The environs of the town are admirable; being adorned with forests of olive-trees mixed with fields, vineyards, gardens, and brooks bordered with myrtle-trees and laurel-roses. The chief revenue of this town consists in oil-olive. E. Long. 24. 15. N. Lat. 35. 28.

CANELLA. See BOTANY *Index*.

CANELLE, or CANE LAND, a large country in the island of Ceylon, called formerly the *kingdom of Cota*. It contains a great number of cantons, now occupied by the English. The chief riches of this country consist in cinnamon, of which there are large forests. There are five towns on the coast, some forts, and a great number of harbours. The rest of the country is inhabited by the natives; and there are several rich mines, from whence they get rubies, sapphires, topazes, cats eyes, and several other precious stones.

CANEPHORÆ, in Grecian antiquity, virgins who when they become marriageable, presented certain baskets full of little curiosities to Diana, in order to get leave to depart out of her train, and change their state of life.

CANEPHORIA, in Grecian antiquity, a ceremony which made part of a feast celebrated by the Athenian virgins on the eve of their marriage-day. At Athens the canephoria consisted in this, that the maid, conducted by her father and mother, went to the temple of Minerva, carrying with her a basket full of presents to engage the goddess to make the marriage state happy; or, as the scholiast of Theocritus has it, the basket was intended as a kind of honourable amends made to that goddess, the protectrix of virginity, for abandoning her party: or as a ceremony to appease her wrath. Suidas calls it a festival in honour of Diana.

CANEPHORIA is also the name of a festival in honour of Bacchus, celebrated particularly by the Athenians, on which the young maids carried golden baskets full of fruit, which baskets were covered, to conceal the mystery from the uninitiated.

CANES, in Egypt, and other eastern countries, a poor sort of buildings for the reception of strangers and travellers. People are accommodated in these with a room at a small price, but with no other necessaries; so that, excepting the room, there are no greater accommodations in these houses than in the deserts, only that there is a market near.

Canes Venatici, in *Astronomy*, the Greyhounds, two new constellations, first established by Hevelius, between the tail of the Great Bear and Bootes's arms, above the Coma Berenices. The first is called *asterion*, being that next the Bear's tail; the other *chara*. They comprehend

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comprehend 23 stars, of which Tycho only observed two. The longitudes and latitudes of each are given by Hevelius. In the British Catalogue they are 25.

CANETO, a strong town in Italy in the duchy of Mantua, seated on the river Oglio, which was taken by the Imperialists in 1701, by the French in 1702, afterwards by the Imperialists, and then by the French in 1705. E. Long. 10. 45. N. Lat. 45. 20.

CANGA, in the Chinese affairs, a wooden clog borne on the neck, by way of punishment for divers offences. The canga is composed of two pieces of wood notched, to receive the criminal's neck; the load lies on his shoulders, and is more or less heavy according to the quality of his offence. Some cangas weigh 200lb.; the generality from 50 to 60. The mandarins condemn to the punishment of the canga. Sentence of death is sometimes changed for this kind of punishment.

CANGE, Charles du Fresne, Sieur du, one of the most learned writers of his time, was born at Amiens in 1601, and studied at the Jesuits college in that city. Afterwards he applied himself to the study of the law at Orleans, and gained great reputation by his works; among which are, 1. The history of the empire of Constantinople under the French emperors. 2. John Cinnamus's six books of the history of the affairs of John and Manuel Comnenus, in Greek and Latin, with historical and philological notes. 3. *Glossarium ad Scriptores mediæ et infimæ Latinitatis.*

CANGI, Ceangi, or *Cangani*, anciently a people of Britain, concerning whose situations antiquaries have been much perplexed. They are all the same people. Camden discovered some traces of them in many different and distant places, as in Somersetshire, Wales, Derbyshire, and Cheshire; and he might have found as plain vestiges of them in Devonshire, Dorsetshire, Essex, Wiltshire, &c. Mr Horsley and others are no less perplexed and undetermined in their opinions on this subject. But Mr Baxter seems to have discovered the true cause of all this perplexity, by observing that the Cangi or Ceangi were not a distinct nation seated in one particular place, but such of the youth of many different nations as were employed in pasturage, in feeding the flocks and herds of their respective tribes. Almost all the ancient nations of Britain had their ceangi, their pastoritia pubes, the keepers of their flocks and herds, who ranged about the country in great numbers, as they were invited by the season and plenty of pasture for their cattle. This is the reason that vestiges of their name are to be found in so many different parts of Britain; but chiefly in those parts which are most fit for pasturage. These ceangi of the different British nations, naturally brave, and rendered still more hardy by their way of life, were constantly armed for the protection of their flocks from wild beasts; and these arms they occasionally employed in the defence of their country and their liberty.

CANGIAGIO, or Cambiasi Ludovico, one of the most eminent of the Genoese painters, was born in 1527. His works at Genoa are very numerous; and he was employed by the king of Spain to adorn part of the Escurial. It is remarked of him, that he was not only a most expeditious and rapid painter, but also that he worked equally well with both hands; and by that unusual power he executed more designs, and finished more grand works with his own pencils, in a much shorter time, than most other artists could do with several assistants. He died in 1585.

In the royal collection at Paris there is a Sleeping Cupid, as large as life, and likewise Judith with her attendant, which are painted by Cangiagio, and are an honour to that master. And in the Pembroke collection at Wilton is a picture, reputed the work of Cangiagio, representing Christ bearing his cross.

CANICULA, is a name proper to one of the stars of the constellation *canis major*, called also simply the *dog star*; by the Greeks Σειριος, *Sirius.* Canicula is the *tenth* in order in the Britannic catalogue; in Tycho's and Ptolemy's it is the second. It is situated in the mouth of the constellation; and is of the first magnitude, being the largest and brightest of all the stars in the heavens. From the rising of this star not cosmically, or with the sun, but heliacally, that is, its emersion from the sun's rays, which now happens about the 15th day of August, the ancients reckoned their *dies caniculares*, or dog days. The Egyptians and Ethiopians began their year at the rising of the Canicula, reckoning to its rise again the next year, which is called *annus canarius*, or canicular year. This year consisted ordinarily of 365 days, and every fourth year of 366, by which it was accommodated to the civil year. The reason of their choice of the Canicula before the other stars, to compute their time by, was not only the superior brightness of that star, but because its heliacal rising was in Egypt a time of singular note, as falling on the greatest augmentation of the Nile, the reputed father of Egypt. Ephestion adds, that, from the aspect and colour of Canicula, the Egyptians drew prognostics concerning the rise of the Nile; and, according to Florus, predicted the future state of the year; so that the first rising of this star was annually observed with great attention.

CANICULUM, or Caniculus, in the Byzantine antiquities, a golden standish or ink vessel, decorated with precious stones, wherein was kept the sacred *encaustum*, or red ink, wherewith the emperors signed their decrees, letters, &c. The word is by some derived from *canis*, or *caniculus*; alluding to the figure of a dog, which it represented, or rather because it was supported by the figures of dogs. The caniculum was under the care of a particular officer of state.

CANINA, the north part of the ancient Epirus, a province of Greece, which now belongs to the Turks, and lies off the entrance of the gulf of Venice. The principal town is of the same name, and is seated on the sea coast, at the foot of the mountains of Chimera. E. Long. 19. 25. N. Lat. 40. 55.

CANINANA, in *Zoology*, the name of a species of serpent found in America, and esteemed one of the less poisonous kinds. It grows to about two feet long; and is green on the back, and yellow on the belly. It feeds on eggs and small birds; the natives cut off the head and tail, and eat the body as a delicate dish.

CANINE, whatever partakes of, or has any relation to, the nature of a dog.

Canine Appetite, amounts to much the same with Bulimy.

Canine Madness. See Medicine *Index.*

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Canine Teeth || Cannabis.

CANINE *Teeth*, are two sharp-edged teeth in each jaw; one on each side, placed between the incisores and molares.

CANINI, JOHN ANGELO and MARC ANTHONY, brothers and Romans, celebrated for their love of antiquities. John excelled in designs for engraving on stones, particularly heads: Marc engraved them. They were encouraged by Colbert to publish a succession of heads of the heroes and great men of antiquity, designed from medals, antique stones, and other ancient remains; but John died at Rome soon after the work was begun: Marc Anthony, however, procured assistance, finished and published it in Italian in 1669. The cuts of this edition were engraved by Canini, Picard, and Valet; and a curious explanation is given, which discovers the skill of the Caninis in history and mythology. The French edition of Amsterdam, in 1731, is spurious.

CANIS, or DOG. See MAMMALIA *Index*.

CANIS *Major*, the Great Dog, in *Astronomy*, a constellation of the southern hemisphere, below Orion's feet, though somewhat to the westward of him; whose stars Ptolemy makes 29; Tycho observed only 13; Hevelius 21; in the Britannic catalogue they are 31.

CANIS *Minor*, the Little Dog, in *Astronomy*, a constellation of the northern hemisphere; called also by the Greeks *Procyon*, and by the Latins *Antecanis* and *Canicula*. The stars in the constellation Canis Minor, are in Ptolemy's catalogue, 2; in Tycho's 5; in Hevelius's, 13; and in the British catalogue, 14.

CANISIUS, HENRY, a native of Nimeguen, and one of the most learned men of his time, was professor of canon law at Ingoldstadt; and wrote a great number of books; the principal of which are, 1. *Summa Juris Canonici*. 2. *Antiquæ Lectiones*, a very valuable work. He died in 1609.

CANITZ, the Baron of, a German poet and statesman, was of an ancient and illustrious family in Brandenburg, and born at Berlin in 1654, five months after his father's death. After his early studies, he travelled to France, Italy, Holland, and England; and upon his return to his country, was charged with important negotiations by Frederic II. Frederic III. employed him also. Canitz united the statesman with the poet; and was conversant in many languages, dead as well as living. His German poems were published for the tenth time, 1750, in 8vo. He is said to have taken Horace for his model, and to have written purely and delicately. But he did not content himself with barely cultivating the fine arts in himself; he gave all the encouragement he could to them in others. He died at Berlin, in 1699, privy counsellor of state, aged 45.

CANKER, a disease incident to trees, proceeding chiefly from the nature of the soil. It makes the bark rot and fall. If the canker be in a bough, cut it off; if a large bough, at some distance from the stem; in a small one, close to it: but for over hot strong ground, the ground is to be cooled about the roots with pond mud and cow dung.

CANKER, among farriers. See FARRIERY *Index*.

CANNA, INDIAN REED. See BOTANY *Index*.

CANNABIS, HEMP. See BOTANY *Index*.

From the leaves of hemp pounded and boiled in water, the natives of the East Indies prepare an intoxicating liquor of which they are very fond. The plant, when fresh, has a rank narcotic smell; the water in which the stalks are soaked, in order to separate the tough rind for mechanic uses, is said to be violently poisonous, and to produce its effects almost as soon as drank. The seeds also have some smell of the herb, and their taste is unctuous and sweetish: they are recommended, boiled in milk, or triturated with water into an emulsion, against coughs, heat of urine, and the like. They are also said to be useful in incontinence of urine, and for restraining venereal appetites; but experience does not warrant their having any virtues of that kind.

CANNÆ, in *Ancient Geography*, a town of Apulia on the Adriatic, at the mouth of the river Aufidus, rendered famous by a terrible overthrow which the Romans here received from the Carthaginians under Hannibal. The Roman consuls, Æmilius Paulus and Terentius Varro, being authorised by the senate to quit the defensive plan, and stake the fortunes of the republic on the chance of a battle, marched from Canusium, and encamped a few miles east, in two unequal divisions, with the Aufidus between them. In this position they meant to wait for an opportunity of engaging to advantage; but Hannibal, whose critical situation in a desolated country, without refuge or allies, could admit of no delay, found means to inflame the vanity of Varro by some trivial advantages in skirmishes between the light horse. The Romans, elated with this success, determined to bring matters to a speedy conclusion; but, finding the ground on the south side too confined for the operations of so large an army, crossed the river; and Varro resting his right wing upon the Aufidus, drew out his forces in the plain. Hannibal, whose head-quarters were at Cannæ, no sooner perceived the enemy in motion, than he forded the water below, and marshalled his troops in a line opposite to that of his adversaries.

The Romans were vastly superior in number to the Carthaginians; but the latter were superior in cavalry. The army of the former, consisting of 87,000 men, was drawn up in the usual manner; the *hastati* in the first line, the *principes* in the second, and the *triarii* in the third. The cavalry were posted on the wings.—On the right, the Roman knights flanked the legionaries; on the left, the cavalry of the allies covered their own infantry. The two consuls commanded the two wings, Æmilius the right, and Terentius the left; and the two proconsuls, Servilius and Attilius, the main body. On the other hand, Hannibal, whose army consisted of 40,000 foot and 10,000 horse, placed his Gaulish and Spanish cavalry in his left wing, to face the Roman knights; and the Numidian horse in his right, over against the cavalry of the allies of Rome. As to his infantry, he divided the African battalions into two bodies; one of which he posted near the Gaulish and Spanish horse, the other near the Numidian. Between these two bodies were placed on one side the Gaulish, on the other the Spanish infantry, drawn up in such a manner as to form an obtuse angle, projecting a considerable way beyond the two wings. Behind this line he drew up a second which had no projection. Asdrubal commanded the left wing; Maherbal the right; and Hannibal himself, with his brother Mago,

Cannæ.

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Cannæ. Mago, the main body. He had also taken care to post himself in such a manner, that the wind *Vulturnus*, which rises at certain stated times, should blow directly in the faces of the Romans during the fight, and cover them with dust. The onset was begun by the light-armed infantry; the Romans discharging their javelins, and the *balcares* their stones, with pretty equal success; nevertheless, the consul Æmilius was wounded. —Then the Roman cavalry in the right wing advanced against the Gaulish and Spanish in Hannibal's left. As they were shut in by the river Aufidus on one side, and by their infantry on the other, they did not fight, as usual, by charging and wheeling off, and then returning to the charge; but continued fighting each man against his adversary, till one of them was killed or retired. After they had made prodigious efforts on both sides to overbear each other, they all on a sudden dismounted, and fought on foot with great fury. In this attack the Gauls and Spaniards soon prevailed, put the Romans to the route, and, pursuing them along the river, strewed the ground with their dead bodies, Asdrubal giving no quarter. This action was scarce over, when the infantry on both sides advanced. The Romans first fell upon the Spaniards and Gauls, who, as already observed, formed a kind of triangle projecting beyond the two wings. These gave ground, and, pursuant to Hannibal's directions, sunk into the void space in their rear, by which means they insensibly brought the Romans into the centre of the African infantry; and then the fugitives rallying, attacked them in front, while the Africans charged them in both flanks. The Romans being, by this artful retreat, drawn into the snare and surrounded, no longer kept their ranks, but formed several platoons in order to face every way. Æmilius, who was on the right wing, seeing the danger of the main body, at the head of his legionaries acted the part both of a soldier and general, penetrating into the heart of the enemy's battalions, and cutting great numbers of them in pieces. All the Roman cavalry that were left attended the brave consul on foot; and, encouraged by his example, fought like men in despair. But, in the mean time, Asdrubal, at the head of a detachment of Gaulish and Spanish infantry brought from the centre, attacked Æmilius's legionaries with such fury, that they were forced to give ground and fly; the consul, being all covered with wounds, was at last killed by some of the enemy who did not know him. In the main body, the Romans, though invested on all sides, continued to sell their lives dear; fighting in platoons, and making a great slaughter of the enemy. But being at length overpowered, and disheartened by the death of the two proconsuls, Servilius and Attilius, who headed them, they dispersed and fled, some to the right, and others to the left, as they could find opportunity; but the Numidian horse cut most of them in pieces; the whole plain was covered with heaps of dead bodies, insomuch that Hannibal himself, thinking the butchery too terrible, ordered his men to put a stop to it.—There is a great disagreement among authors as to the number of Romans killed and taken at the battle of Cannæ. According to Livy, the republic lost 50,000 men, including the auxiliaries. According to Polybius, of 6000 Roman horse, only 70 escaped to Venusia with Terentius Varro, and 300 of the auxiliary horse. As to the infantry, that writer tells us, that 70,000 of the Roman foot died in the field of battle fighting like brave men; and that 13,000 were made prisoners. According to Dionysius of Halicarnassus, of 6000 horse, only 370 escaped the general slaughter, and of 80,000 foot, 3000 only were left. The most moderate computation makes the number of Romans killed to amount to 45,000. The scene of action is marked out to posterity, by the name of *Pezzo di Sangue*, "Field of Blood."

These plains have more than once, since the Punic war, afforded room for men to accomplish their mutual destruction. Melo of Bari, after raising the standard of revolt against the Greek emperors, and defeating their generals in several engagements, was at last routed here in 1019, by the Catapan Bolanus. Out of 250 Norman adventurers, the flower of Melo's army, only ten escaped the slaughter of that day. In 1201, the archbishop of Palermo and his rebellious associates, who had taken advantage of the nonage of Frederick of Swabia, were cut to pieces at Cannæ by Walter de Brienne, sent by the Pope to defend the young king's dominions.

The traces of the town of Cannæ are very faint, consisting of fragments of altars, cornices, gates, walls, vaults, and under-ground granaries. It was destroyed the year before the battle: but, being rebuilt, became an episcopal see in the infancy of Christianity. It was again ruined in the sixth century, but seems to have subsisted in a humble state many ages later; for we read of its contending with Barletta for the territory which till then had been enjoyed in common by them; and in 1284, Charles I. issued an edict for dividing the lands, to prevent all future litigation. The prosperity of the towns along the coast, which increased in wealth and population by embarkations of the crusades and by traffic, proved the annihilation of the great inland cities; and Cannæ was probably abandoned entirely before the end of the thirteenth century.

Cannæ ‖ Cannon. CANNEQUINS, in commerce, white cotton cloths brought from the East Indies. They are a proper commodity for trading on the coast of Guinea, particularly about the rivers Senegal and Gambia. These linens are folded square-wise, and are about eight ells long.

CANNEL COAL. See MINERALOGY *Index*.

CANNES, a sea-port of France, in Provence, seated on the coast of the Mediterranean sea, with a castle. Bonaparte landed here on his return from Elba, 1. March 1815. E. Long. 7. 7. N. Lat. 43. 34.

CANNIBAL, a modern term for an anthropophagus or man-eater, more especially in the West Indies. See ANTHROPOPHAGI.

CANNON, a military engine for throwing balls, &c. by the help of GUNPOWDER.

The invention of brass cannon is by Laney ascribed to J. Owen: he says, that they were first known in England in the year 1535; but yet acknowledges, that, in 1346, there were four pieces of cannon in the English army at the battle of Cressy, and that these were the first that were known in France. And Mezeray relates, that King Edward, by five or six pieces of cannon, struck terror into the French army, it being the first time they had seen any of these thunder-

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ing machines; though others affirm that cannon were known also in France at the same time; but that the French king, in his hurry to attack the English, and in confidence of victory, left all his cannon behind him as useless incumbrances (see ARTILLERY). The Germans carry the invention farther back, and attribute it to Albertus Magnus, a Dominican monk, about the year 1250. Vossius rejects all these opinions, and finds cannon in China almost 1700 years ago. According to him, they were invented by the emperor Kitey in the year of Christ 85. See GUN and GUNNERY.

For the casting of cannon, see FOUNDERY. For their different parts, proportions, management, operation, and effect, see GUNNERY. See also CANNON, SUPPLEMENT.

CANNON, with letter-founders and printers, the name of the largest size of letters they use.

CANNONADE, the application of artillery to the purposes of war, or the direction of its efforts against some distant object intended to be seized or destroyed, as a ship, battery, or fortress. See GUNNERY.

Since a large ship of war may be considered as a combination of floating batteries, it is evident that the efforts of her artillery must be greatly superior to those of a fortress on the sea coast; that is to say, in general; because, on some particular occasions, her situation may be extremely dangerous, and her cannonading ineffectual. Her superiority consists in several circumstances, as the power of bringing her different batteries to converge to one point; of shifting the line of her attack so as to do the greatest possible execution against the enemy, or to lie where she will be the least exposed to his shot; and chiefly because, by employing a much greater number of cannon against a fort than it can possibly return, the impression of her artillery against stone walls soon becomes decisive and irresistible. Besides these advantages in the attack, she is also greatly superior in point of defence; because the cannon shot, passing with rapidity through her sides, seldom do any execution out of the line of their flight, or occasion much mischief by their splinters; whereas they very soon shatter and destroy the faces of a parapet, and produce incredible havock among the men by the fragments of the stones, &c. A ship may also retreat when she finds it too dangerous to remain longer exposed to the enemy's fire, or when her own fire cannot produce the desired effect. Finally, The fluctuating situation of a ship, and of the element on which she rests, renders the effects of bombs very uncertain, and altogether destroys the effect of the *ricochet*, or rolling and bounding shot, which is so pernicious and destructive in a fortress or land engagement. The chief inconveniency to which a ship is exposed, on the contrary, is, that the low-laid cannon in a fort near the brink of the sea, may strike her repeatedly on or under the surface of the water, so as to sink her before her cannonade can have any considerable efficacy.

CANO, a kingdom of Africa, in Negroland, with a town of the same name. It is bounded by Zaara on the north, by the river Niger on the south, the kingdom of Agades on the west, and that of Cashna on the east. Some of the inhabitants are herdsmen, and others till the ground and dwell in villages. It produces corn, rice, and cotton. Here are also many deserts, and mountains covered with woods, in which are wild citrons and lemon trees. The walls and houses of the town are made of clay, and the principal inhabitants are merchants. E. Long. 16. 18. N. Lat. 21. 5.

CANOBIA, a town of Italy, in the duchy of Milan, seated on the western bank of Lago Maggiore, or the Greater Lake. E. Long. 8. 47. N. Lat. 45. 55.

CANOE, a sort of Indian boat or vessel, formed of the trunk of a tree hollowed, and sometimes of several pieces of the bark put together.

Canoes are of various sizes, according to the uses for which they may be designed, or the countries wherein they are formed. The largest are made of the cotton tree; some of them will carry between 20 and 30 hogsheads of sugar or melasses. Some are made to carry sail; and for this purpose are steeped in water till they become pliant; after which their sides are extended, and strong beams placed between them, on which a deck is afterwards laid that serves to support their sides. The other sorts very rarely carry sail, unless when going before the wind; their sails are made of a sort of short silk grass or rushes. They are commonly rowed with paddles, which are pieces of light wood somewhat resembling a corn shovel; and, instead of rowing with it horizontally like an oar, they manage it perpendicularly. The small canoes are very narrow, having only room for one person in breadth, and seven or eight lengthwise. The rowers, who are generally American savages, are very expert in managing their paddles uniformly, and in balancing the canoes with their bodies; which would be difficult for a stranger to do, how well accustomed soever to the conducting of European boats, because the canoes are extremely light, and liable to be overturned. The American Indians, when they are under the necessity of landing to avoid a water-fall, or of crossing the land from one river to another, carry their canoes on their heads, till they arrive at a place where they can launch them again. This is the general construction of canoes, and method of managing them; but some nations have vessels going under the name of canoes, which differ considerably from the above; as the inhabitants of Greenland, Hudson's Bay, Otaheite, &c.

CANON, a person who possesses a prebend, or revenue allotted for the performance of divine service, in a cathedral or collegiate church.

Canons are of no great antiquity. Paschier observes, that the name canon was not known before Charlemagne; at least the first we hear of are in Gregory de Tours, who mentions a college of canons instituted by Baldwin XVI. archbishop of that city, in the time of Clotharius I. The common opinion attributes the institution of this order to Chrodegangus, bishop of Metz, about the middle of the eighth century.

Originally canons were only priests, or inferior ecclesiastics, who lived in community; residing by the cathedral church, to assist the bishop; depending entirely on his will; supported by the revenues of the bishopric; and living in the same house, as his domestics, or counsellors, &c. They even inherited his moveables, till the year 817, when this was prohibited by the council of Aix-la-Chapelle, and a new rule substituted

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Canons. stituted in the place of that which had been appointed by Chrodegangus, and which was observed for the most part in the west till the 12th century. By degrees, these communities of priests, shaking off their dependence, formed separate bodies; whereof the bishops, however, were still heads. In the tenth century, there were communities or congregations of the same kind, established even in cities where there were no bishops: these were called collegiates, as they used the terms congregation and college indifferently: the name chapter, now given to these bodies, being much more modern. Under the second race of the French kings, the canonical or collegiate life had spread itself all over the country; and each cathedral had its chapter, distinct from the rest of the clergy. They had the name canon from the Greek κανων, which signifies three different things; a rule, a pension or fixed revenue to live on, and a catalogue or matricula; all which are applicable to them.

In time, the canons freed themselves from their rules, the observance relaxed, and, at length, they ceased to live in community: yet they still formed bodies; pretending to other functions besides the celebration of the common office in the church; yet assuming the rights of the rest of the clergy: making themselves as a necessary council of the bishop; taking upon them the administration of a see during a vacancy, and the election of a bishop to supply it. There are even some chapters exempt from the jurisdiction of the bishop, and owning no head but their dean. After the example of cathedral chapters, collegiate ones also continued to form bodies, after they had abandoned living in community.

CANONS are of various kinds; as,

Cardinal CANONS, which are those attached, and, as the Latins call it, *incardinati*, to a church, as a priest is to a parish.

Domicellary CANONS, were young canons, who, not being in orders, had no right in any particular chapters.

Expectative CANONS, were such as, without having any revenue or prebend, had the title and dignities of canons, a voice in the chapter, and a place in the choir; till such time as a prebend should fall.

Foreign CANONS, were such as did not officiate in the canonries to which they belonged. To these were opposed mansionary canons, or canons residentiary.

Lay or *honorary* CANONS, are such among the laity as have been admitted, out of honour and respect, into some chapter of canons.

Regular CANONS, are canons that still live in community; and who, like religious, have, in process of time, to the practice of their rules, added the solemn profession of vows. They are called regulars, to distinguish them from those secular canons who abandon living in community, and at the same time the observance of the canons made as the rule of the clergy, for the maintenance of the ancient discipline. The canons subsisted in their simplicity till the eleventh, some say the twelfth century, when some of them, separating from the community, took with them the name of canons, or acephalous priests, because they declined to live in community with the bishop; and those who were left thenceforth acquired the denomination of canons regular, and adopted most of the professions of the rule of St Augustine. This order of regular canons of St Augustine was brought into England by Adelwald, confessor to Henry I. who erected a priory at Nostel in Yorkshire; and obtained for them the church of Carlisle as an episcopal see, with the privilege of choosing their own bishop. They were singularly protected and encouraged by Henry I. who gave them the priory of Dunstable in 1107, and by Queen Maud, who, in the following year, gave them the priory of the Holy Trinity in London. It appears, that under the reign of Edward I. they had fifty-three priories.

Tertiary CANONS, those who had only the third part of the revenues of the canonicate.

CANON, in an ecclesiastical sense, is a law or rule, either of doctrine or discipline, enacted especially by a council, and confirmed by the authority of the sovereign.

Canons are properly decisions of matters of religion; or regulations of the policy and discipline of a church, made by councils, either general, national, or provincial. Such are the canons of the council of Nice, or Trent, &c.

There have been various collections of the canons of the eastern councils; but four principal ones, each ampler than the preceding. The first, according to Usher, A. D. 380, containing only those of the first ecumenical council, and the first provincial ones: they were but 164 in number. To these, Dionysius Exiguus, in the year 520, added the 50 canons of the apostles, and those of the other general councils. The Greek canons in this second collection end with those of the council of Chalcedon; to which are subjoined those of the council of Sardica, and the African councils. The fourth and last collection comes down as low as the second council of Nice; and it is on this that Balsamon and Zonaras have commented.

Apostolical CANONS, are those which have been usually ascribed to St Clement, Bellarmin, Baronius, &c. will have them to be genuine canons of the apostles; Catelerius observes, that they cannot be ascribed to the apostles or Clement, because they are not received with other books of Scripture, are not quoted by the writers of the first ages, and contain many things not agreeable to the apostolical times: Hincmar, De Marca, Beveridge, &c. take them to be framed by the bishops who were the apostles disciples in the second or third century; S. Basnage is of opinion that they were collected by an anonymous writer in the fifth century; but Daille, &c. maintain them to have been forged by some heretic in the sixth century; and S. Basnage conjectures that some of them are ancient, and others not older than the seventh century. The Greek church allows only 85 of them, and the Latins only 50; though there are 84 in the edition given of them in the Corpus Juris Canonici.

CANON is also used for the authorized catalogue of the sacred writings. See BIBLE.

The ancient canon, or catalogue of the books of the Old Testament, was made by the Jews, and is ordinarily attributed to Ezra; who is said to have distributed them into the law, the prophets, and the hagiographa, to which our Saviour refers, Luke, chap. xxiv. ver. 44. The same division is also mentioned by Josephus, cont. Appion.

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This is the canon allowed to have been followed by the primitive church, till the council of Carthage; and, according to St Jerome, this consisted of no more than 22 books; answering to the number of the Hebrew alphabet; though at present they are classed into 24 divisions, containing Genesis, Exodus, Leviticus, Numbers, Deuteronomy, Joshua, Judges, Samuel, Kings, Isaiah, Jeremiah, Ezekiel, the twelve minor prophets, the Psalms, the Proverbs, Job, Canticles, Ruth, Lamentations, Ecclesiastes, Esther, Daniel, Ezra, comprehending the book of Nehemiah and the Chronicles. However, this order is not universally observed either among Jews or Christians; nor were all the books above enumerated admitted into the canon in Ezra's time. It is most likely, says Dr Prideaux, that the two books of Chronicles, Ezra, Nehemiah, Esther, and Malachi, were added in the time of Simon the Just, when the canon was completed. But that council enlarged the canon very considerably, taking into it the books which we call apocryphal; which the council of Trent has further enforced, enjoining all these to be received as books of Holy Scripture, upon pain of anathema, and being attainted of heresy. The Romanists, in defence of this canon, say, that it is the same with that of the council of Hippo, held in 393; and with that of the third council of Carthage, in 397, at which were present 46 bishops, and, among the rest, St Augustine: who declared that they received it from their fathers.

Their canon of the New Testament perfectly agrees with ours. It consists of books that are well known; some of which have been universally acknowledged; such are the four Gospels, and acts of the Apostles, thirteen Epistles of St Paul, one Epistle of St Peter, and one Epistle of St John; and others, concerning which doubts were entertained, but which were afterwards received as genuine; such are the epistle to the Hebrews, that of James, the second of Peter, the second and third of John, that of Jude, and the Revelation. These books were written at different times; and they are authenticated, not by the decress of councils, or infallible authority, but by such kind of evidence as is thought sufficient in the case of any other ancient writings. They were very extensively diffused; they were read in every Christian society; they were valued and preserved with care by the first Christians; they were cited by Christian writers of the second, third, and fourth century, as by Irenæus, Clement the Alexandrian, Tertullian, Origen, Eusebius, &c. and their genuineness is proved by the testimony of those who were contemporary with the apostles themselves, and by tradition. The four Gospels, and most of the other books of the New Testament, were collected either by one of the apostles, or some of their disciples and successors, before the end of the first century. The catalogue of canonical books furnished by the more ancient Christian writers, as Origen about the year 210, Eusebius and Athanasius in 315, Epiphanius in 370, Jerome in 382, Austin in 394, and many others, agrees with that which is now received among Christians. For the time of writing the several books of the New Testament, see the titles of the books themselves; as the Gospel of St MATTHEW, MARK, &c.

Some of the fathers distinguish the inspired writings into three classes; proto-canonical, deutero-canonical, and apocryphal.

Paschal CANON, a table of the moveable feasts, showing the day of Easter, and the other feasts depending on it, for a cycle of 19 years.

The paschal canon is supposed to be the calculation of Eusebius of Cæsarea, and to have been done by order of the council of Nice.

CANON, in monastic orders, a book wherein the religious of every convent have a fair transcript of the rules of their order, frequently read among them as their local statutes. This is also called *regula*, as containing the rule and institution of their order.

The canon differs from the missale, martyrologium, and necrologium.

CANON, again, is used for the catalogue of saints acknowledged and canonized in the Romizh church.

CANON is also used, by way of excellence, in the Romish church, for the secret words of the mass, from the preface to the *Pater*; in the middle of which the priest consecrates the host. The common opinion is, that the canon of the mass commences with *Te igitur*, &c. The people are to be on their knees, hearing the canon; and are to rehearse it to themselves, so as not to be heard.

CANON, in the ancient music, is a rule or method of determining the intervals of notes.

Ptolemy, rejecting the Aristoxenian way of measuring the intervals in music, by the magnitude of a tone (which was supposed to be formed by the difference between a diapente and a diatessaron), thought that musical intervals should be distinguished, according to the ratios or proportions which the sounds terminating those intervals bear to one another, when considered according to their degree of acuteness or gravity; which, before Aristoxenus, was the old Pythagorean way. He therefore made the diapason consist in a double ratio; the diapente, in a sesquialterate; the diatessaron, in a sesquitertian; and the tone itself, in a sesquioctave; and all the other intervals, according to the proportion of the sounds that terminate them: wherefore taking the canon (as it is called) for a determinate line of any length, he shows how this canon is to be cut accordingly, so that it may represent the respective intervals: and this method answers exactly to experiment, in the different lengths of musical chords. From this canon, Ptolemy and his followers have been called *Canonici;* as those of Aristoxenus were called *Musici.*

CANON, in modern music, is a kind of fugue, which they call a *perpetual fugue*, because the different parts beginning one after another, repeat incessantly the same air.

Formerly, says Zarlino, they placed, at the head of perpetual fugues, particular directions which showed how this kind of fugues was to be sung; and these directions, being properly the rules by which perpetual fugues were composed, were called *canoni*, *rules* or *canons*. From this custom, others taking the title for the thing signified, by a metonymy, termed this kind of composition *canon*. Such canons as are composed with the greatest facility, and of consequence most generally used, begin the fugue either with the octave or the unison; that is to say, that every part repeats in the same tone the melody of the preceding. In order to form

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form a canon of this kind, it is only necessary for the composer to make an air according to his taste: to add in score as many parts as he chooses, where the voices in octave or unison repeat the same melody; then forming a single air from all these parts successively executed, to try whether this succession may form an entire piece, which will give pleasure as well in the harmony as the melody.

In order to execute such a *canon*, he who sings the first part begins alone, and continues till the air is finished; then recommences immediately, without any suspense of sound or interruption of time; as soon as he has ended the first couplet, which ought to serve for the perpetual subject upon which the whole *canon* has been composed, the second part begins and repeats the same couplet, whilst the first who had begun pursues the second: others in succession begin and proceed the same way, as soon as he who precedes has reached the end of the first couplet. Thus, by incessantly recommencing, an universal close can never be found, and the *canon* may be repeated as long as the singers please.

A perpetual fugue may likewise consist of parts which begin with the intervals of a fourth or fifth; or, in other words, every part may repeat the melody of the first, a fourth or a fifth higher or lower. It is then necessary that the whole *canon* should be invented *di prima intenzione*, as the Italians say; and that sharps or flats should be added to the notes, whose natural gradations do not answer exactly, by a fourth or fifth, to the melody of the preceding part, and produce the same intervals with itself. Here the composer cannot pay the least regard to modulation; his only care is, that the melody may be the same, which renders the formation of a *canon* more difficult; for at every time when any part resumes the fugue, it takes a new key; it changes the tone almost at every note, and, what is still worse, no part is at the same time found in the same tone with another; hence it is that this kind of *canons*, in other respects far from being easy to be perused, never produce a pleasing effect, however good the harmony may be, and however properly it may be sung.

There is a third kind of *canon*, but very scarce, as well because it is extremely difficult, as because it is for the most part incapable of giving pleasure, and can boast no other merit but the pains which have been thrown away in its composition. This may be called a *double canon inverted*, as well by the inversions which are practised in it with respect to the melody of the parts, as by those which are found among the parts themselves in singing. There is such an artifice in this kind of *canon*, that, whether the parts be sung in their natural order, or whether the paper in which they are set be turned the contrary way, to sing them backward from the end to the beginning, in such a manner that the bass becomes the upper part, and the rest undergo a similar change, still you have pretty harmony and still a regular *canon*. The reader may consult Rousseau's Dictionary in this article, where he is referred to Plate D. fig. 11. for two examples of canons of this sort extracted from Bontempi, who likewise gives rules for their composition. But he adds, that the true principle from which the rule is deduced will be found at the word *systeme*, in his account of the system of Tartini, to which we must likewise once more refer the reader; as a quotation of such length must have protracted our article to an enormous extent.

To form a *canon*, in which the harmony may be a little varied, it is necessary that the parts should not follow each other in a succession too rapid, and that the one should only begin a considerable time after the other. When they follow one another so immediately as at a distance of a semibreve or a minim, the duration is not sufficient to admit a great number of chords, and the canon must of necessity exhibit a disagreeable monotony; but it is a method of composing, without much difficulty, a canon in as many parts as the composer chooses. For a *canon* of four bars only will consist of eight parts, if they follow each other at the distance of half a bar: and by each bar which is added, two parts will constantly be gained.

The emperor Charles VI. who was a great musician, and composed extremely well, took much pleasure in composing and singing *canons*. Italy is still replete with most beautiful *canons* composed for this prince, by the best masters in that country. To what has been said by Rousseau, we need only subjoin, that the English *catch* and the Italian *canon* are much the same; as any intelligent reader may perceive, from comparing the structure and execution of the English *catch* with the account of *canons* which has now been given.

Canon, in *Geometry* and *Algebra*, a general rule for the solution of all cases of a like nature with the present inquiry. Thus every last step of an equation is a canon; and, if turned into words, becomes a rule to solve all questions of the same nature with that proposed.

Canon Law, a collection of ecclesiastical laws, serving as the rule and measure of church-government.

The power of making laws was exercised by the church before the Roman empire became Christian. The canon law that obtained throughout the west, till the 12th century, was the collection of canons made by Dionysius Exiguus in 520, the capitularies of Charlemagne, and the decrees of the popes from Sircius to Anastasius.

The canon law, even when papal authority was at its height in England, was of no force when it was found to contradict the prerogative of the king, the laws, statutes and customs of the realm, or the doctrine of the established church.

The ecclesiastical jurisdiction of the see of Rome in England was founded on the canon law; and this created quarrels between kings and several archbishops and prelates who adhered to the papal usurpation.

Besides the foreign canons, there were several laws and constitutions made here for the government of the church: but all these received their force from the royal assent; and if, at any time, the ecclesiastical courts did, by their sentence, endeavour to enforce obedience to such canons, the courts at common law, upon complaints made, would grant prohibition. The authority vested in the church of England of making canons, was ascertained by a statute of Henry VIII. commonly called the *act of the clergy's submission*; by which they acknowledged, that the convocation had always been assembled by the king's writ; so that,

 though

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though the power of making canons resided in the clergy met in convocation, their force was derived from the authority of the king's assenting to and confirming them.

The old canons continued in full force till the reign of James I. when the clergy being assembled in convocation, the king gave them leave to treat and consult upon canons; which they did, and presented them to the king, who gave them the royal assent: these were a collection out of several preceding canons, and injunctions. Some of these canons are now obsolete. In the reign of Charles I. several canons were passed by the clergy in convocation.

CANONESS, in the Romish church, a woman who enjoys a prebend, affixed, by the foundation, to maids, without their being obliged to renounce the world, or make any vows.

CANONICA, in philosophical history, an appellation given by Epicurus to his doctrine of logic. It was called *canonica*, as consisting of a few canons or rules for directing the understanding in the pursuit and knowledge of truth. Epicurus's *canonica* is represented as a very slight and insufficient logic by several of the ancients, who put a great value on his ethics and physics. Laertius even assures us, that the Epicureans rejected logic as a superfluous science; and Plutarch complains that Epicurus made an unskilful and preposterous use of syllogisms. But these censures seem too severe. Epicurus was not averse to the study of logic, but even gave better rules in this art than these philosophers who aimed at no glory but that of logics. He only seems to have rejected the dialectics of the Stoics, as full of vain subtleties and deceits, and fitted rather for parade and disputation than real use. The stress of Epicurus's *canonica* consists in his doctrine of the criteria of truth. All questions in philosophy are either concerning words or things: concerning things, we seek their truth; concerning words, their signification; things are either natural or moral; and the former are either perceived by sense or by the understanding. Hence, according to Epicurus, arise three criterions of truth, viz. sense, anticipation or prænotion, and passion. The great canon or principle of Epicurus's logic is, that the senses are never deceived; and therefore, that every sensation or perception of an appearance is true.

CANONICAL, something that belongs to, or partakes of, the nature of a rule or canon.

Canonical Hours, are certain stated times of the day, consigned, more especially by the Romish church, to the offices of prayer and devotion. Such are *matins, lauds, sixth, ninth vespers*. In our country the canonical hours are from eight to twelve in the forenoon, before or after which marriage cannot be legally performed in any parish church.

Canonical Obedience, is that submission which, by the ecclesiastical laws, the inferior clergy are to pay to their bishops, and religious to their superiors.

Canonical Sins, in the ancient church, those which were capital or mortal. Such especially were idolatry, murder, adultery, heresy, and schism.

Canonical Punishments, are those which the church may inflict; such as excommunication, degradation, and penance, in Roman Catholic countries; also fasting, alms, whipping, &c.

Canonical Life, the method or rule of living prescribed by the ancient clergy who lived in community. The canonical life was a kind of medium between the monastic and clerical lives. Originally the orders of monks and clerks were entirely distinct; but pious persons, in process of time, instituted colleges of priests and canons, where clerks, brought up for the ministry, as well as others already engaged therein, might live under a fixed rule, which, though somewhat more easy than the monastic, was yet more restrained, than the secular. This was called the *canonical life*, and those who embraced it *canons*. Authors are divided about the founder of the canonical life. Some will have it to be founded by the apostles; others ascribe it to Pope Urban I. about the year 1230, who is said to have ordered bishops to provide such of their clergy as were willing to live in community, with necessaries out of the revenues of their churches. The generality attribute it to St Augustine; who, having gathered a number of clerks to devote themselves to religion, instituted a monastery within the episcopal palace, where he lived in community with them. Onuphrius Panvinus, brings the institution somewhat lower; according to him, Pope Gelasius I. about the year 495, placed the first regular canons of St Augustine in the Lateran church.

Canonical Letters, in the ancient church, were a sort of testimonials of the orthodox faith, which the bishops and clergy sent each other to keep up the Catholic communion, and distinguish orthodox Christians from Arians and other heretics. They were denominated *canonical*, either as being composed according to a certain rule or form, or because they were given to the *canonici*, that is, those comprehended in the canon or catalogue of their church. When they had occasion to travel into other dioceses or countries, dimissory and recommendatory letters, also letters of peace, &c. were so many species of canonical letters.

Canonical is also an appellation given to those epistles in the New Testament, more frequently called *catholic* or *general* epistles.

CANONICUM, in a general sense, denotes a tax or tribute.

Canonicum is more particularly used in the Greek church for a fee paid by the clergy to bishops, archbishops, and metropolitans, for degrees and promotions.

Canonicum also denotes a due of first fruits, paid by the Greek laity to their bishops, or, according to Du Cange, to their priests. The *canonicum* is affected according to the number of houses or chimneys in a place.

The emperor Isaac Comnenus made a constitution for regulating the *canonicum* of bishops, which was confirmed by another made in 1086, by his nephew Alexis Comnenus. A village containing thirty fires, was to pay for its *canonicum* one piece of gold, two of silver, one sheep, six bushels of barley, six of wheat flour, six measures of wine, and thirty hens.

CANONIST, a person skilled in or who makes profession of the study and practice of the canon law. Canonists and civilians are usually combined in the same persons: and hence the title of *doctor juris utriusque*, or *legum doctor*, usually expressed in abbreviature, LL. D. or J. U. D.

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CANONIZATION, a ceremony in the Romish church, by which persons deceased are ranked in the catalogue of the saints. It succeeds beatification.

Before a beatified person is canonized, the qualifications of the candidate are strictly examined into, in some consistories held for that purpose; after which, one of the consistorial advocates, in the presence of the pope and cardinals, makes the panegyric of the person who is to be proclaimed a saint, and gives a particular detail of his life and miracles; which done, the holy father decrees his canonization, and appoints the day.

On the day of canonization the pope officiates in white, and their eminences are drest in the same colour. St Peter's church is hung with rich tapestry, upon which the arms of the pope, and of the prince or state requiring the canonization, are embroidered in gold and silver. An infinite number of lights blaze all round the church, which is crowded with pious souls, who wait with devout impatience till the new saint has made his public entry as it were into paradise, that they may offer up their petitions to him without danger of being rejected.

The following maxim with regard to canonization is now observed, though it has not been followed above a century, viz. not to enter into the inquiries prior to canonization, till 50 years at least after the death of the person to be canonized. By the ceremony of canonization, it appears that this rite of the modern Romans has something in it very like the apotheosis or deification of the ancient Romans, and, in all probability, takes its rise from it; at least several ceremonies of the same nature are conspicuous in both.

CANONRY, the benefice filled by a canon. It differs from a prebend, in that the prebend may subsist without the canonicate, whereas the canonicate is inseparable from the prebend; again, the right of suffrages, and other privileges, are annexed to the canonicate, and not to the prebend.

CANOPUS, in *Astronomy*, a star of the first magnitude in the rudder of Argo, a constellation of the southern hemisphere.

CANOPUS, in Pagan mythology, one of the deities of the ancient Egyptians, and, according to some the god of water. It is said, that the Chaldeans, who worshipped fire, carried their fancied deity through other countries to try its powers, in order that, if it obtained the victory over the other gods, it might be acknowledged as the true object of worship; and it having easily subdued the gods of wood, stone, brass, silver and gold, its priests declared that all gods did it homage. This the priest of Canopus hearing, and finding that the Chaldeans had brought their god to contend with Canopus, they took a large earthen vessel, in which they bored several holes, which they afterwards stopped with wax, and having filled the vessel with water, painted it of several colours, and fitting the head of an idol to it, brought it out in order to contend with the Chaldean deity. The Chaldeans accordingly kindled their fire all round it; but the heat having melted the wax, the water gushed out through the holes, and extinguished the fire; and thus Canopus conquered the god of the Chaldeans.

CANOPUS, or *Canobus*, according to Strabo, had been Menelaus's pilot, and had a temple erected to him in a town called *Canopus*, near one of the mouths of the Nile. Dionysius mentions it:

> Και τεμενος περιπυστον Αμυκλαιοιο Κανωβου.
>
> There stands Canobus' temple known to fame;
> The pilot who from fair Amycla came.

Vossius remarks, on this occasion, the vanity of the Greeks, who, as he conjectures, hearing of an Egyptian deity named *Canopus*, took from thence an opportunity of deifying the pilot of Menelaus who bore the same name, and giving out that the Egyptian god Canopus had been a Greek. F. Montfaucon gives several representations of this deity. One, in allusion to the victory above-mentioned, throws out water on every side through little holes.

CANOPUS, or *Canobus*, in *Ancient Geography*, a town of the Lower Egypt, on the Mediterranean, a hundred and twenty stadia, or fifteen miles, to the east of Alexandria; as old as the war of Troy, Canopus, or Canobus, Menelaus's steersman, being there buried. *Canopæi* the gentilitious name; famous for their luxury and debauchery (Strabo, Juvenal). See ABOUKIR.

CANOPY, in *Architecture* and *Sculpture*, a magnificent kind of decoration, serving to cover and crown an altar, throne, tribunal, pulpit, chair, or the like. The word is formed from the barbarous Latin *canopeum*, of *κωνωπειον*, *a net spread over a bed to keep off the gnats*, from *κωνωψ*, *a gnat*.

Canopies are also borne over the head in processions of state, after the manner of umbrellas. The canopy of an altar is more peculiarly called *ciborium*.

The Roman grandees had their canopies, or spread veils, called *thensæ*, over their chairs; the like were also in temples over the statues of their gods. The modern cardinals still retain the use of canopies.

CANOSA, a town of Puglia in Italy, occupying part of the site of the ancient Canusium. The old city was founded by Diomedes, according to Strabo. It afterwards became a Roman colony, and one of the most considerable cities of this part of Italy for extent, population, and magnificence of building. The era of Trajan seems to have been that of its greatest splendour; but this pomp only served to mark it as a capital object for the avarice and fury of the Barbarians. Genseric, Totila, and Autharis, treated it with extreme cruelty. The deplorable state to which this province was reduced in 590 is concisely but strongly painted by Gregory the Great in these terms: "On every side we hear groans; on every side we behold crowds of mourners, cities burnt, castles razed to the ground, countries become waste, provinces become deserts, some citizens led away captives, and others inhumanly massacred." No town in Puglia suffered more than Canosa from the outrages of the Saracens; the contests between the Greeks and Normans increased the measure of its woes, which was filled by a conflagration that happened when it was stormed by duke Robert. In 1090, it was assigned, by agreement, to Bohemund prince of Antioch, who died here in 1111. Under the reign of Ferdinand the Third, this estate belonged to the Grimaldis. On their forfeiture, the Affaititi acquired it, and still retain the title of marquis, though the Capeci are the proprietors of the fief.

Swinburne's Travels in Sicily, p. 408.

The

Canosa ‖ Cantabria.

The ancient city stood in a plain between the hills and the river Ofanto, and covered a large tract of ground. Many brick monuments, though degraded and stripped of their marble casing, still attest its ancient grandeur. Among them may be traced the fragments of aqueducts, tombs, amphitheatres, baths, military columns, and two triumphal arches, which, by their position, seem to have been two city gates. The present town stands above, on the foundations of the old citadel, and is a most pitiful remnant of so great a city, not containing above three hundred houses. The church of Sabinus, built, as is said, in the sixth century, is now without the enclosure. It is astonishing that any part of this ancient cathedral should have withstood so many calamities. Its altars and pavements are rich in marble; and in a small court adjoining, under an octagonal cupola, is the mausoleum of Bohemund, adorned in a minute Gothic style.

CANSO, a sea-port town of Nova Scotia, in North America, seated on a narrow strait which separates Nova Scotia from Cape Breton. It has two bays which afford safe anchorage. Near this town is a fine fishery for cod. W. Long. 62. N. Lat. 46.

CANSTAT, a town of Swabia, in Germany, in the kingdom of Wirtemberg, situated on the river Neckar, in E. Long. 9. 9. N. Lat. 48. 51.

CANT, a quaint affected manner of speaking, adapted chiefly to the lower sort. Skinner racks his invention for the origin of this word; which he successively deduces from the German, Flemish, and Saxon tongues. According to the general opinion, Cant is originally the proper name of a Cameronian preacher in Scotland, who by exercise had attained the faculty of talking in the pulpit in such a tone and dialect as was understood by none but his own congregation: since Andrew Cant's time, the word has been extended to signify all sudden exclamations, and whining unmusical tones, especially in praying and preaching. But this origin of the word has been disputed by others: and perhaps the true derivation is from the Latin *cantare* "to sing."

CANT is also applied to words and phrases affected by particular persons or professions for low ends, and not authorized by the established language *. The difference between *cant* and *technical* seems to be this: the former is restrained to words introduced out of folly, affectation, or imposture: the latter is applied to such as are introduced for the sake of clearness, precision, and significancy.

* See *Canting Language*.

CANT is also used to denote a sale by auction. The origin of the word in this sense is dubious; it may come, according to some, from *quantum*, how much; according to others, from *cantare*, to sing or cry aloud; agreeably to which, we sometimes also call it an *outcry*.

CANT-*Timbers*, in ship-building, those timbers which are situated at the two ends of a ship. They derive their name from being *canted*, or raised obliquely from the keel; in contradistinction from those whose planes are perpendicular to it. The upper ends of those on the bow, or fore part of the ship, are inclined to the stern; as those in the after or hind part, incline to the stern post above. See *Ship-Building*.

CANTABRIA, in *Ancient Geography*, a district of Tarraconensis, on the Oceanus Cantabricus, or bay of Biscay; now BISCAY. The inhabitants were famous for their warlike character. In conjunction with the Asturians †, they carried on desperate wars with the Romans; but were subdued by them about 25 years before Christ. Being impatient, however, of a foreign yoke, they in a few years revolted. Most of their youth had been already taken prisoners by the Romans, and sold for slaves to the neighbouring nations: but having found means to break their chains, they cut the throats of their masters; and returning into their own country, attacked the Roman garrisons with incredible fury. Agrippa marched against them with great expedition; but on his arrival, met with so vigorous a resistance, that his soldiers began to despair of ever being able to reduce them. As the Cantabrians had waged war with the Romans for upwards of 200 years, they were well acquainted with their manner of fighting, no way inferior to them in courage, and were now become desperate; well knowing, that if they were conquered, after having so often attempted to recover their liberty, they must expect the most severe usage, and cruel slavery. Animated with this reflection, they fell upon the Romans with a fury hardly to be expressed, routed them in several engagements, and defended themselves when attacked by the enemy with such intrepidity, that Agrippa afterwards owned that he had never, either by sea or land, been engaged in a more dangerous enterprise. That brave commander was obliged to use entreaties, menaces, and to brand some of his legionaries with ignominy, before he could bring them to enter the lists with such a formidable enemy. But having at last, with much ado, prevailed upon them to try the chance of an engagement in the open field, he so animated them by his example, that after a most obstinate dispute, he gained a complete victory, which indeed cost him dear, but put an end to that destructive war. All the Cantabrians fit to bear arms were cut in pieces, their castles and strong holds taken and razed; and their women, children, and old men (none else being left alive,) were obliged to abandon the mountainous places, and settle in the plain.

† See *Asturias*.

Dr Wallis seems to make the Cantabrian the ancient language of all Spain: which, according to him, like the Gaulish, gave way to a kind of broken Latin called *romance*, *romansh;* which by degrees was refined into the Castilian or present Spanish. But we can hardly suppose that so large a country, inhabited by such a variety of people, spoke all the same language. The ancient Cantabrian, in effect, is still found to subsist in the more barren and mountainous parts of the provinces of Biscay, Asturias, and Navarre, as far as Bayonne, much as the British does in Wales; but the people only talk it: for writing, they use either the Spanish or French, as they happen to live under the one or the other nation. Some attribute this to a jealousy of foreigners learning the mysteries of their language; others to a poverty of words and expressions. The Cantabrian does not appear to have any affinity with any other known language, abating that some Spanish words have been adopted in it for things whose use the Biscayans were anciently unacquainted with. Its pronunciation is not disagreeable. The Lord's prayer, in the Cantabrian tongue, runs thus: *Gure aita cervetan aicena, santifica bedi hire icena, ethor bedi hire resuma,* *eguin*

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eguin bedi hire vorandatea cervan becala lurrean ere, &c.

CANTABRICA, in *Botany*, a synonyme of a species of CONVOLVULUS.

CANTABRUM, in antiquity, a large kind of flag used by the Roman emperors, distinguished by its peculiar colour, and bearing on it some word or motto of good omen, to encourage the soldiers.

CANTACUZENUS, JOHANNES, of Constantinople, a celebrated statesman, general, and historian, was born in that city, of a very ancient and noble family. He was bred to letters and to arms, and admitted to the highest offices in the state. The emperor Andronicus loaded him with wealth and honour; made him generalissimo of his forces; and was desirous of having him join him in the government, but this he refused. Andronicus dying in 1341, left to Cantacuzenus the care of the empire, till his son John Paleologus, who was then but nine years of age, should be fit to take it upon himself. This trust he faithfully discharged; till the empress-dowager and her faction forming a party against him, declared him a traitor. On this the principal nobility and the army besought him to ascend the throne; and accordingly he was crowned on the 21st of May 1342. This was followed by a civil war, which lasted five years; when he admitted John a partner with him in the empire, and their union was confirmed by his giving him his daughter in marriage. Suspicions and enmities, however, soon arising, the war broke out again, and continued till John took Constantinople in 1355. A few days after, Cantacuzenus, unwilling to continue the effusion of blood, abdicated his share of the empire, and retiring to a monastery, took the habit of a monk, and the name of *Joasaphas.* His wife also retired to a nunnery, and changed her name of *Irene* for that of *Eugenia.* In this retirement he lived till the year 1411, when he was upwards of 100 years of age. Here he wrote a history of his own times, a Latin translation of which, from the Greek manuscript, was published by Pontanus at Ingolstadt, in 1603; and a splendid edition was printed at Paris in 1645, in three volumes folio, of the original Greek, and Pontanus's Latin version. He also wrote an apology for the Christian religion against that of Mahomet, under the name of *Christodulus.*

CANTAL, a department of France, forming part of the ancient Auvergne. It contains 2300 square miles, and had 252,000 inhabitants in 1815. Aurillac is the chief town.

CANTALIVERS, in *Architecture*, pieces of wood framed into the front or sides of a house, to suspend the mouldings and eyes over it.

CANTAR, or CANTARO, an eastern weight, of different value in different places, equal at Acra in Turkey to 603 pounds, at Tunis and Tripoli to 114 pounds.

CANTAR is also an Egyptian weight, which is denominated a *quintal*, and consists of a hundred or of an hundred and fifty rotolos, according to the goods they are to weigh.

CANTARO is also an Egyptian weight, which at Naples is equivalent to 25 pounds, at Genoa to 150 pounds. At Leghorn there are three kinds of *cantaros*, one weighing 150 pounds, another 151, and a third 160 pounds.

CANTARO is also a Spanish liquid measure, in use especially at Alicant, containing three gallons.

CANTARO is also a measure of capacity, used at Cochin, containing four rubis, the rubi 32 rotolos.

CANTARINI, SIMON, a famous painter, called the *Peserese*, from his being born at Pesaro, was the disciple of Guido; and copied the manner of his master so happily that it is often difficult to distinguish between their works. He died at Verona in 1648.

CANTATA, in *Music*, a song or composition, intermixed with recitatives, airs, and different movements, chiefly intended for a single voice, with a thorough bass, though sometimes for other instruments. It was first used in Italy, then in France, whence it passed to us.

CANTAZARO, an episcopal city of Italy, in the kingdom of Naples, and in the territory of Calabria Ulterior. It is the residence of the governor of the province, and is seated near the sea, in E. Long. 17.0. N. Lat. 38. 59.

CANTECROIX, a small territory of the Netherlands in Brabant, and in the quarter of Antwerp, with the title of a principality; there is a small town of the same name, but Lire is the capital.

CANTEMIR, DEMETRIUS, son of a prince of Moldavia. Disappointed by not succeeding his father in that dignity, held under the Ottoman Porte, he went over with his army to the Czar Peter the Great, against whom he had been sent by the Grand Signior: He signalized himself in the czar's service; and in the republic of letters, by a Latin history of the origin and decline of the Ottoman empire, &c. He died in 1723.

CANTEMIR, *Antiochus*, esteemed the founder of the Russian poetry, was the youngest son of the preceding. Under the most ingenious professors, whom the czar had invited to Petersburgh, he learned mathematics, physic, history, moral philosophy, and polite literature; without neglecting the study of the Holy Scriptures, to which he had a great inclination. Scarce had he finished his academic course, when he printed a Concordance of the Psalms in the Russian language, and was elected member of the academy. The affairs of state in which he was soon after engaged, did not make him neglect his literary pursuits. In order to make himself useful to his fellow citizens, he composed his satires, to ridicule certain prejudices which had got footing among them. When but 24 years of age, he was nominated minister at the court of Great Britain; and his dexterity in the management of public affairs was as much admired as his taste for the sciences. He had the same reputation in France, whither he went in 1738 in quality of minister plenipotentiary, and soon after was invested with the character of ambassador extraordinary. The wise and prudent manner in which he conducted himself during the different revolutions which happened in Russia during his absence, gained him the confidence and esteem of three successive princes. He died of a dropsy, at Paris, in 1744, aged 44. Besides the pieces already mentioned, he wrote, 1. Some Fables and Odes. 2. A translation of Horace's Epistles in Russian verse. 3. A prose

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Cantemir, Canterbury. prose translation of Fontenelle's Plurality of Worlds; and, 4. Algarotti's Dialogues on Sight. The Abbé Guasco has written his life in French, and translated his satires into that language.

CANTERBURY, a city of England, and capital of the county of Kent, situated in E. Long. 1. 15. N. Lat. 51. 16. It has the names of *Durovernum* and *Darvernum* given it by the Romans, and *Durobernia* by Bede, which are thought to be derived from *Durwhem*, signifying a rapid stream, such as the Stour, on which it stands, is. The Britons call it *Caer Kent*, i. e. the city of Kent; and its present English name is of the same import, derived from the Saxon. Modern writers in Latin call it *Cantuaria*. Its great antiquity appears not only from Antoninus's Itinerary, but from the military way which has been discovered here, and the causeways leading to Dover and Lymme, besides the coins and other curiosities found about it. The archiepiscopal and metropolitan dignity seems to have been settled here very early; and to prevent its being removed, an anathema was decreed against any who should attempt it. After that, the city flourished greatly; though it suffered in common with other towns during the Danish invasions, and at other times by the casualties of fire. The city was given entirely to the bishops by William Rufus, and was held in the utmost veneration in the Popish times, especially after the murder of Becket in the reign of Henry II. to whose shrine so great was the resort, and so rich were the offerings, that Erasmus, who was an eye-witness of its wealth, says the whole church and chapel in which he was interred glittered with jewels; and at the dissolution, the plate and jewels filled two great chests, each of which required eight strong men to carry out. The cathedral was granted by Ethelbert, king of Kent, upon his conversion, to Austin the Monk, together with his palace, and the royalty of the city and its territories. This Austin founded a monastery for monks, called from him *Augustine*. After the cathedral had been several times destroyed by fire and rebuilt, the present was begun about the year 1174, and augmented and embellished by the succeeding archbishops, till it was completed in the reign of Henry V. It is a noble Gothic pile, and before the Reformation had 37 altars. A great many kings, princes, cardinals, and archbishops, are buried in it. At the dissolution, Henry VIII, seized all the revenues both of the church and monastery, except what he allotted for the maintenance of a dean, 12 prebendaries, and six preachers, whom he established in place of the monks. During the grand rebellion, it suffered much; the usurper Cromwell having made a stable of it for his dragoons. After the Restoration, it was repaired, and made what it now appears.

Besides the cathedral and other churches, as well as a monastery, the city had anciently a castle on the south side, and strong walls, with towers, a ditch, and rampart; it had also a mint and an exchange. As to its government, it seems to have been entirely subject to the archbishop, both in spirituals and temporals; at least from the time that William Rufus gave it solely to Bishop Anselm, till the Reformation. It is now a county of itself: and the corporation consists of a mayor, recorder, 12 aldermen, a sheriff, 24 common council men, a mace-bearer, a sword-bearer, and four serjeants at mace. Every Monday a court is held at Guildhall for civil and criminal causes; and every other Tuesday for the government of the city. Here were formerly 2000 or 3000 French Protestants employed in the silk manufacture; but this branch is now greatly decayed in the place, since Spittalfields became so flourishing. Besides the cathedral, it contains 15 parish churches, seven hospitals, a free school, a house of correction, a gaol for criminals, and sumptuous conduit for supplying the inhabitants with water. It consists of four streets, disposed in the form of a cross, and divided into six wards, which are about three miles in circumference. It is surrounded on all hands with hop grounds much to its advantage, and is famed for its excellent brawn. The population in 1811 was 10,200.

Canterbury, Canterus.

The diocese of Canterbury contains 257 parishes, besides chapels, in Kent, and about 100 more in other dioceses. These are called *Peculiars*; it being an ancient privilege of this see, that, wheresoever the archbishops had either manors or advowsons, the place was exempted from the jurisdiction of the ordinary of the diocese where it was situated, and was deemed in the diocese of Canterbury. This see is valued in the king's books at 2816l. 17s. 9¼d. but is reckoned to produce a clear revenue of 8000l. a year. The clergy's tenths come to 615l. 18s. 2¼d. This see had many great privileges in the time of Popery, some of which it still retains. The archbishop is accounted primate and metropolitan of all England, and is the first peer in the realm; having the precedence of all dukes not of the blood-royal, and of all the great officers of state. In common speech he is styled *His Grace*, and he writes himself *Divina Providentia*; whereas other bishops style themselves *Divina Permissione*. At coronations, he places the crown on the king's head; and, wherever the court may be, the king and queen are the proper domestic parishioners of the archbishop of Canterbury. The bishop of London is accounted his provincial dean, the bishop of Winchester his sub-dean, the bishop of Lincoln his chancellor, and the bishop of Rochester his chaplain. This see hath yielded to the church 18 saints; to the church of Rome, 9 cardinals; to the civil state of England, 12 lord chancellors, 4 lord treasurers, and 1 lord chief justice; and 9 chancellors to the university of Oxford. To this see belongs only one archdeacon, viz. of Canterbury. To the cathedral belong an archbishop, a dean, a chancellor, an archdeacon, 12 prebends, 6 preachers, 6 minor canons, 6 substitutes, 12 lay clerks, 10 choristers, 2 masters, 50 scholars, and 12 almsmen.

Canterbury *Bell*, the English name of a species of Campanula. See Botany *Index*.

CANTERUS, William, an eminent linguist and philologer, was born at Utrecht, in 1541. He studied at Louvain and Paris; and gave surprising proofs of his progress in Greek and Latin literature. He afterwards visited the several universities of Germany and Italy; and died at Louvain, in 1575, aged 33. He understood six languages, besides that of his native country; and, notwithstanding his dying so young, wrote several philological and critical works, among which are, *Notæ, Scholæ, Emendationes, et Explicationes, in Euripidem, Sophoclem, Eschylum, Ciceronem, Propertium, Ausonium*, &c. and many translations of Greek authors.

CANTHARIDES,

CANTHARIDES, in the *Materia Medica*, flies which are employed to produce blisters on the skin.

CANTHARIS, in *Zoology*, a genus of insects belonging to the order of insecta coleoptera. Linnæus enumerates 27 species of the cantharis, most of them to be found in different parts of Europe. The cantharis used in making blistering plasters is ranked under the genus MELOE. See ENTOMOLOGY *Index*.

CANTHI, in *Anatomy*, cavities at the extremities of the eye-lids, commonly called the *corners of the eye:* the greater of them, or the great canthus, is next the nose; the lesser of them, or the little canthus, lies towards the temple.

CANTICLES, a canonical book of the Old Testament, otherwise called the *Song of Solomon;* by the Jews the *Song of Songs*, *Canticum Canticorum*. The book of Canticles is usually supposed to be an epithalamium composed by Solomon, on occasion of his marriage with the king of Egypt's daughter. But those who penetrate further into the mystery, find in it the marriage of Jesus Christ with human nature, the church, and good men. On this principle the Canticles is held to be a continued allegory, wherein, under the terms of a common wedding, a divine and spiritual marriage is expressed. This song contains the adventures of seven days and seven nights; the exact time allowed for the celebration of marriage among the Hebrews. The Jews themselves, apprehending the book liable to be understood in a gross and carnal manner, prohibited the reading of it before the age of 30, and the same usage anciently obtained in the Christian church. Among the ancients, Theodore Mopsuetanus rejected the book of Canticles as not divine. Divers rabbins have also questioned its being written by inspiration. It is alleged, that the name of God is not once found in it. Mr Whiston has a discourse express to prove that the Canticles is not a sacred book of the Old Testament. He alleges it indeed to have been written by King Solomon the son of David; but asserts that it was composed at the time when that prince, blinded by his concubines, was sunk in lust and idolatry. This he chiefly infers from the general character of vanity and dissoluteness which reigns through the Canticles: in which there is not, according to Whiston, one thought that leads the mind towards religion, but all is worldly and carnal, to say no worse. For the mystic sense, he asserts it to be without foundation; and that the book is not cited as canonical by any writer before the destruction of Jerusalem. Mr Whiston will have it to have been taken into the canon between the years 77 and 128, when allegories came into vogue, and the rabbins began to corrupt the text of Scripture. Grotius, Nierembergius, the Dutch divines who criticised F. Simon, Menetrier, Basnage, and some others, seem also to take the Canticles for a profane composition, on a footing with the love pieces of Catullus or Ovid. But this opinion is refuted by Michaelis, Majus, Witsius, Nat. Alexander, Outrein, Francius, and others. Mr Whiston's arguments have been particularly considered by Itchener, and also by Dr Gill. R. Akiba finds the book of Canticles more divine than the rest; the whole world, according to this rabbin, is not worth that day when the Canticles was given to Israel; for, whereas all the hagiographers are holy, the Canticles is the holy of holies.

CANTIMARONS, or CATIMARONS, a kind of floats or rafts, used by the inhabitants of the coast of Coromandel to go a fishing in, and to trade along the coast. They are made of three or four small canoes, or trunks of trees dug hollow, and tied together with cacao ropes, with a triangular sail in the middle, made of mats. The persons who manage them are almost half in the water, there being only a place in the middle a little raised to hold their merchandise: which last particular is only to be understood of the trading cantimarons, and not of those that go a fishing.

CANTIN, CAPE, a promontory of the coast of Morocco, in Africa, situated in W. Long. 10. 2. N. Lat. 33. 9.

CANTING, a sea phrase, denotes the act of turning any thing about.

CANTING Language or *Dialect*, is a mysterious sort of jargon used by gypsies, thieves, and strolling beggars, to express their sentiments to each other, without being understood by the rest of mankind. This dialect is not founded on any rules; yet even out of that irregularity many words seem to retain something of scholarship; as *togeman*, a gown, from *toga* in the Latin; *pannam*, bread, from *panis; casan*, cheese, from *caseus*, &c. It is observable, that, even unknown to ourselves, we have adopted some of their terms into our vulgar language; as *bite* and *bilk*, to cheat; *bounce*, to vapour; *bowse*, strong drink; *filch*, to steal; *flog*, to whip; *rig*, game or ridicule; *roast*, to rally; *rhino*, money. From the same source proceed the words *sham*, *banter*, *bubble*, *bully*, *sharper*, *cutting*, *shuffling*, *palming*, &c. An anonymous author has given a canting dictionary, comprehending all the terms used by the several tribes of gypsies, beggars, shoplifters, highwaymen, foot-pads, and other clans of cheats and villains, with a collection of songs in the canting dialect: London, 1725, 8vo.

CANTIUM, in *Ancient Geography*, a promontory of Britain, literally denoting a headland: giving name to a territory called *Cantium*, now Kent; and to a people called *Cantii* (Cæsar), commended for their great humanity and politeness. The promontory now the North *Foreland*. It is supposed that this was the first district in Britain which received a colony from the continent; and that it had frequently changed its masters, by new colonies coming over from time to time, and driving the inhabitants further north. In the midst of all these revolutions it still retained its ancient name (which was so agreeable to its shape and situation), and gave the same name to all the successive tribes by which it was inhabited. Those who possessed it at the time of the first Roman invasion were evidently of Belgic origin, and had come over so lately, that they differed in nothing from their countrymen on the continent. "The inhabitants of Kent (says Cæsar) are the most civilized of all the Britons, and differ but very little in their manners from the Gauls." This great resemblance between the people of Kent and their neighbours on the continent, might be partly owing to the situation of their country, which being nearest to the continent, was most frequented by strangers from thence. It was this situation also which exposed them to the first assaults of the Romans. For Cæsar, in both his expeditions into this island, landed in Kent; and therefore we may conclude, that

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that the Cantii had a great share in the vigorous opposition that was made to his landing, and in the several battles and skirmishes which were fought against him after his landing; particularly, they made a very bold, but unsuccessful attempt, upon his naval camp. The Cantii did not make the same vigorous resistance to the Romans on their next invasion in the reign of Claudius. For Aulus Plautius, the Roman general in that expedition, traversed their country without seeing an enemy; and as they now submitted to the power of Rome without a struggle, so they continued in a state of quiet submission to it to the very last. The situation of Cantium occasioned its being much frequented by the Romans, who generally took their way through it in their marches to and from the continent. Few places in Britain are more frequently mentioned by the Roman writers than Rutupium and Portus Rutupensis, most probably Richborough and Stonar. Rutupium was the same in those times that Dover is in ours; the usual place of embarking for, and landing from, the continent. Before the final departure of the Romans out of Britain, Portus Dubris, now Dover, had become a considerable place, and a well frequented harbour, where the third iter of Antoninus ends, and from whence they often embarked for Gaul. Portus Lemanus, supposed to be Lime near West Hythe, was also a noted sea-port in these times, and the termination of the fourth iter of Antoninus. Durobrivæ and Durovernum, now Rochester and Canterbury, were both Roman towns and stations, and are often mentioned in the Itinerary and other books. Besides these, there were several other Roman stations, towns, and ports in Cantium, which need not be particularly enumerated here. Cantium, in the most perfect state of the Roman government, made a part of the province which was called *Flavia Cæsariensis*.

CANTO, denotes a part or division of a poem, answering to what is otherwise called a *book*. The word is Italian, where it properly signifies *song*. Tasso, Ariosto, and several other Italians, have divided their longer or heroic poems into cantos. In imitation of them, Scarron has also divided his *Gigantomachia*, and Boileau his *Lutrin*, into chants or songs. The like usage has been adopted by some English writers, as Butler, who divides his Hudibras, and Dr Garth his Dispensary, into cantos. A late translator of part of Virgil's Æneid has even subdivided a book of Virgil into several cantos.

CANTO, in the Italian music, signifies a *song*: hence *canto simplice* is where all the notes or figures are equal, and called also *canto sermo*; *canto figurato*, that where the figures are unequal, and express different motions.

CANTO also signifies the treble part of a song; hence *canto concertante*, the treble of the little chorus; *canto repieno*, the treble of the grand chorus, or that which sings only now and then in particular places. *Canto* signifies the first treble, unless some other word be added to it, as *secondo*; in which case it denotes the second treble.

CANTON, in *Geography*, denotes a small district or country constituting a distinct government: such are the cantons of Switzerland.

CANTON, *Quang-tong*, or Koanton, one of the southern provinces of China; bounded on the north-east by Fokien, on the north by Kiang-si, on the west by Quang-si and the kingdom of Tonking, and everywhere else by the sea. The country is diversified with hills and plains, and the soil in general so fertile that it produces two crops annually. Besides many of the fruits of Europe, and those common in other parts of the Indies, the province of Canton produces some peculiar to itself. Abundance of valuable aromatic woods is also to be met with in this province, as well as eagle wood, ebony, &c. and in the mineral kingdom the province furnishes gold, precious stones, tin, quicksilver, and copper. Silk and sugar are also cultivated here, and pearls are fished upon the coasts; so that every thing which can contribute to the pleasure or convenience of life is to be met with in Canton. "One begins (says F. Premare) to have an idea of China, on entering the river Canton. Both sides of it present large fields of rice which resemble green meadows, and extend beyond the reach of sight. They are intersected by an infinite number of small canals, in such a manner that the barks which pass and repass in them seem at a distance, while the water which carries them is concealed, to glide along the grass. Farther inland the country appears covered with trees, and cultivated along the valleys; and the whole scene is interspersed with villages, rural seats, and such a variety of delightful prospects, that one is never tired of viewing them, and regrets to be obliged to pass them so quickly.

All the coasts of this province abound with fish, and furnish vast numbers of crabs, oysters, and tortoises of an immense size. The inhabitants keep a prodigious number of tame ducks, which they hatch in ovens or dunghills, though it does not appear that they borrowed this custom from the Egyptians. The docility of these creatures exceeds what we should be apt at first to imagine. The inhabitants load a number of small barks with them, and carry them in flocks to feed on the sea shore, where they find shrimps and other animals proper for their nourishment. But though the ducks from the different barks are thus unavoidably mixed together in the day time, they are easily collected by only beating on a bason, on which they immediately collect themselves into different flocks, and each returns to its proper bark.

In this province the Chinese have also a method of preserving, not only the flesh of the ducks, in such a manner that it loses nothing of its original flavour, but their eggs also. The latter operation is performed by covering the eggs with a coat of clay mixed with salt. When mixed in this manner, it seems that the salt has the property of penetrating through the pores of the shell, and thus impregnating the substance in the egg, which it could not do by simple solution in water.

Canton, though it suffered much in the Chinese wars, is at present one of the most flourishing provinces of the empire; and being at a great distance from court, its government is one of the most important. A great number of fortresses, many of which are cities, provided with numerous garrisons, have been built along the coasts for the suppression of pirates and robbers; for which purpose also a certain number of troops are kept properly posted in different parts of the province. It is divided into ten districts, which contain as many cities of the first class, and 84 of the second and third. The air in general is warm but healthy,

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Canton. healthy, and the people are very industrious. They possess in an eminent degree the talent of imitation; so that if they are only shown any European work, they can execute others like it with surprising exactness. The most remarkable cities in the province besides Canton the capital are, 1. Chao-tcheou-fou, chiefly noted for a monastery of bonzes in its neighbourhood, to which the adjacent country belongs, and the origin of which is traced back for 800 or 900 years. It has under its jurisdiction six cities of the third class; near one of these grows a reed of which several instruments are made, which cannot be distinguished from real ebony. The air of Chao-tcheou-fou, however, is unhealthy; and great numbers of the inhabitants are carried off annually by contagious distempers, which prevail from the middle of October to the beginning of December. 2. Kao-tcheou-fou, situated in a delightful and plentiful country. In the neighbourhood is found a singular kind of stone much resembling marble, on which are natural representations of rivers, mountains, landscapes, and trees. These stones are cut into slabs, and made into tables, &c. Crabs are also caught on the coasts here, which very much resemble those of Europe; but, says Mr Grosier, they have this singularity, that when taken out of the water, they become petrified, without losing any thing of their natural figure. 3. Kiun-tcheou-fou, the capital of the island of Hai-nan. See HAI-NAN.

CANTON, a large, populous, and wealthy city of China, capital of the province of that name, stands on the banks of the river Taa, or great river, which, near the city, is wide and spacious. The wall of the city is pretty high, and about six or seven miles in circumference, though not more than one third of the ground is occupied by buildings, the other parts being appropriated to pleasure grounds or to fish ponds. The country is extremely pleasant, and towards the east hilly, so as to command a beautiful prospect of the city and suburbs, the compass of which, together, is about ten miles.

The buildings of Canton are in general low, consisting of one story and a ground floor, which is covered with earth or red tiles in order to keep it cool; but the houses of the most respectable merchants and mandarins are comparatively lofty and well built. In different parts of the city and suburbs are joss houses or temples, in which are placed the images worshipped by the Chinese: before whom are placed, at particular seasons, a vast variety of sweetmeats, oranges, great plenty of food ready dressed, and also incense, which is kept perpetually burning.

The streets of Canton are long and narrow, paved with flat stones, adorned at intervals with triumphal arches, which have a pleasing effect, and much crowded with people. On both sides are shops as in London, appropriated to the sale of different commodities; and a kind of awning is extended from house to house, which prevents the sun's rays from incommoding either inhabitants or passengers. At the end of every street is a barrier, which, with the gates of the city, is shut in the evening. In China street, which is pretty long and considerably wider than the rest, reside merchants, whose trade, so far as respects china, lackered ware, fans, &c. is wholly confined to Europeans. Most of them speak the foreign languages tolerably well, or at least sufficiently intelligible to transact business. Besides these merchants there is a company of twelve or thirteen, called the *Cohong*; who have an exclusive right by appointment from authority to purchase the cargoes from the different ships, and also to supply them with teas, raw silks, &c. in return. The establishment of the Cohong, though injurious to private trade, is admirably well adapted for the security of the different companies with which they traffic; because each individual becomes a guarantee for the whole; so that if one fail, the others consider themselves as responsible.

In Canton there are no carriages; all burdens are carried by porters across their shoulders on bamboos; as are also the principal people in sedan chairs, and the ladies always. The streets of Canton may be traversed from morning till evening without seeing a woman, those excepted who are Tartars, and even these but very seldom.

On the wharf of the river, which is commodious and pleasant, stand the factories of the different European nations, viz. the Dutch, French, Swedes, Danes, English, &c. In those reside the supercargoes belonging to their respective companies, who are appointed to dispose of the cargoes brought to market; to supply the ships with others from Europe in return; and, during their absence, to contract with the merchants for such articles as may be judged necessary for the next fleet. Between the residents of the factories the most perfect cordiality subsists; in each a common and splendid table is kept at the company's expence, and visits are reciprocally exchanged; so that nothing is wanting to make residence at Canton agreeable to an European, but the pleasure naturally resulting from the society of women.

The side of the river next the city is covered with boats, which form a kind of town, or streets, in which live the poorer sort of the Chinese, or rather the descendants of the Tartars. Some of the men come on shore in the morning to their respective employments, and in those sampans, or boats which are not stationary, the women and also the men carry passengers from place to place in the same manner as is done by wherries on the Thames. On this river live many thousand souls who never were permitted to come on shore; whose only habitation is their boat; in which they eat, drink, sleep, carry on many occupations, keep ducks, &c. and occasionally a hog.

The manufactures of Canton are principally carried on in the suburbs; though it has been frequently supposed that they were confined to the city; and this, by some writers, has been given as a reason why Europeans are not permitted to enter within the gates. But this is a mistake; and perhaps the true reason for this very singular restraint is, that the houses in which they keep their women are chiefly within the city.

At Wampoa, a large commodious place for anchorage, and which is about 12 or 14 miles from Canton, the European vessels lie and unload their cargoes, which are transmitted by lighters to the factories; and by the same conveyance receive their respective freights. Between this place and the city are three hoppo, or customhouses, at which the boats passing and repassing are obliged to stop, and undergo, with their passengers, an examination, in order to prevent smuggling.

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Canton.

gling. The lighters just mentioned, and also the captain's pinnace, are, however, excepted; the former having proper officers on board for the purpose, and the latter being narrowly watched and examined at the landing.

The weather at Canton is, in summer, extremely hot, and in the months of December, January, and February, cold: the country is nevertheless pleasant and healthful, abounding with all the necessaries and delicacies of life, which may be procured on terms much cheaper than in Europe. The number of inhabitants has been estimated at one million; but later calculations have made the number considerably less. N. Lat. 23. 30. E. Long. 113. 20.

CANTON, *John*, an ingenious natural philosopher, was born in Stroud, in Gloucestershire, in 1718; and was placed, when young, under the care of a Mr Davis of the same place, a very able mathematician, with whom, before he had attained the age of nine years, he had gone through both vulgar and decimal arithmetic. He then proceeded to the mathematics, and particularly to algebra and astronomy, wherein he had made a considerable progress, when his father took him from school, and put him to learn his own business, which was that of a broad-cloth weaver. This circumstance was not able to damp his zeal for the acquisition of knowledge. All his leisure time was devoted to the assiduous cultivation of astronomical science; and, by the help of the Caroline tables annexed to "Wing's Astronomy," he computed eclipses of the moon and other phenomena. His acquaintance with that science he applied likewise to the constructing of several kinds of dials. But the studies of our young philosopher being frequently pursued to very late hours, his father, fearing that they would injure his health, forbade him the use of a candle in his chamber any longer than for the purpose of going to bed, and would himself often see that his injunction was obeyed. The son's thirst of knowledge was, however, so great, that it made him attempt to evade the prohibition, and to find means of secreting his light till the family had retired to rest, when he rose to prosecute undisturbed his favourite pursuits. It was during this prohibition, and at these hours, that he computed, and cut upon stone, with no better an instrument than a common knife, the lines of a large upright sun dial, on which, besides the hour of the day, was shown the rising of the sun, his place in the ecliptic, and some other particulars. When this was finished, and made known to his father, he permitted it to be placed before the front of his house, where it excited the admiration of several gentlemen in the neighbourhood, and introduced young Mr Canton to their acquaintance, which was followed by the offer of the use of their libraries. In the library of one of these gentlemen, he found "Martin's Philosophical Grammar," which was the first book that gave him a taste for natural philosophy. In the possession of another gentleman, a few miles from Stroud, he first saw a pair of globes: an object that afforded him uncommon pleasure, from the great ease with which he could solve those problems he had hitherto been accustomed to compute. The dial was beautified a few years ago at the expence of the gentlemen at Stroud, several of whom had been his schoolfellows, and who continued still to regard it as a very distinguished performance. Among other persons with whom he became acquainted in early life, was the late reverend and ingenious Dr Henry Miles of Tooting, a learned and respectable member of the Royal Society, and of approved eminence in natural knowledge. This gentleman perceiving that Mr Canton possessed abilities too promising to be confined within the narrow limits of a country town, prevailed on his father to permit him to come to London. Accordingly he arrived at the metropolis, March 4. 1737, and resided with Dr Miles at Tooting till the 6th of May following; when he articled himself for the term of five years, as a clerk to Mr Samuel Watkins, master of the Academy in Spital-square. In this situation, his ingenuity, diligence, and good conduct, were so well displayed, that on the expiration of his clerkship in May 1742, he was taken into partnership with Mr Watkins for three years; which gentleman he afterwards succeeded in Spital-square, and there continued during his whole life. In 1744, he married Penelope, the eldest daughter of Mr Thomas Colbrooke, and niece to James Colbrooke, Esq. banker in London.

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Towards the end of 1745, electricity, which seems early to have engaged Mr Canton's notice, received a very capital improvement by the discovery of the famous Leyden Phial. This event turned the thoughts of most of the philosophers of Europe to that branch of natural philosophy; and our author, who was one of the first to repeat and to pursue the experiment, found his assiduity and attention rewarded by many capital discoveries. Towards the end of 1749, he was concerned with his friend, the late Mr Benjamin Robins, in making experiments in order to determine to what height rockets may be made to ascend, and at what distance their light may be seen. In 1750 was read at the Royal Society Mr Canton's "Method of making artificial magnets, without the use of, and yet far superior to, any natural ones." This paper procured him the honour of being elected a member of the society, and the present of their gold medal. The same year he was complimented with the degree of M. A. by the University of Aberdeen; and, in 1751, was chosen one of the council of the Royal Society.

In 1752, our philosopher was so fortunate as to be the first person in England who, by attracting the electric fire from the clouds during a thunder storm, verified Dr Franklin's hypothesis of the similarity of lightning and electricity. Next year, his paper entitled, "Electrical Experiments, with an attempt to account for their several Phenomena," was read at the Royal Society. In the same paper Mr Canton mentioned his having discovered, by a great number of experiments, that some clouds were in a positive, and some in a negative, state of electricity. Dr Franklin, much about the same time, made the like discovery in America. This circumstance, together with our author's constant defence of the doctor's hypothesis, induced that excellent philosopher, immediately on his arrival in England, to pay Mr Canton a visit, and gave rise to a friendship which ever after continued without interruption or diminution. In the "Lady's Diary for 1756," our author answered the prize question that had been proposed in the preceding year. The question

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tion was, "How can what we call the shooting of stars be best accounted for; what is the substance of this phenomenon; and in what state of the atmosphere doth it most frequently shew itself?" The solution, though anonymous, was so satisfactory to his friend, Mr Thomas Simpson, who then conducted that work, that he sent Mr Canton the prize, accompanied with a note, in which he said, he was sure that he was not mistaken in the author of it, as no one besides, that he knew of, could have answered the question. Our philosopher's next communication to the public, was a letter in the "Gentleman's Magazine, for September 1759," on the electrical properties of the tourmalin, in which the laws of that wonderful stone are laid down in a very concise and elegant manner. On December 13. in the same year, was read at the Royal Society, "An attempt to account for the regular diurnal variation of the Horizontal Magnetic Needle; and also for its irregular variation at the time of an Aurora Borealis." A complete year's observations of the diurnal variations of the needle are annexed to the paper. On November 5. 1761, our author communicated to the Royal Society an account of the Transit of Venus, June 6. 1761, observed in Spital-square. M. Canton's next communication to the Society, was a letter addressed to Dr Benjamin Franklin, and read Feb. 4. 1762; containing some remarks on Mr Delaval's electrical experiments. On Dec. 16. in the same year, another curious addition was made by him to philosophical knowledge, in a paper entitled, "Experiments to prove that water is not incompressible." These experiments are a complete refutation of the famous Florentine experiments, which so many philosophers have mentioned as a proof of the incompressibility of water. On St Andrew's day, 1763, our author was the third time elected one of the council of the Royal Society: and on Nov. 8. in the following year, were read before that learned body, his farther "Experiments and observations on the compressibility of water, and some other fluids." The establishment of this fact, in opposition to the received opinion, formed on the hasty decision of the Florentine Academy, was thought to be deserving of the Society's gold medal. It was accordingly moved for in the council of 1764; and after several invidious delays, which terminated much to the honour of Mr Canton, it was presented to him Nov. 30. 1766.

The next communication of our ingenious author to the Royal Society, which we shall take notice of in this place, was on Dec. 22. 1763, being "An easy method of making a Phosphorus that will imbibe and emit light like the Bolognian stone; with experiments and observations." When he first showed to Dr Franklin the instantaneous light acquired by some of this phosphorus from the near discharge of an electrified bottle, the doctor immediately exclaimed, "And God said, Let there be light, and there was light." The dean and chapter of St Paul's having, in a letter to the president, dated March 5. 1769, requested the opinion of the Royal Society relative to the best and most effectual method of fixing electrical conductors to preserve that cathedral from damage by lightning, Mr Canton was one of the committee appointed to take the letter into consideration, and to report their opinion upon it. The gentlemen joined with him in this business were, Dr Watson, Dr Franklin, Mr Delaval, and Mr Wilson. Their report was made on the 8th of June following; and the mode recommended by them has been carried into execution. The last paper of our author's, which was read before the Royal Society, was on Dec. 21. 1769; and contained "Experiments to prove that the Luminousness of the Sea arises from the putrefaction of its animal substances." In the account now given of his communications to the public, we have chiefly confined ourselves to such as were the most important, and which threw new and distinguished light on various objects in the philosophical world. Besides these he wrote a number of papers both in earlier and in later life, which appeared in several different publications, and particularly in the Gentleman's Magazine.

The close and sedentary life of Mr Canton, arising from an unremitted attention to the duties of his profession, and to the prosecution of his philosophical inquiries and experiments, probably contributed to shorten his days. The disorder into which he fell, and which carried him off, was a dropsy. His death happened on March 22. 1772, in the 54th year of his age.

CANTONING, in the military art, is the allotting distinct and separate quarters to each regiment: the town where they are quartered being divided into as many cantons as there are regiments.

CANTRED, or CANTRETH, signifies a hundred villages. It is a British word, compounded of the adjective *cant*, i. e. hundred; and *tref*, a town or village. In Wales some of the counties are divided into cantreds, as in England into hundreds.

CANTYRE, from *Cantierre*, signifying a "headland;" the southern division of the shire of Argyle in Scotland. It is a peninsula, stretching 27 miles from north to south, and seven miles in breath. It is mostly plain, arable, and populous; inhabited promiscuously by Highlanders and Lowlanders, the latter being invited to settle in this place by the Argyle family, that the lands might be the better cultivated. It gives the title of *marquis* to the duke, and is by Lochfyn divided from Argyle Proper. This loch is an inlet from the sea, about 60 miles in length and four in breadth, celebrated for its herring fishery. There are many paltry villages in this country, but no town of any consequence except Campbelltown.

Cantyre was granted to the house of Argyle after the suppression of a rebellion of the Macdonalds of the Isles (and it is supposed of this peninsula) in the beginning of the last century, and the grant was afterwards ratified by parliament. The ancient inhabitants were the Mac-donalds, Mac-eachrans, Mac-kays, and Mac-maths.

Mull of CANTYRE, the south cape or promontory of the peninsula. There is here a lighthouse 235 feet above the sea at high water, situated on the rocks called the *Merchants*. Lat. 55. 22. Long. 5. 42. west of London. The sound of Isla from the lighthouse bearing, by the compass, N. by E. distant 27 miles; the south end of Isla N. N. W. distant 25 miles; the north end of Rathlin island, N. W. by W. one half W.; the Maiden Rocks, S. by W. one half W. distant 14 miles; Copland light, S. by W. one half W. distant

distant 31 miles. The lanthorn is seen from N. N. E. 1-4th E. from S. by W. 1-4th W. and intermediate points of the compass N. of these two points.

CANTZ, a town of Silesia in Germany. E. Long. 16. 36. N. Lat. 51. 6.

CANVAS, in *Commerce*, a very clear unbleached cloth of hemp, or flax, wove regularly in little squares. It is used for working tapestry with the needle, by passing the threads of gold, silver, silk, or wool, through the intervals or squares.

CANVAS is also a coarse cloth of hemp, unbleached, somewhat clear, which serves to cover women's stays, also to stiffen men's clothes, and to make some other of their wearing apparel, &c.

CANVAS is also used among the French for the model or first words whereon an air or piece of music is composed, and given to a poet to regulate and finish. The canvas of a song contains certain notes of the composer, which shew the poet the measure of the verses he is to make. Thus Du Lot says, he has canvas for ten sonnets against the Muses.

CANVAS is also the name of a cloth made of hemp, and used for ship sails.

CANVAS, among painters, is the cloth on which they usually draw their pictures; the canvas being smoothed over with a slick stone, then sized, and afterwards whited over, makes what the painters called their *primeo cloth*, on which they draw their first sketches with coal or chalk, and afterwards finish with colours.

CANULA, in *Surgery*, a tube made of different metals, principally of silver and lead, but sometimes of iron.

They are introduced into hollow ulcers, in order to facilitate a discharge of pus or any other substance: or into wounds, either accidental or artificial, of the large cavities, as the thorax or abdomen: they are used in the operation of bronchotomy; and by some, after the cutting for the stone, as a drain for urine.

Other canulas are used for introducing cauteries, either actual or potential, into hollow parts, in order to guard the parts adjacent to that to be cauterized, from injury. They are of various figures; some being oval, some round, and some crooked.

CANUSIUM, in *Ancient Geography*, a town of Apulia, on the right or south side of the Aufidus, to the west of Cannæ, whither the Romans fled after the defeat sustained there. It was famous for its red shining wool; whence those who wore clothes made of it were called *Canusinati*. Now called CANOSA; which see.

CANUTE, the first Danish king of England after Ironside. He married Emma, widow of King Ethelred; and put to death several persons of quality who stood in his way to the crown. Having thus settled his power in England, he made a voyage to his other kingdom of Denmark, in order to resist the attacks of the king of Sweden; and he carried along with him a great body of the English under the command of the earl of Godwin. This nobleman had there an opportunity of performing a service by which he both reconciled the king's mind to the English nation, and gaining to himself the friendship of his sovereign, laid the foundation of that immense fortune which he acquired to his family. He was stationed next the Swedish camp; and observing a favourable opportunity which he was obliged suddenly to seize, he attacked the enemy in the night, drove them suddenly from their trenches, threw them into disorder, pursued his advantage, and obtained a decisive victory over them. Next morning, Canute, seeing the English camp entirely abandoned, imagined that these disaffected troops had deserted to the enemy; and he was agreeably surprised to find that they were at that time engaged in pursuit of the discomfited Swedes. He was so pleased with this success, and the manner of obtaining it, that he bestowed his daughter in marriage upon Godwin, and treated him ever after with the most entire confidence and regard.

In another voyage which he afterwards made to Denmark, Canute attacked Norway, and expelled the just but unwarlike Olaus from his kingdom, of which he kept possession till the death of that prince. He had now by his conquests and valour attained the utmost height of his ambition, and having leisure from wars and intrigues, he felt the unsatisfactory nature of all human enjoyments: and equally weary of the glory and turmoils of this life, he began to cast his view towards that future existence, which it is so natural for the human mind, whether satiated by prosperity, or disgusted with adversity, to make the object of its attention. Unfortunately the spirit which prevailed in that age gave a wrong direction to his devotion; and, instead of making atonement to those whom he had formerly injured by his acts of violence, he entirely employed himself in those exercises of piety, which the monks represented as most meritorious. He built churches; he endowed monasteries; he enriched ecclesiastics; and he bestowed revenues for the support of chantries at Assington and other places, where he appointed prayers to be said for the souls of those who had there fallen in battle against him. He even undertook a pilgrimage to Rome, where he sojourned a considerable time; and, besides obtaining from the pope some privileges for the English school erected there, he engaged all the princes through whose dominions he was obliged to pass, to desist from these heavy impositions and tolls which they were accustomed to exact from the English pilgrims. By this spirit of devotion, no less than by his equitable and politic administration, he gained in a good measure the affections of his subjects.

Canute, who was the greatest and most powerful prince of his time, sovereign of Denmark and Norway as well as of England, could not fail to meet with adulation from his courtiers; a tribute which is liberally paid even to the meanest and weakest of princes. Some of his flatterers breaking out one day in admiration of his grandeur, exclaimed that every thing was possible for him: upon which the monarch, it is said, ordered a chair to be set on the sea shore while the tide was making; and as the waters approached, he commanded them to retire, and obey the voice of him who was lord of the ocean. He feigned to sit some time in expectation of their submission; but when the sea still advanced towards him, and began to wash him with its billows, he turned to his courtiers, and remarked to them, That every creature in the universe was feeble and impotent, and that power resided with one Being alone, in whose hands were all the elements of nature, who could say to the ocean, "Thus far shalt thou go, and no farther," and who could level with his nod the most towering piles of human pride and

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and ambition. From that time, it is said, he never would wear a crown. He died in the 20th year of his reign, and was interred at Winchester, in the old monastery.

CANZONE, in *Music*, signifies, in general, a song, where some little fugues are introduced; but it is sometimes used for a sort of Italian poem, usually pretty long, to which music may be composed in the style of a cantata. If this term be added to a piece of instrumental music, it signifies much the same as cantata; if placed in any part of a sonata, it implies the same meaning as *allegro*, and only denotes that the part to which it is prefixed is to be played or sung in a brisk and lively manner.

CANZONETTA, a diminutive of canzone, denoting a little short song. The canzonette Neapolitane has two strains, each whereof is sung twice over, as the vaudevilles of the French. The canzonette Siciliane is a species of jig, the measure whereof is usually twelve eighths, and six eighths, and sometimes both, as rondeaus.

CAORLO, a small island in the gulf of Venice, on the coast of Friuli, 20 miles south-west of Aquileia, subject to Venice. It has a town of the same name, with a bishop's see.

CAOUTCHOUC, Elastic Resin, or *India rubber*, a substance produced from the syringe tree of Cayenne and other parts of South America, and possessed of the most singular properties. No substance is yet known which is so pliable, and at the same time so elastic; and it is farther a matter of curiosity, as being capable of resisting the action of very powerful menstrua. From the account of M. de la Condamine, we learn that this substance oozes out, under the form of a vegetable milk, from incisions made in the tree; and that it is gathered chiefly in time of rain, because, though it may be collected at all times, it flows then most abundantly. The means employed to inspissate and indurate it, M. de la Borde says, are kept a profound secret. M. Bomare, and others, affirm, that it thickens and hardens gradually by being exposed to the air; and as soon as it acquires a solid consistence it manifests a very extraordinary degree of flexibility and elasticity. Accordingly the Indians make boots of it which water cannot penetrate, and which, when smoked, have the appearance of real leather. Bottles are also made of it, to the necks of which are fastened hollow reeds, so that the liquor contained in them may be squirted through the reeds or pipes by pressure. One of these filled with water is always presented to each of the guests at their entertainments, who never fail to make use of it before eating. This whimsical custom led the Portuguese in that country to call the tree that produced the resin *pao di xirringa*; and hence the name of *seringat* is given both to the tree and to its resinous production. Flambeaux, an inch and a half in diameter, and two feet long, are likewise made of this resin, which give a beautiful light, have no bad smell, and burn twelve hours. A kind of cloth is also prepared from it, which the inhabitants of Quito apply to the same purpose as our oil cloth and sail cloth. It is formed, in fine, by means of moulds, into a variety of figures for use and ornament; and the process is said to be thus:—The juice, which is obtained by incision, is spread over pieces of clay formed into the desired shape; and as fast as one layer is dry, another is added, till the vessel be of the proper thickness; the whole is then held over a strong smoke of vegetables on fire, whereby it hardens into the texture and appearance of leather; and before the finishing, while yet soft, is capable of having any impression made on the outside, which remains for ever after. When the whole is done, the inside mould is picked out.

Since this resin has been known in Europe, its chemical qualities and other interesting properties have been very diligently investigated. In particular, it has been endeavoured to discover some method of dissolving it in such a manner that it would assume different figures, with equal ease as when in its original fluid state. In the memoirs of the Academy of Sciences for 1768, we have an account of several attempts for this purpose, and how it may be effected.—The state of vegetable milk in which the caoutchouc resin is found when it comes from the tree, led M. Macquer to imagine that it was composed of an oil and a watery matter. From its wanting aromatic flavour, from its little volatility, and from its being incapable of solution in spirit of wine, he concluded that the oil which entered its composition was not an essential, but a fatty one. Hence he thought it probable that it passed from a fluid to a solid form by the evaporation of the watery part, and that the oily solvents would reduce it to a soft state. The first trials he made for dissolving it were with linseed oil, essence of turpentine, and several others. But all he could obtain by means of these menstrua was a viscid substance, incapable of being hardened, and totally void of elasticity. The rectified essential oil of turpentine was employed seemingly with greater success. To separate from this menstruum the caoutchouc which it had dissolved, M. Macquer added spirit of wine; but the consequence was, that part only of the oil united with the spirit; the rest remaining obstinately attached to the resin which it had dissolved, and thus preventing it from assuming a solid consistence. The author next endeavoured to dissolve it by means of heat in Papin's digester. But neither water, nor spirit of wine, although in this way capable of dissolving the hardest bones, could produce any other effect upon it than to render it more firm than before. After this, he tried what effect the milky juice of other vegetables would have upon it. He used several kinds, particularly that of the fig. But, in this way, he could obtain no solution. From the great volatility of ether, he was next induced to try it as a menstruum; and, for this purpose, he prepared some with great attention. The caoutchouc, cut into little bits, and put into a proper vessel with so much ether as was sufficient to cover it, was perfectly dissolved without any other heat than that of the atmosphere. This solution was transparent and of an amber colour. It still preserved the smell of ether, but mixed with the disagreeable odour of the caoutchouc, and it is a little less fluid than pure ether. Upon its being thrown into water, no milky liquor was produced; but there arose to the surface a solid membrane, which possessed the great elasticity and other peculiar properties of the caoutchouc. He observes, however, that two pints of the best ether, obtained by rectifying eight or ten pints of the common ether by a gentle heat, must be used, in order to the success of the operation.

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Caoutchouc.

ration.—The distinguishing properties of this substance, viz. its solidity, flexibility, and elasticity, and its quality of resisting the action of aqueous, spirituous, saline, oily, and other common solvents, render it extremely fit for the construction of tubes, catheters, and other instruments, in which these properties are wanted. In order to form this resin into small tubes, M. Macquer prepared a solid cylindrical mould of wax, of the desired size and shape; and then dipping a pencil into the ethereal solution of the resin, daubed the mould over with it, till he had covered it with a coat of resin of a sufficient thickness. The whole piece is then thrown into boiling water; by the heat of which the wax is soon melted, and rises to the surface, leaving the resinous tube completely formed behind.

Grossart informs us, that he has succeeded very well in employing the essential oils of turpentine and lavender as a solvent for the elastic gum, and thus forming it into tubes or giving it any shape that is wanted. When the elastic tube is prepared with oil of lavender, the latter may be separated by immersing the tube in alcohol, which charges itself with the oil, and becomes a good lavender water. Alcohol serves another purpose beside taking up the essential oil. It accelerates very much the drying of caoutchouc instruments which are thus formed. Oil of turpentine appeared always to have a kind of stickiness; and the smell which could not be got rid of, by any means yet discovered, was another inconvenience.

Grossart proposes another solvent, which is easily procured, and is not liable to the inconvenience just mentioned. This solvent is *water*. "I conceive (says he) it will appear strange to mention water as a solvent of elastic gum, that liquid having been always supposed to have no action upon it. I myself resisted the idea; but reflecting that ether, by being saturated with water, is the better enabled to act on caoutchouc, and that this gum when plunged into boiling water becomes more transparent at the edges, I presumed that this effect was not due simply to the dilatation of its volume by the heat. I thought that, at that temperature, some action might take place, and that a long continued ebullition might produce more sensible effects. I was not disappointed in my expectations, and one of those tubes was prepared without any other solvent than water and heat. I proceeded in the same manner as with ether: the elastic gum dilates but very little in boiling water; it becomes whitish, but recovers its colour again by drying it in the air and light. It is sufficiently prepared for use when it has been a quarter of an hour in boiling water: by this time its edges are somewhat transparent. It is to be turned spirally round the mould, in the manner we described before, and replunged frequently into the boiling water, during the time that is employed in forming the tube, to the end that the edges may be disposed to unite together. When the whole is bound with packthread, it is to be kept some hours in boiling water; after which it is to be dried, still keeping on the binding.

"If we wish to be more certain that the connexion is perfect, the spiral may be doubled; but we must always avoid placing the exterior surfaces of the slips one upon the other, as those surfaces are the parts which most resist the action of solvents. This precaution is less necessary when ether is employed, on account of its great action upon the caoutchouc.

"It might be feared that the action of water upon caoutchouc would deprive us of the advantages which might otherwise be expected: but these fears will be removed, if we consider that the affinities differ according to the temperatures; that it is only at a very high temperature that water exercises any sensible action upon caoutchouc. I can affirm, that at 120° of Reaumur's thermometer (302° of Fahrenheit) this affinity is not such as that the water can give a liquid form to caoutchouc; and it does not appear that we have any thing to fear in practice from a combination between these two bodies, which, though it really is a true solution, does not take place in any sensible degree but at a high temperature. It is therefore at present easy to make of caoutchouc whatever instruments it may be advantageous to have of a flexible, supple, and elastic substance, which is impermeable to water at the temperature of our atmosphere, and resists the action of acids as well as that of most other solvents. As to the durability of these instruments, few substances promise more than this, because it may be soldered afresh in a damaged part. Any woven substance may be covered with it; it is only required that the substance should be of a nature not to be acted upon during the preparation, either by ether or by boiling water; for these two agents are those which appear to me to merit the preference. Artists will frequently find an advantage in employing ether, as it requires less time; so that a person may make, in a single day, any tube he may have occasion for. The expence of ether is very little, since it is needful only to dispose the caoutchouc to adhere; and being brought into that state, the caoutchouc may be kept in a vessel perfectly well closed. It would also diminish the expence of the ether, if, instead of washing it with a large quantity of water, there should be added to it only as much water as it can take up." *Annales de Chimie*, vol. xi. p. 149.

A resin similar to this was some years ago discovered by M. Poivre, in the isle of France; and there are various milky juices extracted from trees in America and elsewhere, which by previous mixtures and preparations are formed into an elastic resin, but of an inferior quality to that of Cayenne; such, for instance, are the juices obtained from the *Cecropia peltata*, the *Ficus religiosa* and *Indica*, &c.

Of the genuine trees, those growing along the banks of the river of the Amazons are described by M. Condamine as attaining a very great height, being at the same time perfectly straight, and having no branches except at top, which is but small, covering no more than a circumference of ten feet. Its leaves bear some resemblance to those of the *manioc*: they are green on the upper part, and white beneath. The seeds are three in number, and contained in a pod consisting of three cells, not unlike those of the *ricinus* or *palma Christi*; and in each of them there is a kernel, which being stripped and boiled in water, produces a thick oil or fat, answering the purpose of butter in the cookery of that country.

A method of dissolving this elastic gum without ether, for the purposes of a varnish or the like, is as follows: Take one pound of the spirit of turpentine, and a

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a pound of the gum cut into very small pieces; pour the turpentine into a long-necked matrass, which must be placed in a sand-bath; throw in the gum, not all at once, but by little and little according as it is perceived to dissolve: When it is entirely dissolved, pour into the matrass a pint of nut or linseed oil, or oil of poppies, rendered desiccative in the usual manner with litharge: Then let the whole boil for a quarter of an hour, and the preparation is finished. This would make an excellent varnish for air balloons, were it not so expensive on account of the price of the gum. —Another method, invented by Mr Baldwin, is as follows. Take any quantity of the caoutchouc, as two ounces avoirdupois: cut it into small bits with a pair of scissars. Put a strong iron ladle (such as plumbers and glaziers melt their lead in) over a common pit-coal or other fire. The fire must be gentle, glowing, and without smoke. When the ladle is hot, much below a red heat, put a single bit into the ladle. If black smoke issues, it will presently flame and disappear; or it will evaporate without flame: the ladle is then too hot. When the ladle is less hot, put in a second bit, which will produce a white smoke. This white smoke will continue during the operation, and evaporate the caoutchouc: therefore no time is to be lost; but little bits are to be put in, a few at a time, till the whole are melted. It should be continually and gently stirred with an iron or brass spoon. Two pounds, or one quart, of the best drying oil (or of raw linseed oil, which, together with a few drops of neats foot oil, has stood a month, or not so long, on a lump of quicklime, to make it more or less drying) is to be put into the melted caoutchouc, and stirred till hot: and the whole poured into a glazed vessel, through a coarse gauze, or fine sieve. When settled and clear, which will be in a few minutes, it is fit for use, either hot or cold.

The Abbé Clavigero informs us, that the elastic gum is called by the Mexicans *Ollin* or *Olli*, and by the Spaniards of that kingdom *Ule*: That it distils from the olquahuitl, which is a tree of moderate size; the trunk of which is smooth and yellowish, the leaves pretty large, the flowers white, and the fruit yellow and rather round, but angular; within which there are kernels as large as filberts, and white, but covered with a yellowish pellicle: That the kernel has a bitter taste, and the fruit always grows attached to the bark of the tree: That when the trunk is cut, the ule which distils from it is white, liquid, and viscous; afterwards it becomes yellow; and lastly of a leaden colour, though rather blacker, which it always retains. The tree, he adds, is very common in the kingdom of Guatimala.

Different trees, it would appear, yield the elastic gum. Aublet, in his *Histoire des Plantes de la Guiane* (p. 871.), describes the tree, the fruit, and manner of collecting the juice; but never saw the flower: he calls it, however, *Hevea Guianensis*. In Jacquin's America, it is called *Echites Corymbosa*. The younger Linnæus, in his *Supplementum Plantarum* (p. 422), names it *Jatropha Elastica*; but acknowledges that he only gives it this name from the structure of the fruit having most resemblance to that genus, his dry species wanting the flowers.

Of the above gum, it is said, the Chinese make elastic rings for lascivious purposes.—Among us it is used by surgeons for injecting liquids, and by painters for rubbing out black lead pencil marks, &c.

CAP, a part of dress made to cover the head, much in the figure thereof.

The use of caps and hats is referred to the year 1449, the first seen in these parts of the world being at the entry of Charles VII. into Rouen: from that time they began to take place of the hoods, or chaperoons, that had been used till then. When the cap was of velvet, they called it *mortier;* when of wool, simply *bonnet*. None but kings, princes, and knights, were allowed the use of the mortier. The cap was the head-dress of the clergy and graduates. Pasquier says, that it was anciently a part of the hood worn by the people of the robe; the skirts whereof being cut off as an encumbrance, left the round cap an easy commodious cover for the head; which round cap being afterwards assumed by the people, those of the gown changed it for a square one, first invented by a Frenchman, called Patrouillet: he adds, that the giving of the cap to the students in the universities, was to denote, that they had acquired full liberty, and were no longer subject to the rod of their superiors; in imitation of the ancient Romans, who gave a *pileus*, or cap, to their slaves, in the ceremony of making them free: whence the proverb, *Vocare servos ad pileum.* Hence, also, on medals, the cap is the symbol of Liberty, whom they represent holding a cap in her right hand, by the point.

The Romans were many ages without any regular covering for the head: when either the rain or sun was troublesome, the lappet of the gown was thrown over the head; and hence it is that all the ancient statues appear bareheaded, excepting sometimes a wreath, or the like. And the same usage obtained among the Greeks, where, at least during the heroic age, no caps were known. The sort of caps or covers of the head in use among the Romans, on divers occasions, were the *pitra*, *pileus*, *cucullus*, *galerus*, and *palliolum;* the differences between which are often confounded by ancient as well as modern writers.

The French clergy wear a shallow kind of cap, called *calotte*, which only covers the top of the head, made of leather, satin, worsted, or other stuff. The red cap is a mark of dignity, allowed only to those who are raised to the cardinalate. The secular clergy are distinguished by black leathern caps, the regulars by knit and worsted ones.

Churchmen, and the members of universities, students in law, physic, &c. as well as graduates, wear square caps. In most universities doctors are distinguished by peculiar caps, given them in assuming the doctorate. Wickliff calls the canons of his time *bifurcati*, from their caps. Pasquier observes, that, in his time, the caps worn by the churchmen, &c. were called square caps; though, in effect, they were round yellow caps.

The Chinese have not the use of the hat, like us; but wear a cap of a peculiar structure, which the laws of civility will not allow them to put off: it is different for the different seasons of the year: that used in summer is in form of a cone, ending at top in a point. It is made of a very beautiful kind of mat, much valued in that country, and lined with satin; to this is added,

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added, at top, a large lock of red silk, which falls all round as low as the bottom; so that, in walking, the silk fluctuating regularly on all sides, makes a graceful appearance: sometimes, instead of silk, they use a kind of bright red hair, the lustre whereof no weather effaces. In winter they wear a plush cap, bordered with martlet's or fox's skin: as to the rest, like those for the summer. These caps are frequently sold for eight or ten crowns; but they are so short, that the ears are exposed.

The cap is sometimes used as a mark of infamy; in Italy the Jews are distinguished by a yellow cap; at Lucca by an orange one. In France, those who had been bankrupts were obliged ever after to wear a green cap, to prevent people from being imposed on in any future commerce. By several arrets in 1584, 1622, 1628, 1688, it was decreed, that if they were at any time found without their green cap, their protection should be null, and their creditors empowered to cast them into prison: but the sentence is not now executed.

Cap *of Maintenance*, one of the regalia, or ornaments of state, belonging to the kings of England, before whom it was carried at the coronation and other great solemnities. Caps of maintenance are also carried before the mayors of the several cities in England.

Cap and Button, are two small islands, lying in longitude 105° 48′ 30″ east; and in latitude, the former 5° 58′ 30″, the latter 5° 49′ south. They are thus described by Sir George Staunton:

"At a little distance they might be mistaken for the remains of old castles, mouldering into heaps of ruins, with tall trees already growing upon the tops; but at a nearer view, they betrayed evident marks of a volcanic origin. Explosions from subterraneous fires, produce, for the most part, hills of a regular shape, and terminating in truncated cones; but when from a subaqueous volcano eruptions are thrown up above the surface of the sea, the materials, falling back into the water, are more irregularly dispersed, and generally leave the sides of the new creation naked and mishapen, as in the instance of Amsterdam, and of those smaller spots called, from some resemblance in shape, the Cap and Button.

"In the Cap were found two caverns, running horizontally into the side of the rock; and in these were a number of those birds nests so much prized by the Chinese epicures. They seemed to be composed of fine filaments cemented together by a transparent viscous matter, not unlike what is left by the foam of the sea upon stones alternately covered by the tide, or those gelatinous animal substances found floating on every coast. The nests adhere to each other, and to the sides of the cavern, mostly in rows, without any break or interruption. The birds that build these nests are small grey swallows, with bellies of a dirty white. They were flying about in considerable numbers; but they were so small and their flight so quick, that they escaped the shot fired at them. The same nests are said also to be found in deep caverns, at the foot of the highest mountains in the middle of Java, and at a distance from the sea, from which the birds, it is thought, derive no materials, either for their food or the construction of their nests; as it does not appear probable they should fly, in search of either, over the intermediate mountains, which are very high, or against the boisterous winds prevailing thereabouts. They feed on insects, which they find hovering over stagnated pools between the mountains, and for catching which their wide-opening beaks are particularly adapted. They prepare their nests from the best remnants of their food. Their greatest enemy is the kite, who often intercepts them in their passage to and from the caverns, which are generally surrounded with rocks of gray limestone or white marble. The nests are placed in horizontal rows at different depths, from 50 to 500 feet. The colour and value of the nests depend on the quantity and quality of the insects caught, and perhaps also on the situation where they are built. Their value is chiefly determined by the uniform fineness and delicacy of their texture; those that are white and transparent being most esteemed, and fetching often in China their weight in silver. These nests are a considerable object of traffic among the Javanese, and many are employed in it from their infancy. The birds having spent near two months in preparing their nests, lay each two eggs, which are hatched in about fifteen days. When the young birds become fledged, it is thought time to seize upon their nests, which is done regularly thrice a-year, and is effected by means of ladders of bamboo and reeds, by which the people descend into the cavern; but when it is very deep, rope ladders are preferred. This operation is attended with much danger; and several break their necks in the attempt. The inhabitants of the mountains generally employed in it begin always by sacrificing a buffalo; which custom is constantly observed by the Javanese on the eve of every extraordinary enterprise. They also pronounce some prayers, anoint themselves with sweet-scented oil, and smoke the entrance of the cavern with gum-benjamin. Near some of those caverns a tutelar goddess is worshipped, whose priest burns incense, and lays his protecting hands on every person preparing to descend into the cavern. A flambeau is carefully prepared at the same time, with a gum which exudes from a tree growing in the vicinity, and is not easily extinguished by fixed air or subterraneous vapours. The swallow, which builds those nests, is described as not having its tail feathers marked with white spots, which is a character attributed to it by Linnæus; and it is possible that there are two species or varieties of the swallow, whose nests are alike valuable *."

* Embassy to China.

Cap, in ship-building, a strong thick block of wood, used to confine two masts together, when one is erected at the head of the other in order to lengthen it. It is for this purpose furnished with two holes perpendicular to its length and breadth, and parallel to its thickness: one of these is square, and the other round: the former being solidly fixed upon the upper end of the lower mast, whilst the latter receives the mast employed to lengthen it, and secures it in this position.

CAPACIO, an episcopal town of Italy in the kingdom of Naples, and in the Hither Principato. E. Long. 15. 18. N. Lat. 40. 40.

CAPACITY, in a general sense, an aptitude or disposition to hold or retain any thing.

Capacity, in *Geometry*, is the solid contents of any body;

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body; also our hollow measures for wine, beer, corn, salt, &c. are called *measures of Capacity*.

Capacity, in *Law*, the ability of a man, or body politic to give or take lands or other things, or sue actions.

Our law allows the king two capacities; a natural, and a political: in the first, he may purchase lands to him and his heirs; in the second, to him and his successors. The clergy of the church of England have the like.

CAPARASON, or Caparison, the covering or clothing laid over a horse; especially a sumpter horse, or horse of state. The word is Spanish, being an augmentative of *capa*, *caput*, *head*.

Anciently the caparasons were a kind of iron armour, wherewith horses were covered in battle.

CAPE, in *Geography*, a high land running out with a point into the sea, as Cape Nord, Cape Horn, the Cape of Good Hope, &c.

Cape Elk. See Cervus, Mammalia *Index*.

Cape Breton. See Breton.

Cape Coast Castle. See Coast.

Cape of Good Hope. See Good Hope.

Cape Verd. See Verd.

CAPELL, Edward, a gentleman well known by his indefatigable attention to the works of Shakespeare, was a native of the county of Suffolk, and received his education at the school of St Edmund's Bury. In the dedication of his edition of Shakespeare, in 1768, to the duke of Grafton, he observes, that "his father and the grandfather of his grace were friends, and to the patronage of the deceased nobleman he owed the leisure which enabled him to bestow the attention of 20 years on that work." The office which his grace bestowed on Mr Capell was that of deputy-inspector of the plays, to which a salary is annexed of 200l. a-year. So early as the year 1745, as Mr Capell himself informs us, shocked at the licentiousness of Hanmer's plan, he first projected an edition of Shakespeare, of the strictest accuracy, to be collated and published in due time, *ex fide codicum*. He immediately proceeded to collect and compare the oldest and scarcest copies; noting the original excellencies and defects of the rarest quartos, and distinguishing the improvements or variations of the first, second, and third folios: and after many years labour produced a very beautiful small octavo, in 10 volumes, with an "Introduction." There is not, the authors of the Monthly Review observe, among the various publications of the present literary era, a more singular composition than that "Introduction." In style and manner it is more obsolete and antique than the age of which he treats. It is Lord Herbert of Cherbury, walking the new pavement in all the trappings of romance; but, like Lord Herbert, it displays many valuable qualities accompanying this air of extravagance, much sound sense, and appropriate erudition. In the title-page of "Mr William Shakespeare, his Comedies, Histories, and Tragedies," it was also announced and promulgated, "Whereunto will be added, in some other volumes, notes critical and explanatory, and a body of various readings entire." "The Introduction" likewise declared, that these "notes and various readings" would be accompanied with another work, disclosing the sources from which Shakespeare "drew the greater part of his knowledge in mythological and classical matters, his fable, his history, and even the seeming peculiarities of his language—to which," says Mr Capell, "we have given for title, The School of Shakespeare." Nothing surely could be more properly conceived than such designs; nor have we ever met with any thing better grounded on the subject of "the learning of Shakespeare," than what may be found in the long note to this part of Mr Capell's Introduction. It is more solid than even the popular "Essay" on this topic. Certain quaintnesses of style, and peculiarities of printing and punctuation, attended the whole of this publication. The outline, however, was correct; and the critic, with unremitting toil, succeeded in his undertaking. But while he was diving into the classics of Caxton (to continue the Reviewer's account), and working his way under ground, like the river Mole, in order to emerge with all his glories; while he was looking forward to his triumphs, certain other active spirits went to work upon his plan; and, digging out the promised treasures, laid them prematurely before the public, defeating the effect of our critic's discoveries by anticipation. Steevens, Malone, Farmer, Percy, Reed, and a whole host of literary ferrets, burrowed into every hole and corner of the warren of modern antiquity, and overran all the country, whose map had been delineated by Edward Capell. Such a contingency nearly staggered the steady and unshaken perseverance of our critic, at the very eve of the completion of his labours, and as his editor informs us—for, alas! at the end of near 40 years, the publication was posthumous, and the critic himself no more!—he was almost determined to lay the work wholly aside. He persevered, however, by the encouragement of some noble and worthy persons; and to such their encouragement, and his perseverance, the public was, in 1783, indebted for three large volumes in 4to. under the title of "Notes and various readings of Shakespeare; together with the School of Shakespeare, or Extracts from divers English Books that were in print in the Author's time; evidently showing from whence his several Fables were taken, and some parcel of his Dialogue. Also farther extracts, which contribute to a due understanding of his Writings, or give a light to the History of his Life, or to the Dramatic History of his Time. By Edward Capell."—Besides the works already mentioned, Mr Capell was the editor of a volume of ancient poems called "Prolusions;" and the alteration of "Anthony and Cleopatra," as acted at Drury Lane in 1758. He died January 24. 1781.

CAPELLA, in *Astronomy*, a bright fixed star in the left shoulder of the constellation Auriga.

CAPELLE, a town of France, in Picardy, in the department of Aisne, eight miles from Guise. It was taken by the Spaniards in 1636; but retaken the year after. E. Long. 3. 59. N. Lat. 49. 58.

CAPELLETS. See Farriery *Index*.

CAPELLUS, Lewis, an eminent French Protestant divine, born at Sedan in Champagne about the year 1579. He was the author of some learned works, but is chiefly known from the controversy he engaged in with the younger Buxtorf concerning the antiquity of Hebrew points, which Capellus undertook to disprove. His *Critica Sacra* was also an elaborate work,

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and excited some disputes. He died in 1658, having made an abridgement of his life in his work *De Gente Capellori*.

CAPER. See CAPPARIS, BOTANY *Index*.

CAPER also denotes a vessel used by the Dutch for cruising and taking prizes from the enemy; in which sense, caper amounts to the same with privateer. Capers are commonly double officered, and crowded with hands even beyond the rates of ships of war, because the thing chiefly in view is boarding the enemies.

CAPERNAUM, a city celebrated in the Gospels, being the place where Jesus usually resided during the time of his ministry. This city is nowhere mentioned in the Old Testament under this or any other name like it; and therefore it is not improbable that it was one of those towns which the Jews built after their return from the Babylonish captivity. It stood on the sea coast, i. e. on the coast of the sea of Galilee, in the borders of Zebulon and Nephtalim (Mat. iv. 15.), and consequently towards the upper part therof. It took its name no doubt from an adjacent spring, of great repute for its clear and limpid water; and which, according to Josephus, was by the natives called *Capernaum*. As this spring might be some inducement to the building the town in the place where it stood, so its being a convenient wafting place from Galilee to any part on the other side of the sea, might be some motive to our Lord for his moving from Nazareth, and making this the place of his most constant residence. Upon this account Capernaum was highly honoured, and said by our Lord himself to be *exalted unto heaven;* but because it made no right use of this signal favour, it drew from him the severe denunciation, that it should *be brought down to hell* (Matt. xi. 23.), which has certainly been verified: for, as Dr Wells observes, so far is it from being the metropolis of all Galilee, as it once was, that it consisted long since of no more than six poor fishermen's cottages, and may perhaps be now totally desolate.

CAPEROLANS, a congregation of religious in Italy, so called from Peter Caperole their founder, in the 15th century.

The Milanese and Venetians being at war, the enmity occasioned thereby spread itself to the very cloisters. The superiors of the province of Milan, of minor brothers, which extended itself as far as the territories of the republic of Venice, carried it so haughtily over the Venetians, that those of the convent of Brescia resolved to shake off a yoke which was grown insupportable to them. The superiors, informed of this, expelled out of the province those whom they considered as the authors of this design; the principal of whom were Peter Caperole, Matthew de Tharvillo, and Bonaventure of Brescia. Peter Caperole, a man of an enterprising genius, found means to separate the convents of Brescia, Bergamo, and Cremona, from the province of Milan, and subject them to the conventuals. This occasioned a law-suit between the vicar-general and these convents, which was determined in favour of the latter; and these convents, in 1475, by the authority of Pope Sextus IV. were erected into a distinct vicarate, under the title of that of *Brescia*. This not satisfying the ambition of Caperole, he obtained, by the interposition of the doge of Venice, that this vicarate might be erected into a congregation, which was called from him *Caperolans*. This congregation still subsists in Italy, and is composed of 24 convents, situated in Brescia, Bergamo, and Cremasco.

CAPEQUIN, a town of Ireland, in the county of Waterford, and province of Munster, situated on the river Blackwater. W. Long. 7. 50. N. Lat. 52. 5.

CAPESTAN, a town of France, in Lower Languedoc, in the diocese of Narbonne, and near the royal canal. E. Long. 3. 5. N. Lat. 43. 35.

CAPH, a Jewish measure of capacity for things, estimated by Kimchi at the 30th part of the log, by Arbuthnot at the 16th part of the hin or 32d of the seah, amounting to five-eighths of an English pint. The caph does not occur in Scripture, as the name of any measure.

CAPHAR, a duty which the Turks raised on the Christians who carry or send merchandises from Aleppo to Jerusalem and other places in Syria.

The duty of caphar was first imposed by the Christians themselves, when they were in possession of the Holy Land, for the maintenance of the troops which were planted in difficult passes to observe the Arabs and prevent their incursions. It is still continued, and much increased by the Turks, under pretence of defending the Christians against the Arabs; with whom, nevertheless, they keep a secret intelligence, favouring their excursions and plunders.

CAPHTOR, in *Ancient Geography*, a town or district of Higher Egypt; and hence the people called *Caphtorim* or *Caphtorei*.—Caphtor is an island of Egypt, Ai Caphtor (Jeremiah): probably one of those in the Nile. Dr Wells supposes it to be Coptos, which stood in a small island. Thence came the *Caphtorim* or *Caphtoræi*, in Palestine; who with the Philistines conspired to extirpate the Hevæi; and whose name was swallowed up in that of the Philistines.

CAPI-AGA, or CAPI-*Agassi*, a Turkish officer who is governor of the gates of the seraglio, or grand-master of the seraglio.

The capi-aga is the first dignity among the white eunuchs: he is always near the person of the grand signior: he introduces ambassadors to their audience: nobody enters or goes out of the grand signior's apartment but by his means. His office gives him the privilege of wearing the turban in the seraglio, and of going everywhere on horseback. He accompanies the grand signior to the apartment of the sultanas, but stops at the door without entering. His appointment is very moderate; the grand signior bears the expence of his table, and allows him at the rate of about sixty French livres per day; but his office brings him in abundance of presents; no affair of consequence coming to the emperor's knowledge without passing through his hand. The capi-aga cannot be bashaw when he quits his post.

CAPIAS, in *Law*, a writ of two sorts; one before judgment in an action, and the other after. That before judgment is called *capias ad respondendum*, where an original is issued out, to take the defendant, and make him answer the plaintiff. That after judgment is of divers kinds; as,

CAPIAS *ad Satisfaciendum*, a writ of execution, that issues on a judgment obtained, and lies where any person recovers in a personal action, as for debt, damages, &c.

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&c. in which cases this writ issues to the sheriff, commanding him to take the body of him against whom the debt is recovered, who is to be kept in prison till he makes satisfaction.

Capias Pro Fine is a writ lying where a person is fined to the king, for some offence committed against a statute, and he does not discharge the fine according to the judgment; therefore his body shall be taken by this writ, and committed to gaol till the fine is paid.

Capias Utlegatum, a writ which lies against any one outlawed, upon any action personal or criminal, by which the sheriff is ordered to apprehend the party outlawed, for not appearing on the exigent, and keep him in safe custody till the day of return, when he is ordered to present him to the court, to be there farther ordered for his contempt.

Capias in Withernam, a writ that lies for cattle *in withernam*: that is, where a distress taken is driven out of the county, so that the sheriff cannot make deliverance upon a replevin; then this writ issues, commanding the sheriff to take as many beasts of the distrainer, &c.

CAPIGI, a porter or doorkeeper of the Turkish seraglio. There are about five hundred *capigis* or porters in the seraglio, divided into two companies: one consisting of three hundred, under a chief called *Capigi-Bassa*, who has a stipend of three ducats per day; the other consists of two hundred, distinguished by the name of *Cuccicapigi*, and their chief *Cuccicapigi-Bassa*, who has two ducats. The capigis have from seven to fifteen aspers per day; some more, others less. Their business is to assist the janizaries in the guard of the first and second gates of the seraglio; sometimes all together; as when the Turk holds a general council, receives an ambassador, or goes to the mosque; and sometimes only in part: being ranged on either side to prevent people entering with arms, any tumults being made, &c. The word, in its original, signifies *gate*.

CAPILLAMENT, in a general sense, signifies a hair: whence the word is applied to several things, which on account of their length or their fineness resemble hairs: as,

Capillaments of the Nerves, in *Anatomy*, the fine fibres or filaments, whereof the nerves are composed.

CAPILLARY, in a general sense, an appellation given to things on account of their extreme fineness, or resembling hair.

Capillary Tubes in *Physics*, are small pipes of glass, whose canals are extremely narrow, their diameter being only a half, a third, or a fourth of a line.

The ascent of water, &c. in capillary tubes, is a phenomenon that has long embarrassed the philosophers; for let one end of a glass tube open at both extremities be immerged in water, the liquor within the tube will rise to a considerable height above the external surface: or if two or more tubes are immerged in the same fluid, one a capillary tube, and the other of a larger bore, the fluid will ascend higher in the former than in the latter; and this will be in a reciprocal ratio of the diameters of the tubes.

In order to account for this phenomenon, it will be necessary first to premise, that the attraction between the particles of glass and water is greater than the attraction between the particles of water themselves: for if a glass tube be placed in a position parallel to the horizon, and a drop of water be applied to the under side of the tube, it will adhere to it: nor will it fall from the glass till its bulk and gravity are so far increased, as to overcome the attraction of the glass. Hence it is easy to conceive how sensibly such a power must act on the surface of a fluid, not viscid, as water, contained within the small cavity or bore of a glass tube; as also that it will be proportionably stronger as the diameter of the bore is smaller; for it will be evident that the efficacy of the power is in the inverse proportion of the diameter, when it is considered that such particles only as are in contact with the fluid, and those immediately above the surface, can effect it.

Now these particles form a periphery contiguous to the surface, the upper part of which attracts and raises the surface, while the lower part, which is in contact with it, supports it: so that neither the thickness nor length of the tube is of any consequence here; the periphery of particles only, which is always proportionable to the diameter of the bore, is the only acting power. The quantity of the fluid raised will therefore be as the surface of the bore which it fills, that is, as the diameter; for otherwise the effect would not be proportional to the cause, since the quantities are always as the ratio of the diameters; the heights therefore to which the fluids will rise in different tubes, will be inversely as the diameters.

Some doubt whether the law holds throughout, of the ascent of the fluid being always higher as the tube is smaller: Dr Hook's experiments, with tubes almost as fine as cobwebs, seem to show the contrary. The water in these, he observes, did not rise so high as one would have expected. The highest he ever found it, was at 21 inches above the level of the water in the bason; which is much short of what it ought to have been by the law above mentioned. See Cohesion.

Capillary Vessels. Many small vessels of animal bodies have been discovered by the modern invention of injecting the vessels of animals, with a coloured fluid, which upon cooling grows hard. But though most anatomists know the manner of filling the large trunks, few are acquainted with the art of filling the capillaries. Dr Monro, in the Medical Essays, has given what, after many trials, he has found most successful. See Injection.

CAPILLUS veneris. See Adiantum, Botany *Index*.

CAPILUPI, or Capilupus, Camillus, a native of Mantua, in the 16th century. He wrote a book, entitled *The Stratagem*; in which he relates not only what was perpetrated at Paris during the massacre on St Bartholomew's day, but also the artful preparations which preceded that horrid massacre. It is, however, blended with a great number of falsities.

Capilupi, *Lalius*, an Italian poet, brother to the former, made himself famous by some Centos of Virgil. The manner in which he applied Virgil's expressions to represent things which the poet never dreamt of, is admired. His Cento against women is very ingenious, but too satirical. The poems of Capilupi are inserted in the *Deliciæ Poetarum Italorum*.

CAPISCOLUS,

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CAPISCOLUS, or CAPISCHOLUS, in ecclesiastical writers, denotes a dignitary in certain cathedrals, who had the superintendency of the choir, or band of music, answering to what in other churches is called *chanter* or *precentor*. The word is also written *cabiscolus*, and *caputscholæ*, q. d. the head of the school, or band of music.

The capiscolus is also called *scholasticus*, as having the instruction of the young clerks and choristers, how to perform their duty.

CAPITA, DISTRIBUTION BY, in *Law*, signifies the appointing to every man an equal share of a personal estate; when all the claimants claim in their own rights, as in equal degrees of kindred, and not *jure representationis*.

CAPITAL, of the Latin *caput* "the head," is used, on various occasions, to express the relation of a head, chief or principal: thus,

CAPITAL City, in *Geography*, denotes the principal city of a kingdom, state, or province.

CAPITAL Stock, among merchants, bankers, and traders, signifies the sum of money which individuals bring to make up the common stock of a partnership when it is first formed. It is also said of the stock which a merchant at first puts into trade for his account. It likewise signifies the fund of a trading company or corporation, in which sense the word stock is generally added to it. Thus we say, the capital stock of the bank, &c. The word capital is opposed to that of profit or gain, though the profit often increases the capital, and becomes of itself part of the capital, when joined with the former.

CAPITAL Crime, such a one as subjects the criminal to capital punishment, that is, to loss of life. *

*See *Crime* and *Punishment*.

CAPITAL Picture in *Painting*, denotes one of the finest and most excellent pieces of any celebrated master.

CAPITAL Letters, in *Printing*, large or initial letters, wherein titles, &c. are composed; with which all periods, verses, &c. commence; and wherewith also all proper names of men, kingdoms, nations, &c. begin. The practice which, for some time, obtained among our printers, of beginning every substantive with a capital, is now justly fallen into disrepute; being a manifest perversion of the design of capitals, as well as an offence against beauty and distinctness.

CAPITAL, *Succession by*, where the claimants are next in degree to the ancestor, in their own right, and not by right of representation.

CAPITAL, in *Architecture*, the uppermost part of a column, or pilaster, serving as the head or crowning, and placed immediately over the shaft, and under the entablature. See ARCHITECTURE.

CAPITANA, or CAPTAIN *Galley*, the chief or principally galley of a state, not dignified with the title of a kingdom. The capitana was anciently the denomination of the chief galley of France, which the commander went on board of. But since the suppression of the office of captain general of the galleys in 1669, they have no capitana, but the first galley is called *reale*, and the second *parone*.

CAPITANATA, one of the 12 provinces of the kingdom of Naples, in Italy, bounded on the north by the gulf of Venice, on the east by the Terra de Bari, on the south by the Basilicata and the Farther Principato, and on the west by the county di Molise and a small part of Hither Abruzzo. It is a level country, without trees, the soil sandy, the air hot: the land, however, near the rivers, is fertile in pastures. The capital town is Manfredonia.

CAPITANEATE, in a general sense, the same with capitania. Capitaneates, in Prussia, are a kind of noble feuds or estates, which, besides their revenue, raise their owners to the rank of nobility. They are otherwise called *starosties*.

CAPITANEI, or CATANEI, in Italy, was a denomination given to all the dukes, marquises, and counts, who were called *capitanei regis*. The same appellation was also given to persons of inferior rank who were invested with fees, formerly distinguished by the appellation *valasores majores*.

CAPITANEUS, in ancient law writers, denotes a tenant in capite or chief.

CAPITANEUS *Ecclesiæ*, the same with advocate.

CAPITANIA, in *Geography*, an appellation given to the 12 governments established by the Portuguese in the Brasils.

CAPITATION, a tax or imposition raised on each person, in proportion to his labour, industry, office, rank, &c. It is a very ancient kind of tribute. The Latins call it *tributum*, by which taxes on persons are distinguished from taxes on merchandise, which were called *vectigalia*.

Capitations are never practised among us but in exigencies of state. In France the capitation was introduced by Louis XIV. in 1695; and is a tax very different from the *taille*, being levied from all persons, whether they be subject to the taille or not. The clergy pay no capitation, but the princes of the blood are not exempted from it.

CAPITE, in *Law*, (from *caput*, i. e. *rex*; whence *tenere in capite* is to hold of the *king*, the *head* or lord paramount of all the lands in the kingdom): An ancient tenure of land, held immediately of the king, as of the crown, either by knight's service or by soccage. It is now abolished. See TENURE.

CAPITE Censi, in antiquity, the lowest rank of Roman citizens, who in public taxes were rated the least of all, being such as never were worth above 365 asses. They were supposed to have been thus called, because they were rather counted and marshalled by their heads than by their estates. The *capite censi* made part of the sixth class of citizens, being below the *proletarii*, who formed the other moiety of that class. They were not enrolled in the army, as being judged not able to support the expence of war; for in those days the soldiers maintained themselves. It does not appear that before Caius Marius any of the Roman generals listed the *capite censi* in their armies.

CAPITOL, CAPITOLIUM, in antiquity, a famous fort or castle, on the Mons Capitolinus at Rome, wherein was a temple dedicated to Jupiter, thence also denominated *Capitolinus*, in which the senate anciently assembled; and which still serves as the city-hall, or townhouse, for the meeting of the conservators of the Roman people.—It had its name *capitol*, from *caput*, "a man's head," said to have been found fresh, and yet bleeding, upon digging the foundation of the temple built in honour of Jupiter. Arnobius adds, that the man's name was *Tolus*, whence *caput tolium*. The first foundations

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foundations of the capitol were laid by Tarquin the Elder, in the year of Rome 139. His successor Servius raised the walls; and Tarquin the Proud finished it in the year 221. But it was not consecrated till the third year after the expulsion of the kings, and establishment of the consulate. The ceremony of the dedication of the temple was performed by the consul Horatius in 246.

The capitol consisted of three parts; a nave sacred to Jupiter, and two wings, the one consecrated to Juno, the other to Minerva; it was ascended to by stairs; the frontispiece and sides were surrounded with galleries, in which those who were honoured with triumphs entertained the senate at a magnificent banquet, after the sacrifice had been offered to the gods.

Both the inside and outside were enriched with an infinity of ornaments, the most distinguished of which was the statue of Jupiter with his golden thunderbolt, his sceptre, and crown. In the capitol also were a temple to Jupiter the Guardian, and another to Juno, with the mint; and on the descent of the hill was the temple of Concord. This beautiful edifice contained the most sacred deposits of religion, such as the ancilia, the books of the Sibyls, &c.

The capitol was burnt under Vitellius, and rebuilt under Vespasian. It was burnt a second time by lightning under Titus, and restored by Domitian.

Anciently the name *capitol* was likewise applied to all the principal temples in most of the colonies throughout the Roman empire; as at Constantinople, Jerusalem, Carthage, Ravenna, Capua, &c.—That of Thoulouse has given the name of *capitouls* to the echevins or sheriffs.

CAPITOLINE GAMES, annual games instituted by Camillus, in honour of Jupiter Capitolinus, and in commemoration of the capitol's not being taken by the Gauls. Plutarch tells us that a part of the ceremony consisted in the public criers putting up the Hetrurians to sale by auction; they also took an old man, and tying a golden bulla about his neck, exposed him to the public derision. Festus says they also dressed him in a pretexta.—There was another kind of Capitoline games, instituted by Domitian, wherein there were rewards and crowns bestowed on the poets, champions, orators, historians, and musicians. These last Capitoline games were celebrated every five years, and became so famous, that, instead of calculating time by lustra, they began to count by Capitoline games, as the Greeks did by Olympiads. It appears, however, that this custom was not of long continuance.

CAPITOLINUS, JULIUS, an historian in the beginning of the fourth age, under Dioclesian, to whom he inscribed the Lives of Verus, Antoninus Pius, Clodius Balbinus, Macrinus, the Maximins, and the Gordians. He wrote other lives, which are most of them lost.

CAPITOUL, or CAPITOL, an appellation given to the chief magistrates of Thoulouse, who have the administration of justice and policy both civil and mercantile in the city. The capitouls at Thoulouse are much the same with the echevins at Paris, and with the consuls, bailiffs, burgomasters, mayors, and aldermen, &c. in other cities. In ancient acts they are called *consules*, *capitularii*, or *capitolini*, and their body *capitulum*. From this last come the words *capitularii* and *capitouls*. The appellative *capitolini* arose hence, that they have the charge and custody of the townhouse, which was anciently called *capitol*.

The office lasts only one year, and ennobles the bearers. In some ancient acts they are called *capitulum nobilium Tolosæ*. Those who have borne it style themselves afterwards burgesses. They are called to all general councils, and have the *jus imaginum;* that is, when the year of their administration is expired, their pictures are drawn in the townhouse; a custom which they have retained from the ancient Romans, as may be seen in Sigonius.

CAPITULATE, an appellation given to the several quarters or districts of the city of Thoulouse, each under the direction of a capitoul: much like the wards of London, under their aldermen. Thoulouse is now divided into eight *capitoulates*, or quarters, which are subdivided into *moulans*, each of which has its tithingman, whose business is to inform the capitoul of what passes in his tithing, and to inform the inhabitants of the tithing of the orders of the capitoul.

CAPITULAR, or CAPITULARE, denotes an act passed in a chapter, either of knights, canons, or religious.

The capitularia or capitulars of Charlemagne, Charles the Bald, &c. are the laws, both ecclesiastical and civil, made by those emperors in the general councils or assemblies of the people; which was the way in which the constitutions of most of the ancient princes were made; each person present, though a plebeian, setting his hand to them.

Some distinguish these from laws; and say, they were only supplements to laws. They had their name, *capitulars*, because divided into capitula, chapters, or sections. In these capitulars did the whole French jurisprudence anciently consist. In process of time, the name was changed for that of ordinances.

Some distinguish three kinds of capitulars, according to the difference of their subject-matter; those on ecclesiastical affairs are really canons, extracted from councils; those on secular affairs, real laws; those relating to particular persons, or occasions, private regulations.

CAPITULATION, in military affairs, a treaty made between the inhabitants or garrison of a place besieged and the besiegers, for the delivering up the place on certain conditions. The most honourable and ordinary terms of capitulation are to march out at the breach with arms and baggage, drums beating, colours flying, a match lighted at both ends, and some pieces of cannon, waggons, and convoys for their baggage, and for their sick and wounded.

CAPITULATION, in the German polity, a contract which the emperor makes with the electors, in the name of all the princes and states of the empire, before he is declared emperor, and which he ratifies before he is raised to that sovereign dignity. The principal points which the emperor undertakes to observe are, 1. To defend the church and empire. 2. To observe the fundamental laws of the empire. And, 3. To maintain and preserve the rights, privileges, and immunities of the electors, princes, and other states of the empire, specified in the capitulation. These articles and capitulations are presented to the emperor by the electors only, without the concurrence of the other

states,

states, who have complained from time to time of such proceedings; and in the time of the Westphalian treaty, in 1648, it was proposed to deliberate in the following diet, upon a way of making a perpetual capitulation; but the electors have always found means of eluding the execution of this article. In order, however, to give some satisfaction to their adversaries, they have inserted in the capitulation of the emperors, and in that of Francis I. in particular, a promise to use all their influence to bring the affair of a perpetual capitulation to a conclusion. Some German authors own, that this capitulation limits the emperor's power; but maintain that it does not weaken his sovereignty: though the most part maintain that he is not absolute, because he receives the empire under conditions which set bounds to absolute authority.

CAPITULUM, in the ancient military art, was a transverse beam, wherein were holes through which passed the strings whereby the arms of huge engines, as balistæ, catapultæ, and scorpions, were played or worked.

CAPITULUM, in ecclesiastical writers, denoted part of a chapter of the Bible read and explained. In which sense they said, *ire ad capitulum*, "to go to such a lecture." Afterwards the place or apartment where such theological exercises were performed was denominated *domus capituli*.

CAPNICON, in antiquity, chimney money, or a tax which the Roman emperors levied for smoke, and which of consequence was due from all, even the poorest, who kept a fire. This was first invented by Nicephorus.

CAPNOMANCY, a kind of divination by means of smoke, used by the ancients in their sacrifices. The words come from καπνος, *smoke*, and μαντεια, *divination*. The general rule was, when the smoke was thin and light, and rose straight up, it was a good omen; if the contrary, it was an ill one. There was also another species of capnomancy, consisting in the observation of the smoke rising from poppy and jasmine seed cast upon lighted coals.

CAPO FINO, a large barren rock in the territory of the Genoese, which has a castle on its eastern peak. Near it is a small harbour of the same name, 13 miles east by south of Genoa.

Capo d'Istria, a considerable town of Italy, in Istria, on the gulf of Trieste, with a bishop's see, and subject to the Venetians. The air is wholesome and temperate; its principal revenue consists in wine and salt. E. Long. 14. 0. N. Lat. 45. 48.

CAPON, a cock chicken, gelded as soon as left by the dam, or as soon as he begins to crow. They are of use either to lead chickens, ducklings, pheasants, &c. and defend them from the kites and buzzards; or to feed for the table, they being reckoned more delicate than either a cock or a hen.

CAPONIERE, or CAPPONIERE, in *Fortification*, a covered lodgment sunk four or five feet into the ground, encompassed with a little parapet about two feet high, serving to support several planks covered with earth. The caponiere is large enough to contain 15 or 20 soldiers; and is usually placed in the glacis on the extremity of the counterscarp, and in dry moats; having little embrasures for the soldiers to fire through

CAPPADOCIA, an ancient kingdom of Asia, comprehending all that country which lies between Mount Taurus and the Euxine sea. It was divided by the Persians into two satrapies or governments; by the Macedonians into two kingdoms, the one called *Cappadocia ad Taurum;* the other *Cappadocia ad Pontum*, and commonly *Pontus;* for the history, &c. of which last, see the article PONTUS.

CAPPADOCIA Magna, or *Cappadocia* properly so called, lies between the 38th and 41st degrees of north latitude. It was bounded by Pontus on the north, Lycaonia and part of Armenia Major on the south, Galatia on the west, and by the Euphrates and part of Armenia Minor on the east. The first king of Cappadocia we read of in history was Pharnaces, who was preferred to the crown by Cyrus king of Persia, who gave him his sister Atossa in marriage. This is all we find recorded of him, except that he was killed in a war with the Hyrcanians. After him came a succession of eight kings, of whom we know scarce any thing but that they continued faithful to the Persian interest. In the time of Alexander the Great, Cappadocia was governed by Ariarathes II. who, notwithstanding the vast conquests and fame of the Macedonian monarchy, continued unshaken in his fidelity to the Persians. Alexander was prevented by death from invading his dominions; but Perdiccas, marching against him with a powerful and well-disciplined army, dispersed his forces, and having taken Ariarathes himself prisoner, crucified him with all those of the royal blood whom he could get into his power. Diodorus tells us that he was killed in the battle. He is said to have reigned 82 years. His son Ariarathes III. having escaped the general slaughter of the royal family, fled into Armenia, where he lay concealed till the civil dissensions which rose among the Macedonians gave him a fair opportunity of recovering his paternal kingdom. Amyntas, at that time the governor of Cappadocia, opposed him; but being defeated in a pitched battle, the Macedonians were obliged to abandon all the strong holds. Ariarathes, after a long and peaceable reign, left his kingdom to his son Ariaramnes II. He applied himself more to the arts of peace than war, in consequence of which Cappadocia flourished greatly during his reign. He was succeeded by his son Ariarathes IV. who proved a very warlike prince, and, having overcome Arsaces, founder of the Parthian monarchy, considerably enlarged his own dominions.

He was succeeded by Ariarathes V. who, marrying the daughter of Antiochus the Great, entered into an alliance with that prince against the Romans; but Antiochus being defeated, the king of Cappadocia was obliged to sue for peace, which he obtained, after having paid 200 talents by way of fine, for taking up arms against the people of Rome. He afterwards assisted the republic with men and money against Perseus king of Macedon, on which account he was by the senate honoured with the title of *the friend and ally of the Roman people*. He left the kingdom in a very flourishing condition to his son Mithridates, who, on his accession, took the name of Ariarathes VI.

This prince (surnamed *Philopater*, from the filial respect and love he showed his father from his very infancy) immediately renewed the alliance with Rome. Out of mere good nature, he restored Mithrobarzanes, son

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Cappadocia.

son to Ladriades, king of the Lesser Armenia, to his father's kingdom, though he foresaw that the Armenians would lay hold of that opportunity to join Artaxias, who was then on the point of invading Cappadocia. These differences, however, were settled before they came to an open rupture by the Roman legates; and Ariarathes seeing himself thus delivered from an impending war by the mediation of the republic, presented the senate with a golden crown; and offered his service in whatever they thought proper to employ him. The senate in return sent him a staff, and chair of ivory; which were presents usually bestowed on those only whom they looked upon as attached to their interest. Not long before this, Demetrius Soter, king of Syria, had offered Ariarathes his sister in marriage, the widow of Perseus king of Macedon: but this offer the king of Cappadocia was obliged to decline for fear of offending the Romans; and his so doing was in the highest degree acceptable to the republic, who reckoned him among the chief of her allies. Demetrius, however, being greatly incensed at the slight put upon his sister, set up a pretender to the throne, one Orophernes, a supposititious, or, as others call him, a natural son of the deceased king. The Romans ordered Eumenes, king of Pergamus, to assist Ariarathes with all his forces: which he did, but to no purpose; for the confederates were overthrown by Demetrius, and Ariarathes was obliged to abandon the kingdom to his rival. This happened about 159 years before Christ, and the usurper immediately dispatched ambassadors to Rome with a golden crown. The senate declined accepting the present, till they heard his pretensions to the kingdom; and this Orophernes, by suborned witnesses, made appear so plain, that the senate decreed that Ariarathes and he should reign as partners; but next year Orophernes was driven out by Attalus, brother to Eumenes, and his successor to the kingdom of Pergamus.

Ariarathes, being thus restored, immediately demanded of the Priennians 400 talents of gold which Orophernes had deposited with them. They honestly replied, that as they had been trusted with the money by Orophernes, they could deliver it to none but himself, or such as came in his name. Upon this, the king entered their territories with an army, destroying all with fire and sword. The Priennians, however, still persevered in their integrity; and though their city was besieged by the united forces of Ariarathes and Attalus, not only made an obstinate defence, but found means to restore the sum to Orophernes. At last they applied to the Romans for assistance, who enjoined the two kings to raise the seige, under pain of being declared enemies to the republic. Ariarathes immediately obeyed; and marching his army into Assyria, joined Alexander Epiphanes against Demetrius Soter, by whom he had been formerly driven out of his kingdom. In the very first engagement Demetrius was slain, and his army entirely dispersed, Ariarathes having on that occasion given uncommon proofs of his courage and conduct. Some years after, a war breaking out between the Romans and Aristonicus, who claimed the kingdom of Pergamus in right of his father, Ariarathes joined the former, and was slain in the same battle in which P. Crassus proconsul of Asia was taken, and the Roman army cut in pieces. He left six sons by his wife Laodice, on whom the Romans bestowed Lycaonia and Cilicia. But Laodice, fearing lest her children, when they came to age, should take the government out of her hands, poisoned five of them, the youngest only having escaped her cruelty by being conveyed out of the kingdom. The queen herself was soon after put to death by her subjects, who could not bear her cruel and tyrannical government.

Laodice was succeeded by Ariarathes VII. who, soon after his accession, married another Laodice, daughter to Mithridates the Great, hoping to find in that prince a powerful friend to support him against Nicomedes king of Bithynia, who laid claim to part of Cappadocia. But Mithridates, instead of assisting, procured one Gordius to poison his unhappy son-in-law, and on his death, seized the kingdom, under pretence of maintaining the rights of the Cappadocians against Nicomedes, till the children of Ariarathes were in a condition to govern the kingdom, The Cappadocians at first fancied themselves obliged to their new protector: but, finding him unwilling to resign the kingdom to the lawful heir, they rose up in arms, and driving out all the garrisons placed by Mithridates, placed on the throne Ariarathes VIII. eldest son of their deceased king.

The new prince found himself immediately engaged in a war with Nicomedes; but, being assisted by Mithridates, not only drove him out of Cappadocia, but stripped him of a great part of his hereditary dominions. On the conclusion of the peace, Mithridates, seeking for some pretence to quarrel with Ariarathes, insisted upon his recalling Gordius, who had murdered his father; which being rejected with abhorrence, a war ensued. Mithridates took the field first, in hopes of overrunning Cappadocia before Ariarathes could be in a condition to make head against him; but, contrary to his expectation, he was met on the frontiers by the king of Cappadocia with an army no way inferior to his own. Hereupon he invited Ariarathes to a conference; and, in sight of both armies, stabbed him with a dagger, which he had concealed under his garment. This struck such terror into the Cappadocians, that they immediately dispersed, and gave Mithridates an opportunity of possessing himself of the kingdom without the least opposition. The Cappadocians, however, not able to endure the tyranny of his prefects, soon shook off the yoke; and recalling the king's brother who had fled into the province of Asia, proclaimed him king. He was scarce seated on the throne, however, before Mithridates invaded the kingdom at the head of a very numerous army, and having drawn Ariarathes to a battle, defeated his army with great slaughter, and obliged him to abandon the kingdom. The unhappy prince soon after died of grief; and Mithridates bestowed the kingdom on his son, who was then but eight years old, giving him also the name of *Ariarathes*. But Nicomedes Philopater, king of Bithynia, fearing lest Mithridates, having now got possession of the whole kingdom of Cappadocia, should invade his territories, suborned a youth to pass himself for the third son of Ariarathes, and to present to them a petition in order to be restored to his father's kingdom. With him he sent to Rome Laodice, sister of Mithridates, whom he had married after the death of her former husband Ariarathes. Laodice declared before the senate, Cappadocia. senate, that she had three sons by Ariarathes, and that the petitioner was one of them; but that she had been obliged to keep him concealed, lest he should undergo the same fate with his brothers. The senate assured him that they would at all events reinstate him in his kingdom. But in the mean time, Mithridates, having notice of these transactions, dispatched Gordius to Rome, to undeceive the senate, and to persuade them that the youth to whom he had resigned the kingdom of Cappadocia was the lawful son of the late king, and grandson to Ariarathes who had lost his life in the service of the Romans against Aristonicus. This unexpected embassy put the senate upon inquiring more narrowly into the matter, whereby the whole plot was discovered; upon which Mithridates was ordered to resign Cappadocia, and the kingdom was declared free. The Cappadocians, however, in a short time sent ambassadors to Rome, acquainting the senate that they could not live without a king. This greatly surprised the Romans, who had such an aversion to royal authority; but they gave them leave to elect a king of their own nation. As the family of Pharnaces was now extinct, the Cappadocians chose Ariobarzanes; and their choice was approved by the senate, he having on all occasions shown himself a steady friend to the Romans.

Ariobarzanes had scarce taken possession of his kingdom when he was driven out by Tigranes king of Armenia; who resigned Cappadocia to the son of Mithridates, in pursuance of an alliance previously concluded between the two parties. Ariobarzanes fled to Rome; and having engaged the senate in his cause, he returned into Asia with Sylla, who was enjoined to restore him to his kingdom. This was easily performed by Sylla, who, with a small body of troops, routed Gordius, who came to meet him on the borders of Cappadocia at the head of a numerous army. Sylla, however, had scarce turned his back, when Ariobarzanes was again driven out by Ariarathes the son of Mithridates, on whom Tigranes had bestowed the kingdom of Cappadocia. This obliged Sylla to return into Asia, where he was attended with his usual success, and Ariobarzanes was again placed on the throne. After the death of Sylla, he was the third time forced by Mithridates to abandon his kingdom; but Pompey, having entirely defeated Mithridates near Mount Stella, restored Ariobarzanes to his throne, and rewarded him for his services during the war, with the provinces of Sophene, Gordiene, and great part of Cilicia. The king, however, being now advanced in years, and desirous of spending the remainder of his life in ease, resigned the crown to his son Ariobarzanes, in presence of Pompey; and never afterwards troubled himself with affairs of state.

Ariobarzanes II. proved no less faithful to the Romans than his father had been. On the breaking out of the civil war between Cæsar and Pompey, he sided with the latter; but, after the death of Pompey, he was received into favour by Cæsar, who even bestowed upon him great part of Armenia. While Cæsar was engaged in a war with the Egyptians, Pharnaces king of Pontus invaded Cappadocia, and stripped Ariobarzanes of all his dominions; but Cæsar, having defeated Pharnaces, restored the king of Cappadocia, and honoured him with new titles of friendship. After the murder of Cæsar, Ariobarzanes, having refused to join Brutus and Cassius, was by them declared an enemy to the republic, and soon after taken prisoner and put to death. He was succeeded by his brother Ariobarzanes III. who was by Mark Antony deprived both of his kingdom and his life; and in him ended the family of Ariobarzanes.

Archelaus, the grandson of that general of the same name who commanded against Sylla in the Mithridatic war, was by Mark Antony placed on the throne of Cappadocia, though nowise related either to the family of Pharnaces or Ariobarzanes. His preferment was entirely owing to his mother Glaphyra, a woman of great beauty, but of loose behaviour, who, in return for her compliance with the desires of Antony, obtained the kingdom of Cappadocia for her son. In the war between Augustus and Antony, he joined the latter; but, at the intercession of the Cappadocians, was pardoned by the emperor. He afterwards received from him Armenia the Lesser, and Cilicia Trachæa, for having assisted the Romans in clearing the seas of pirates, who greatly infested the coasts of Asia. He contracted a strict friendship with Herod the Great, king of Judæa; and even married his daughter Glaphyra to Alexander, Herod's son. In the reign of Tiberius, Archelaus was summoned to appear before the senate; for he had always been hated by that emperor, because in his retirement at Rhodes he had paid him no sort of respect. This had proceeded from no aversion in him to Tiberius, but from the warning given by Archelaus to his friends at Rome. For Caius Cæsar, the presumptive heir to the empire, was then alive, and had been sent to compose the differences of the east; whence the friendship of Tiberius was then looked upon as dangerous. But when he came to the empire, Tiberius, remembering the disrespect shewn him by Archelaus, enticed the latter to Rome by means of letters from Livia, who promised him her son Tiberius's pardon, provided he came in person to implore it. Archelaus obeyed the summons, and hastened to Rome; where he was received by the emperor with great wrath and contempt, and soon after accused as a criminal in the senate. The crimes of which he were accused were mere fictions; but his concern at seeing himself treated as a malefactor was so great, that he died soon after of grief, or, as others say, laid violent hands on himself. He is said to have reigned 50 years.

On the death of Archelaus, the kingdom of Cappadocia was reduced to a Roman province, and governed by those of the equestrian order. It continued subject to the Romans till the invasion of the eastern empire by the Turks, to whom it is now subject, but has no distinguishing modern name. In what was anciently called *Cappadocia*, however, the Turks have four beglerbeglics, called *Siwas*, *Trebizond*, *Maraisch*, and *Cogni*.

In the time of the Romans, the inhabitants of Cappadocia bore so bad a character, and were reputed so vicious and lewd, that, among the neighbouring nations, a wicked man was emphatically called a *Cappadocian*. In after ages, however, their lewd disposition was so corrected and restrained by the pure doctrines of of Christianity, that no country whatever has produced greater champions of the Christian religion, or given to the church prelates of more unblemished characters.

We have now no system of the Cappadocian laws, and scarce wherewithal to form any particular idea of them. As to their commerce, they carried on a considerable trade in horses, great numbers of which were produced in their country; and we read of them in Scripture as frequenting the fairs of Tyre with this commodity. As Cappadocia abounded with mines of silver, brass, iron, and alum, and afforded great store of alabaster, crystal, and jasper, it is probable that they might supply the neighbouring countries with these commodities.

The religion of the ancient Cappadocians was much the same with that of the Persians. At Comana there was a rich and stately temple dedicated to Bellona; whose battles the priests and their attendants used to represent on stated days, cutting and wounding each other as if seized with an enthusiastic fury. No less famous and magnificent were the temples of Apollo Catanius, and of Jupiter; the last of which had 3000 sacred servants, or religious votaries. The chief priest was next in rank to that of Comana; and, according to Strabo, had a yearly revenue of 15 talents. Diana Persica was worshipped in a city called *Castaballa*, where women, devoted to the worship of that goddess, were reported to tread barefooted on burning coals, without receiving any hurt. The temples of Diana at Diospolis, and of Anias at Zela, were likewise held in great veneration both by the Cappadocians and Armenians, who flocked to them from all parts. In the latter were tendered all oaths in matters of consequence; and the chief among the priests was no way inferior in dignity, power, and wealth, to any in the kingdom; having a royal attendance, and an unlimited authority over all the inferior servants and officers of the temple. The Romans, who willingly adopted all the superstitions and superstitious rites of the nations they conquered, greatly increased the revenues of this and other temples; conferring the priesthood on such as they thought most fit for carrying on their designs.—We are told that human sacrifices were offered at Comana; and that this barbarous custom was brought by Orestes and his sister Iphigenia from Taurica Scythica, where men and women were immolated to Diana. But this custom, if ever it obtained in Cappadocia, was abolished in the times of the Romans.

CAPPANUS, a name given by some authors to a worm that adheres to and gnaws the bottoms of ships; to which it is extremely pernicious, especially in the East and West Indies; to prevent this, several ships have lately been sheathed with copper; the first trial of which was made on his majesty's frigate the Alarm.

CAPPARIS. See Botany *Index*.

The buds of this plant, pickled with vinegar, &c. are brought to Britain annually from Italy and the Mediterranean. They are supposed to excite appetite and assist digestion; and to be particularly useful as detergents and aperients in obstructions of the liver and spleen.

CAPRA, or Goat. See Mammalia *Index*.

Capra *Saltans*, in *Meteorology*, a fiery meteor or exhalation sometimes seen in the atmosphere. It forms an inflected line, resembling in some measure the caperings of a goat; whence it has its name.

CAPRALA, an isle of Italy, in the Tuscan sea, to the north-east of Corsica, on which it depends. It is pretty populous, and has a strong castle for its defence. It is about 15 miles in circumference. E. Long. 11. 5. N. Lat. 43. 15.

CAPRARIA. See Botany *Index*.

CAPRAROLA, one of the most magnificent palaces in Italy, seated on a hill, in Ronciglione, whose foot is watered by the river Tircia. It was built by Cardinal Farnese; and has five fronts, in the middle of which is a round court, though all the rooms are square, and well proportioned. It is 27 miles north-west of Rome.

CAPRÆ. See Capri.

CAPREOLUS, Elias, an excellent civilian, and learned historian, born at Brescia in Italy, wrote a history of Brescia, and other works: died in 1519.

CAPRI, (anciently *Capreæ*), a city and island at the entrance of the gulf of Naples, E. Long. 14. 50. N. Lat. 40. 45.—The island is only four miles long and one broad; the city is a bishop's see, and situated on a high rock at the west end of the island. Capreæ was anciently famous for the retreat of the emperor Tiberius for seven years, during which he indulged himself in the most scandalous debaucheries*. Before Tiberius came hither, Capri had attracted the notice of Augustus, as a most eligible retreat, though in sight of populous cities, and almost in the centre of the empire. His successor preferred it to every other residence; and in order to vary his pleasure, and enjoy the advantages as well as avoid the inconveniences of each revolving season, built 12 villas in different situations, dedicated to the 12 greater gods: the ruins of some of them are still to be seen: at Santa Maria are extensive vaults and reservoirs; and on an adjoining brow are the remains of a lighthouse; two broken columns indicate the entrance of the principal court. According to Dion Cassius, this island was wild and barren before the Cæsars took it under their immediate protection: at this day a large portion of its surface is uncultivated and impracticable; but every spot that will admit the hoe is industriously tilled, and richly laden with the choicest productions of agriculture. The odium attached to the memory of Tiberius proved fatal to his favourite abode; scarce was his death proclaimed at Rome, when the senate issued orders for the demolition of every fabric he had raised on the island, which by way of punishment was thenceforward destined to be a state prison. The wife and sister of Commodus were banished to its inhospitable rocks, which were soon stained with their blood. In the middle ages Capri became an appendage of the Amalfitan republic, and after the downfal of that state, belonged to the duchy of Naples. There stood a pharos on this island, which, a few days before the death of Tiberius, was overthrown by an earthquake.

* See *Tiberius*.

CAPRIATA, Peter John, a civilian and historian, was born at Genoa. He wrote, in Italian, the history of the wars of Italy; an English translation of which was printed in London in 1663.

CAPRICORN, in *Astronomy*, one of the 12 signs of the zodiac. See Astronomy *Index*.

 The

Capricorn, Caprification.

The ancients accounted Capricorn the tenth sign; and when the sun arrived thereat, it made the winter solstice with regard to our hemisphere: but the stars having advanced a whole sign towards the east, Capricorn is now rather the 11th sign; and it is at the sun's entry into Sagittary that the solstice happens, though the ancient manner of speaking is still retained.

The sign is represented on ancient monuments, medals, &c. as having the forepart of a goat and the hindpart of a fish, which is the form of an Ægipan; sometimes simply under the form of a goat.

Tropic of CAPRICORN, a lesser circle of the sphere, which is parallel to the equinoctial, and at 23° 30′ distance from it southwards; passing through the beginning of Capricorn.

CAPRIFICATION, a method used in the Levant, for ripening the fruit of the domestic fig tree, by means of insects bred in that of the wild fig tree.

The most ample and satisfactory accounts of this curious operation in gardening, are those of Tournefort and Pontedra: the former, in his Voyage to the Levant, and in a Memoir delivered to the Academy of Sciences at Paris in 1705; the latter, in his *Anthologia*. The substance of Tournefort's account follows: "Of the thirty species or varieties of the domestic fig tree which are cultivated in France, Spain, and Italy, there are but two cultivated in the Archipelago. The first species is called *ornos*, from the old Greek *erinos*, which answers to *caprificus* in Latin, and signifies a wild fig tree. The second is the domestic or garden fig tree. The former bears successively, in the same year, three sorts of fruit, called *fornites*, *cratitires*, and *orni*; which, though not good to eat, are found absolutely necessary towards ripening those of the garden fig. These fruits have a sleek even skin; are of a deep green colour; and contain in their dry and mealy inside several male and female flowers placed upon distinct footstalks, the former above the latter. The *fornites* appear in August, and continue to November without ripening: in these are bred small worms, which turn to a sort of gnats, nowhere to be seen but about these trees. In October and November, these gnats of themselves make a puncture into the second fruit, which is called *cratitires*.

These do not show themselves till towards the end of September. The *fornites* gradually fall away after the gnats are gone; the *cratitires*, on the contrary, remain on the tree till May, and enclose the eggs deposited by the gnats when they pricked them. In May, the third sort of fruit, called *orni*, begins to be produced by the wild fig trees. This is much bigger than the other two; and when it grows to a certain size, and its bud begins to open, it is pricked in that part by the gnats of the *cratitires*, which are strong enough to go from one fruit to another to deposite their eggs. It sometimes happens that the gnats of the *cratitires* are slow to come forth in certain parts, while the *orni* in those very parts are disposed to receive them. In this case, the husbandman is obliged to look for the *cratitires* in another part, and fix them at the ends of the branches of those fig trees whose *orni* are in a fit disposition to be pricked by the gnats. If they miss the opportunity, the *orni* fall, and the gnats of the *cratitires* fly away. None but those that are well acquainted with the culture know the critical moment of doing this; and in order to know it, their eye is perpetually fixed on the bud of the fig; for that part not only indicates the time that the prickers are to issue forth, but also when the fig is to be successfully pricked; if the bud is too hard and compact the gnat cannot lay its eggs; and the fig drops when the bud is too open.

"The use of all these three sorts of fruit is to ripen the fruit of the garden fig tree, in the following manner: During the months of June and July, the peasants take the *orni*, at the time their gnats are ready to break out, and carry them to the garden fig trees; if they do not nick the moment, the *orni* fall; and the fruit of the domestic fig tree, not ripening, will in a very little time fall in like manner. The peasants are so well acquainted with these precious moments, that, every morning, in making their inspection, they only transfer to their garden fig trees such *orni* as are well conditioned, otherwise they lose their crop. In this case, however, they have one remedy, though an indifferent one; which is, to strew over the garden fig trees another plant in whose fruit there is also a species of gnats which answer the purpose in some measure."

The caprification of the ancient Greeks and Romans, described by Theophrastus, Plutarch, Pliny, and other authors of antiquity, corresponds in every circumstance with what is practised at this day in the Archipelago and in Italy. These all agree in declaring, that the wild fig tree, *caprificus*, never ripened its fruit, but was absolutely necessary for ripening that of the garden or domestic fig, over which the husbandmen suspended its branches. The reason of this success has been supposed to be, that by the punctures of these insects the vessels of the fruit are lacerated, and thereby a greater quantity of nutritious juice derived thither. Perhaps, too, in depositing their eggs, the gnats leave behind them some sort of liquor proper to ferment gently with the milk of the figs, and to make their flesh tender. The figs in Provence, and even at Paris, ripen much sooner for having their buds pricked with a straw dipped in olive oil. Plums and pears likewise, pricked by some insects, ripen much the faster for it; and the flesh round such puncture is better tasted than the rest. It is not to be disputed, that considerable changes happen to the contexture of fruits so pricked, just the same as to parts of animals pierced with any sharp instrument. Others have supposed that these insects penetrated the fruit of the tree to which they were brought, and gave a more free admission to the air and to the sun. Linnæus explained the operation, by supposing that the insects brought the farina from the wild fig, which contained male flowers only, to the domestic fig, which contained the female ones. Hasselquist, from what he saw in Palestine, seemed to doubt of this mode of fructification. M. Bernard, in the Memoirs of the Society of Agriculture, opposes it more decidedly. He could never find the insect in the cultivated fig; and, in reality, it appeared to leave the wild fig, after the stamina were mature, and their pollen dissipated; besides, he adds, what they may have brought on their wings must be rubbed away, in the little aperture which they would form for themselves. At Malta, where there are seven or eight varieties of the domestic fig, this operation is only performed on those which ripen latest; the former are of a proper size, fine flavour, and in great abundance without it; so that he thinks the caprification only hastens the ripening.

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ripening. He examined the parts of fructification of the fig; and he observes, if this examination be made previous to the ripening, that round the eye of the fig, and in the substance of its covering, may be seen triangular dentated leaves, pressed one against another; and under these leaves are the stamina, whose pollen is destined for the impregnation of the grains, which fill the rest of the fruit. These male organs are much more numerous in the wild fig than in the domestic; and the stamina are found to contain a yellow dust, which may be collected when it is ripe. The wild figs, when ripe, are not succulent, and have no taste, though the grains are disposed in the same manner as in the other kind. The pith of the grain of the wild fruit serves as food to a species of the cynips, whose larva is white, till the moment of its transformation; and it is by an opening, in the direction of the pistil, that the insect penetrates the grain. From this account it is thought probable that the insect is only communicated by accident to the domestic fig, and that the flowers of this genus are sometimes hermaphrodites. But the number of hermaphrodite flowers being fewer on the cultivated than on the wild fig, the seeds are fecundated more certainly and quickly by the caprification; and every botanist knows, that when the impregnation is completed, the flower soon withers: while, if by any accident it is delayed, it continues in bloom much longer. This view of the subject, therefore, explains very completely the reason why, in Malta, the caprification is practised on the late kind of figs, because it hastens the formation and maturity of the fruit.

CAPRIMULGUS, Goatsucker, or *Fern-owl*. See Ornithology *Index*.

CAPRIOLES, in the manege, leaps that a horse makes in the same place without advancing, in such a manner, that, when he is at the height of the leap, he jerks out with his hinder legs even and near. It is the most difficult of all the high manege. It differs from a croupade, in this, that in a croupade, a horse does not show his shoes; and from a ballotade, because in this he does not jerk out. To make a horse work well at caprioles, he must be put between two pillars, and taught to raise first his fore quarters, and then his hind quarters while his fore ones are yet in the air; for which reason you must give him the whip and the poinson.

CAPSA, in *Ancient Geography*, a large and strong town of Numidia, situated amidst vast deserts, waste, uncultivated, and full of serpents, where Jugurtha kept his treasure. In his time it was taken and razed by Marius the Roman general, who put to death all the citizens capable of bearing arms, and sold the rest for slaves. It was, however, afterwards rebuilt by the Romans, and strongly fortified; but, on the decline of their empire, was taken and demolished a second time, by Occuba a famous Arab general. The walls of the citadel are still remaining, and are monuments of the ancient glory and strength of Capsa. They are 24 fathoms in height, and five in thickness, built of large square stones, and have now acquired the solidity and firmness of a rock. The walls of the town were rebuilt by the inhabitants since their first demolition; but were afterwards destroyed by Jacob Almanzor, who sent a governor and troops into the province. In Marmol's time Capsa was very populous, and abounded with stately mosques and other structures of superb and elegant workmanship: but at present it is occupied by a poor and indigent people, fleeced and oppressed by the Tunisian government. In the very centre of the city stands an enclosed fountain, which both supplies the people with drink, and affords them an agreeable bath. The adjacent country is now cultivated, and produces several kinds of fruits; but the climate is unhealthy. The inhabitants are remarkable for their peevishness of temper. Both men and women dress handsomely, except their feet, which they cover with coarse shoes of bungling workmanship, and made of the rough skins of wild beasts, equally inconvenient and unbecoming. E. Long. 9. 3. N. Lat. 33. 15.

CAPSARIUS, (from *capsa*, satchel), in antiquity, a servant who attended the Roman youth to school, carrying a satchel with their books in it, sometimes also called librarius.

Capsarius was also an attendant at the baths, to whom persons committed the keeping of their clothes.

Capsarius (from *capsa*, "a chest,") among the Roman bankers, was he who had the care of the money chest or coffer.

CAPSICUM, or Guinea-pepper. See Botany *Index*.

The bell-pepper produces fruit for pickling; for which purpose they must be gathered before they arrive at their full size, while their rind is tender. They must be slit down on one side to get out the seeds, after which they should be soaked two or three days in salt and water; when they are taken out of this and drained, boiling vinegar must be poured on them in a sufficient quantity to cover them, and closely stopped down for two months, then they should be boiled in the vinegar to make them green; but they want no addition of any spice, and are the wholesomest and best pickle in the world. Another species is used for making what is called *cayan-butter* or *pepper-pots*, by the inhabitants of America, and which they esteem the best of all the spices. The following is a receipt for making of a pepper-pot: "Take of the ripe seeds of this sort of capsicum, and dry them well in the sun; then put them into an earthen or stone pot, mixing flour between every stratum of pods; and put them into an oven after the baking of bread, that they may be thoroughly dried: after which they must be well cleansed from the flour; and if any of the stalks remain adhering to the pods, they should be taken off, and the pods reduced to a fine powder; to every ounce of this add a pound of wheat flour, and as much leaven as is sufficient for the quantity intended. After this has been properly mixed and wrought, it should be made into small cakes, and baked in the same manner as common cakes of the same size; then cut them into small parts, and bake them again, that they may be as dry and hard as biscuit; which being powdered and sifted, is to be kept for use." This is prodigiously hot and acrimonious, setting the mouth as it were on fire. It is by some recommended as a medicine for flatulencies; but it is greatly to be doubted whether all those hot irritating medicines are not productive of more harm than good, in this country at least. If the ripe pods of capsicum are thrown into the fire, they will raise strong and noisome vapours, which occasion vehement sneezing,

ing, coughing, and often vomiting, in those who are near the place, or in the room where they are burnt. Some persons have mixed the powder of the pods with snuff, to give to others for diversion: but where it is in quantity, there may be danger in using it; for it will occasion such violent fits of sneezing, as may break the blood-vessels of the head.

CAPSQUARES, strong plates of iron which come over the trunnions of a gun, and keep it in the carriage. They are fastened by a hinge to the prize-plate, that they may lift up and down, and form a part of an arch in the middle to receive a third part of the thickness of the trunnions: for two-thirds are let into the carriage, and the other end is fastened by two iron wedges called the *forelocks* and *keys*.

CAPSTAN, or CAPSTERN, a strong massy column of timber, formed like a truncated cone, and having its upper extremity pierced with a number of holes to receive the bars or levers. It is let perpendicularly down through the decks of a ship; and is fixed in such a manner, that the men, by turning it horizontally with their bars, may perform any work which requires any extraordinary effort.

Plate CXXXV. A capstern is composed of several parts, where A is the barrel, *b* the whelps, *c* the drumhead, and *d* the spindle. The whelps rise out from the main body of the capstern like buttresses, to enlarge the sweep, so that a greater quantity of cable, or whatever rope encircles the barrel, may be wound about it at one turn, without adding much to the weight of the capstern. The whelps reach downwards from the lower part of the drumhead to the deck. The drumhead is a broad cylindrical piece of wood resembling a millstone, and fixed immediately above the barrel and whelps. On the outside of this piece are cut a number of square holes parallel to the deck, to receive the bars. The spindle or pivot *d*, which is shod with iron, is the axis or foot upon which the capstern rests, and turns round in the saucer, which is a sort of iron socket let into a wooden stock or standard called the *step*, resting upon and bolted to the beams.

Besides the different parts of the capstern above explained, it is furnished with several appurtenances, as the *bars*, the *pins*, the *pawls*, the *swifter*, and the *saucer*, already described. The bars are long pieces of wood, or arms, thrust into a number of square holes in the drumhead all round, in which they are the radii of a circle, or the spokes in the nave of a wheel. They are used to heave the capstern round, which is done by the men setting their breasts against them, and walking about, like the machinery of a horse mill, till the operation is finished.—The pins *e*, are little bolts of iron thrust perpendicularly through the holes of the drumhead, and through a corresponding hole in the end of the bar, made to receive the pins when the bars are fixed. They are used to confine the bars, and to prevent them from working out as the men heave, or when the ship labours. Every pin is fastened to the drumhead with a small iron chain; and that the bars may exactly fit their respective holes, they are all numbered. The pawls *f*, No. 1. are situated on each side the capstern, being two short bars of iron, bolted at one end through the deck to the beams close to the lower part of the whelps; the other end, which occasionally turns round on the deck, being placed in the intervals of the whelps, as the capstern turns round, prevents it from recoiling or turning back by any sudden jerk of the cable, as the ship rises on the sea, which might greatly endanger the men who heave. There are also hanging pawls *g g*, No. 3. used for the same purposes, reaching from the deck above to the drumhead immediately below it. The swifter is a rope passed horizontally through holes in the outer end of the bars, and drawn very tight; the intent of this is to keep the men steady as they walk round when the ship rocks, and to give room for a greater number to assist by pulling upon the swifter itself.

The most frequent use of the capstern is to heave in the cable, and thereby remove the ship or draw up the anchor. It is also used to wind up any weighty body, as the masts, artillery, &c. In merchant ships it is likewise frequently employed to discharge or take in the cargo, particularly when consisting of weighty materials that require a great exertion of mechanical powers to be removed.

There are commonly two capsterns in a man of war, the *main* and the *gear* capstern; the former of which has two drumheads, and may be called a *double one*. This is represented in No. 3. The latter is represented in No. 2.

Formerly the bars of the capstern went entirely through the head of it, and consequently were more than double the length of the present ones; the holes were therefore formed at different heights, as represented in No. 1. But this machine had several inconveniences, and has long been entirely disused in the navy. Some of these sort of capsterns, however, are still retained in merchant ships, and are usually denominated *crabs*. The situation of the bars in a crab, as ready for heaving, is represented in No. 4.

To rig the CAPSTERN, is to fix the bars in their respective holes, and thrust in the pins, in order to confine them.—*Surge the* CAPSTERN, is the order to slacken the rope heaved round upon it, of which there are generally two turns and a half about the barrel at once, and sometimes three turns.—*To heave the* CAPSTERN, is to go round with it heaving on the bars, and drawing in any rope of which the purchase is created.—*To come-up the* CAPSTERN, is to let go the rope upon which they had been heaving.—*To Pawl the* CAPSTERN, is to fix the pawls to prevent it from recoiling during any pause of heaving.

CAPSULE, in a general sense, denotes a receptacle or cover in form of a bag.

CAPSULE, among botanists, a dry hollow seed-vessel or pericarpium, that cleaves or splits in some determinate manner. See PERICARPIUM, BOTANY *Index*.

This species of seed-vessel is frequently fleshy and succulent, like a berry, before it has attained maturity; but, in ripening, becomes dry, and often so elastic as to dart the seeds from their departments with considerable velocity. This elasticity is remarkably conspicuous in wood sorrel; balsam, *impatiens*; African spiræa, *diosma*; *fraxinella*; *justicia*; *ruellia*; *barleria*; *lathræa*; and many others.—The general aptitude or disposition of this species of seed-vessel to cleave or separate for the purpose of dispersing its seeds, distinguishes it not less remarkably than its texture from the pulpy or succulent fruits of the apple, berry, and cherry kind. This opening of the capsule for discharging

ing its seeds when the fruit is ripe, is either at the top, as in most plants; at the bottom, as in triglochin; at the side, through a pore or small hole, as in campanula and orchis; horizontally, as in plantain, amaranthus, and anagallis; or longitudinally, as in convolvulus. All fruit that is jointed, opens at every one of the joints, each of which contains a single seed. Capsules, in splitting, are divided, externally, into one or more pieces, called by Linnæus *valves*. The internal divisions of the capsules are called *cells*, *loculamenta*: these, in point of number, are exceedingly diversified; some having only one cell, as the primrose; and others many, as the water lily. Hence a capsule is termed *unilocular*, *bilocular*, *trilocular*, &c. according as it has one, two, three, &c. cells or cavities.

Capsulæ Atrabiliariæ, called also *glandulæ renales*, and *renes succenturiati*. See Anatomy *Index*.

CAPTAIN, a military officer whereof there are several kinds, according to their commands.

Captain of a Troop or Company, an inferior officer who commands a troop of horse or a company of foot, under a colonel. The duty of this officer is to be careful to keep his company full of able-bodied soldiers; to visit their tents and lodgings, to see what is wanting; to pay them well; to cause them keep themselves neat and clean in their clothes, and their arms bright. He has power in his own company of making serjeants, corporals, and lanspesades.

In the horse and foot guards, the captains have the rank of colonels.

Captain-General, he who commands in chief.

Captain-Lieutenant, he who, with the rank of captain, but the pay of lieutenant, commands a troop or company in the name and place of some other person who is dispensed with, on account of his quality, from performing the functions of his post.

Thus the colonel being usually captain of the first company of his regiment, that company is commanded by his deputy under the title of *Captain-Lieutenant*.

So in England, as well as in France, the king, queen, dauphin, princes, &c. have usually the title of captain of the guards, *gens d'armes*, &c. the real duty of which offices is performed by captain-lieutenants.

Captain Reformed, one who, upon the reduction of the forces, has his commission and company suppressed; yet is continued captain, either as second to another, or without any post or command at all.

Captain of a Ship of War, the officer who commands a ship of the line of battle, or a frigate carrying 20 or more cannon. The charge of a captain in his majesty's navy is very comprehensive, in as much as he is not only answerable for any bad conduct in the military government, navigation, and equipment of the ship he commands, but also for any neglect of duty or ill management in his inferior officers, whose several charges he is appointed to superintend and regulate.

On his first receiving information of the condition and quality of the ship he is appointed to command, he must attend her constantly, and hasten the necessary preparations to fit her for sea. So strict, indeed, are the injunctions laid on him by the lord high admiral, or commissioners of the admiralty, that he is forbid to lie out of his ship, from his arrival on board to the day of his discharge, unless by particular leave from the admiralty or from his commander in chief. He is enjoined to show a laudable example of honour and virtue to the officers and men; and to discountenance all dissolute, immoral, and disorderly practices, and such as are contrary to the rules of subordination and discipline; as well as to correct those who are guilty of such offences as are punishable according to the usage of the sea. He is ordered particularly to survey all the military stores which are sent on board, and to return whatever is deemed unfit for service. His diligence and application are required to procure his complement of men; observing carefully to enter only such as are fit for the necessary duty, that the government may not be put to unnecessary expence. When his ship is fully manned, he is expected to keep the established number of men complete, and superintend the muster himself, if there is no clerk of the check at the port. When his ship is employed on a cruising station, he is expected to keep the sea the whole length of time previously appointed; but if he is compelled by some unexpected accident to return to port sooner than the time limited, he ought to be very cautious in the choice of a good situation for anchoring, ordering the master or other careful officers to sound and discover the depths of water and dangers of the coast. Previous to any possibility of an engagement with the enemy, he is to quarter the officers and men to the necessary stations according to their office and abilities, and to exercise them in the management of the artillery, that they may be more expert in time of battle. His station in the time of an engagement is on the quarter-deck; at which time he is expected to take all opportunities of annoying his enemy, and improving every advantage over him; to exhibit an example of courage and fortitude to his officers and crew; and to place his ship opposite to his adversary in such a position as that every cannon shall do effectual execution. At the time of his arrival in port, after his return from abroad, he is to assemble his officers, and draw up a detail of the observations that have been made during the voyage, of the qualities of the ship as to her trim, ballast, stowage, manner of sailing, for the information and direction of those who may succeed him in the command; and this account is to be signed by himself and officers, and to be returned to the resident commissioner of the navy at the port where the ship is discharged.

Captain of a Merchant-ship, he who has the direction of the ship, her crew, and lading, &c. In small ships and short voyages, he is more ordinarily called the *master*. In the Mediterranean, he is called the *patroon*.—The proprietor of the vessel appoints the captain or master; and he is to form the crew, and choose and hire the pilots, mates, and seamen; though, when the proprietor and master reside on the same spot, they generally act in concert together.

Captain Bashaw, or *Capondan Bashaw*, in the polity of the Turks, signifies the Turkish high admiral. He possesses the third office of the empire, and is invested with the same power at sea that the vizier has on shore. Soliman II. instituted this office in favour of the famous Barbarossa, with absolute authority over the officers of the marine and arsenal, whom he may punish, cashier, or put to death, as soon as he is without

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out the Dardanelles. He commands in chief in all the maritime countries, cities, castles, &c.; and, at Constantinople, is the first magistrate of police in the villages on the side of the Porte, and the canal of the Black sea. The mark of his authority is a large Indian cane, which he carries in his hand, both in the arsenal and with the army.—The captain bashaw enjoys two sorts of revenues; the one fixed, the other casual. The first arises from a capitation of the islands in the Archipelago, and certain governments in Natolia and Galipoli. The latter consists in the pay of the men who die during a campaign; in a fifth of all prizes made by the begs; in the profits accruing from the labour of the slaves, whom he hires as rowers to the grand signior; and in the contributions he exacts in all places where he passes.

CAPTION, in *Scots Law*, a writ issuing under his majesty's signet, in his majesty's name, obtained at the instance of a creditor in a civil debt, commanding messengers at arms and other officers of the law to apprehend and imprison the person of the debtor until he pay the debt.—It is also the name of a writ issued by the court of session against the agents of the court, to return papers belonging to processes or law suits, or otherwise to go to prison.

CAPTIVE, a slave, or a person taken from the enemy.

Formerly captives in war became the slaves of those who took them; and though slavery, such as obtained among the ancients, is now abolished, some shadow of it still remains in respect of prisoners of war, who are accounted the property of their captors, and have no right to liberty but by concession from them. —The Romans used their captives with great severity; their necks were exposed to the soldiers to be trampled on, and their persons afterwards sold by public auction. Captives were frequently burnt in the funeral piles of the ancient warriors, as a sacrifice to the infernal gods. Those of royal or noble blood had their heads shaven, and their hair sent to Rome to serve as decorations for female toys, &c. They were led in triumph loaded with chains through Rome, in the emperor's train, at least as far as the foot of the Capitoline mount, for they were not permitted to ascend the sacred hill, but carried thence to prison. Those of the prime quality were honoured with golden chains on their hands and feet, and golden collars on their necks. If they made their escape, or killed themselves, to avoid the ignominy of being carried in triumph, their images or effigies were frequently carried in their place.

CAPTIVITY, in a general sense, the state or condition of a captive.

Captivity, in sacred history, a punishment which God inflicted upon his people for their vices and infidelities. The first of these captivities is that of Egypt, from which Moses delivered them; after which, are reckoned six during the government of the judges; but the greatest and most remarkable were those of Judah and Israel, which happened under the kings of each of these kingdoms. It is generally believed, that the ten tribes of Israel never came back again after their dispersion; and Josephus and St Jerome are of this opinion: nevertheless, when we examine the writings of the prophets, we find the return of Israel from captivity pointed out in a manner almost as clear as that of the tribes of Benjamin and Judah: see Hosea, i. 10. 11. Amos, ix. 14. The captivities of Judah are generally reckoned four; the fourth and last of which fell in the year of the world 3416, under Zedekiah; and from this period begins the 70 years captivity foretold by Jeremiah.

Since the destruction of the temple by the Romans, the Hebrews boast that they have always had their heads, or particular princes, whom they call *princes of the captivity*, in the east and west. The princes of the captivity in the east governed the Jews that dwelt in Babylon, Assyria, and Persia; and the princes of the captivity in the west governed those who dwelt in Judæa, Egypt, Italy, and in other parts of the Roman empire. He who resided in Judæa commonly took up his abode at Tiberias, and assumed the name of *Ros-chabboth* "head of the fathers or patriarchs." He presided in assemblies, decided in cases of conscience, levied taxes for the expences of his visits, and had officers under him who were dispatched through the provinces for the execution of his orders. As to the princes of the captivity of Babylon, or the east, we know neither the original nor succession of them. It only appears that they were not in being before the end of the second century.

CAPTURE, a prize, or prey; particularly that of a ship taken at sea. Captures made at sea were formerly held to be the property of the captors after a possession of twenty-four hours; but the modern authorities require, that before the property can be changed, the goods must have been brought into port, and have continued a night *intra præsidia*, in a place of safe custody, so that all hope of recovering them was lost.

Capture also denotes an arrest or seizure of a criminal, debtor, &c. at land.

CAPUA, in *Ancient Geography*, a very ancient city of Italy, in Campania, and capital of that district. It is famous for the abode of Hannibal the Carthaginian general after the battle of Cannæ, and where Livy accuses him, but unjustly, of having enervated himself with pleasures *. It still retains the name, and is the see of an archbishop. It is seated on the river Volturno, in E. Long. 15. 5. N. Lat. 41. 7. The history of Capua is thus shortly deduced by Mr Swinburne. "It was a settlement of the Osci long before the foundation of Rome. As the amazing fertility of the land and a lucrative commerce poured immense wealth upon its inhabitants, it became one of the most extensive and magnificent cities in the world. With riches excessive luxury crept in, and the Capuans grew insolent; but by their effeminacy they soon lost the power of repelling those neighbouring nations which their insolence had exasperated. For this reason Capua was continually exposed to the necessity of calling in foreign aid, and endangering its safety by the uncommon temptations it offered to needy auxiliaries. The Roman soldiers sent to defend Capua were on the point of making it their prey, and often the voice of the Roman people was loud for a removal from the barren unwholesome banks of the Tiber to the garden of Italy, near those of the Volturno. Through well-founded jealousy of the ambition of Rome, or, as Livy and other partial writers term it, natural inconstancy, the

* See Carthage.

Capua, Capuchins.

the Capuans warmly espoused the quarrel of Carthage: Hannibal made Capua his winter quarters after the campaign of Cannæ; and there, if we are to believe historians, his rough and hitherto invincible soldiers were enervated by pleasure and indolence.

"When through a failure of supplies from Carthage Hannibal was under a necessity of remaining in Bruttium, and leaving the Capuans to defend themselves, this city, which had been long invested, was surrendered at discretion to the consuls Appius Claudius and Q. Fulvius Flaccus. The senators were put to death, the nobles imprisoned for life, and all the citizens sold and dispersed. Vibius, the chief of Hannibal's friends, avoided this ignominious fate, and escaped from the cruel vengeance of the Romans, by a voluntary death. —When the mob insisted upon the gates being thrown open to the enemy, Vibius assembled his steady associates, and sat down with them to a superb banquet, after which each of the guests swallowed a poisonous draught, and expired in full possession of their freedom. The buildings were spared by the victor; and Capua was left to be merely a harbour for the husbandmen of the plain, a warehouse for goods, and a granary for corn; but so advantageous a situation could not long be neglected; colonies were sent to inhabit it, and in process of time it regained a degree of importance.

"Genseric the Vandal was more cruel than the Roman conquerors had been; for he massacred the inhabitants, and burnt the town to the ground. Narses rebuilt it; but in 841 it was totally destroyed by an army of Saracens, and the inhabitants driven into the mountains. Some time after the retreat of these savage invaders, the Lombards ventured down again into the plain; but not deeming their force adequate to the defence of so large a circuit as the old city, they built themselves a smaller one on the river, and called it Capua.—They chose the site of Casilinum, famous in the second Punic war, for the resistance made by its garrison against Hannibal. Since the foundation of the new city, Old Capua has remained in ruins.

"In 856, Landulph formed here an independent earldom dismembered from the duchy of Benevento, and in the course of a few generations Capua acquired the title of a principality. In the 11th century, the Normans of Aversa expelled the Lombard race of princes, and Richard their chief became prince of Capua; the grandson of Tancred of Hauteville drove out the descendants of Richard, and united this state to the rest of his possessions.

"Capua is at present a neat little city, fortified according to the rules of modern art, and may be considered as the key of the kingdom; though far removed from the frontier, it is the only fortification that really covers the approach to Naples."

CAPUCHINS, religious of the order of St Francis in its strictest observance; deriving their name from *capuce*, or *capuchon*, a stuff cap, or cowl, wherewith they cover their heads. They are clothed with brown or gray; always barefooted; and never to go in a coach, nor ever shave their beard.—The Capuchins are a reform made from the order of Minors, commonly called *Cordeliers*, set on foot in the 16th century by Matthew Baschi, a religious observant of the monastery of Montefiascone; who, being at Rome,

Capuchins, Caracalla.

was advertised several times from heaven, to practise the rule of St Francis to the letter. Upon this he made application to Pope Clement in 1525; who gave him permission to retire into a solitude, with as many others as chose to embrace the strict observance. In 1528, they obtained the pope's bull. In 1529, the order was brought into complete form: Matthew was elected general, and the chapter made constitutions. In 1543, the right of preaching was taken from the Capuchins by the pope: but in 1545 it was restored to them again with honour. In 1578, there were already 17 general chapters in the order of Capuchins.

CAPUT, the head. See Head.

Caput baroniæ, the head of the barony, in ancient customs, denotes the ancient or chief seat or castle of a nobleman, where he made his usual residence, and held his court; sometimes also called *caput honoris*, or the head of the honour. The caput baroniæ could not be settled in dowry; nor could it be divided among the daughters, in case there was no son to inherit; but was to descend entire to the eldest daughter, *cæteris filiabus aliunde satisfactis*.

Caput Gallinaginis, in *Anatomy*, is a kind of septum, or spongy border, at the extremities or apertures of each of the *vesiculæ seminales*; serving to prevent the seed coming from one side, from rushing upon, and so stopping, the discharge of the other.

Caput Lupinum. Anciently an outlawed felon was said to have *caput lupinum*, and might be knocked on the head like a *wolf*, by any one that should meet him; because, having renounced all law, he was to be dealt with as in a state of nature, when every one that should find him might slay him; yet now, to avoid such inhumanity, it is holden that no man is entitled to kill him wantonly and wilfully; but in so doing he is guilty of murder, unless it is done in the endeavour to apprehend him.

Caput Mortuum, a Latin name given to fixed and exhausted residuums remaining in retorts after distillations. As these residuums are very different, according to the substances distilled, and the degree of heat employed, they are by the more accurate modern chemists particularly specified by adding a term denoting their qualities; as *earthy residuum*, *charry residuum*, *saline residuum*, &c.

CARABINE, a fire arm shorter than a musket, carrying a ball of 24 in the pound, borne by the light horse, hanging at a belt over the left shoulder. The barrel is two feet and a half long; and is sometimes furrowed spirally within, which is said to add to the range of the piece.

CARABINEERS, regiments of light horse, carrying longer carabines than the rest, and sometimes used on foot.

CARABUS. See Entomology *Index*.

CARACALLA, M. Antoninus Bassianus, emperor after his father Severus in 211, put the physicians to death for not despatching his father, as he would have had them. He killed his brother Geta; and put Papinianus to death, because he would not defend nor excuse his parricide. In short, it is said that 20,000 persons were massacred by his order. He married Julia, his father's widow. Going to Alexandria, he slew the inhabitants, and applied to the magicians and astrologers. At last, going from Edessa to Mesopotamia,

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one of his captains slew him, by order of Macrinus, who succeeded him. He died after he had reigned somewhat more than six years.

CARACALLA, in antiquity, a long garment, having a sort of capuchin, or hood a-top, and reaching to the heels; worn equally among the Romans by the men and the women, in the city and the camp. Spartian and Xiphilian represent the emperor Caracalla as the inventor of this garment, and hence suppose the appellation *Caracalla* was first given him. Others, with more probability, make the caracalla originally a Gallic habit, and only brought to Rome by the emperor above mentioned, who first enjoined the soldiery to wear it. The people call it *antoninian*, from the same prince, who had borrowed the name of Antoninus. The caracalla was a sort of cassock, or surtout. Salmasius, Scaliger, and after them Du Cange, even take the name *casaque* to have been formed from that of *caraque*, for *caracalla*. This is certain from St Jerome, that the caracalla, with a retrenchment of the capuchin, became an ecclesiastical garment. It is described as made of several pieces cut and sewed together, and hanging down to the feet; but it is more than probable there were some made shorter, especially out of Rome, otherwise we do not see how it could have fitted the soldiers purposes.

CARACCAS, a district of Terra Firma in South America, belonging to the Spaniards. The coast is rocky and mountainous, interspersed with small fertile valleys; subjected at certain seasons of the year to dry north-west winds, but blessed in general with a clear air and wholesome climate. A very great illicit trade is carried on by the English and Dutch with this province, notwithstanding all the vigilance of the Spaniards, who have scouts perpetually employed, and breastworks raised in all the valleys. A vast number of cacao trees are cultivated in this province; and it is reckoned that the crop of cacao produced here amounts to more than 100,000 fanegas of 110 pounds each. The country of Santa Fe consumes 20,000; Mexico a little more; the Canaries a small cargo; and Europe from 50 to 60,000. The cultivation of the plant employs 10 or 12,000 negroes. Such of them as have obtained their liberty have built a little town called *Nirva*, into which they will not admit any white people. The chief town is likewise called *Caraccas*, and is situated in N. Lat. 10. 10. It stands at a considerable distance from the sea; contains 34,000 inhabitants, and is extremely difficult of access, by reason of the steep and craggy hills over which an enemy must take his route. The commerce of this town, to which the bay of Guaira at two leagues distance serves for a harbour, was for a long time open to all the subjects of the Spanish monarchy, and is still so to the Americans; but the Europeans are not so well treated. The Caraccas contain altogether, according to Depons, 728,000 inhabitants, of whom the whites form two-tenths, the slaves three-tenths, the descendants of freedmen four, and the Indians the remainder. An insurrection began in this country in 1810, which it is probable will end in its separation from Old Spain. See CARACCAS, SUPPLEMENT.

CARACCI, LEWIS, AUGUSTINE, and HANNIBAL, three celebrated painters of the Lombard school, all of Bologna. Lewis was born in 1555; and was cousin-german to Augustine and Hannibal, who were brothers, the sons of a tailor, who was yet careful to give them a liberal education. They were both disciples of their cousin Lewis. Augustine gained a knowledge of mathematics, natural philosophy, music, poetry, and most of the liberal arts; but, though painting was his principal pursuit, he learned the art of engraving from Cornelius Cort, and surpassed all the masters of his time. Hannibal, again, never deviated from his pencil. —These three painters, at length, having reaped all the advantages they could by contemplation and practice, formed a plan of association, continued always together, and laid the foundation of that celebrated school which has ever since been known by the name of *Caracci's academy*. Hitherto all the young students, who had a view of becoming masters, resorted to be instructed in the rudiments of painting; and here the Caracci taught freely, and without reserve, all that came. Lewis's charge was to make a collection of antique statues and bas reliefs. They had designs of the best masters, and a collection of curious books on all subjects relating to their art; and they had a skilful anatomist always ready to teach what belonged to the knitting and motions of the muscles, &c. There were often disputations in the academy; and not only painters, but men of learned professions, proposed questions, which were always decided by Lewis. Every body was well received; and though stated hours were allotted to treat of different matters, yet improvements might be made at all hours by the antiquities and the designs which were to be seen.

The fame of the Caracci reaching Rome, the cardinal Farnese sent for Hannibal thither, to paint the gallery of his palace. Hannibal was the more willing to go, because he had a great desire to see Raphael's works, with the antique statues and bass reliefs. The gusto which he took there from the ancient sculpture, made him change his Bolognian manner for one more learned but less natural in the design and in the colouring.—Augustine followed Hannibal, to assist him in his undertaking of the Farnese gallery; but the brothers not rightly agreeing, Farnese sent Augustine to the court of the duke of Parma, where he died in the year 1602, being only 45 years of age. His most celebrated piece of painting is that of the Communion of St Jerome, in Bologna.

In the mean while, Hannibal continued working in the Farnese gallery at Rome; and, after inconceivable pains and care, finished the paintings in the perfection in which they are now to be seen. He hoped that the cardinal would have rewarded him in some proportion to the excellence of his work, and the time it took him up, which was eight years; but he was disappointed. The cardinal, influenced by an ignorant Spaniard, his domestic, gave him but a little above 200l. though it is certain he deserved more than twice as many thousands. When the money was brought him, he was so surprised at the injustice done him, that he could not speak a word to the person who brought it. This confirmed him in a melancholy to which his temper naturally inclined, and made him resolve never more to touch his pencil; which resolution he had undoubtedly kept, if his necessities had not compelled him to break it. It is said, that his melancholy gained so much upon him, that at certain times it deprived him of the use of his senses. It did not, however, put a stop to his amours; and his debauches at Naples, whither he had retired for the

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the recovery of his health, brought a distemper upon him of which he died in 1609, when he was 49 years of age. His veneration for Raphael was so great, that it was his deathbed request to be buried in the same tomb with him; which was accordingly done, in the Pantheon or Rotunda at Rome. There are extant several prints of the blessed Virgin, and some other subjects, etched by the hand of this incomparable artist. He is said to have been a friendly, plain, honest, and open-hearted man; very communicative to his scholars, and so extremely kind to them, that he generally kept his money in the same box with his colours, where they might have recourse to either as they had occasion.

While Hannibal Caracci worked at Rome, Lewis was courted from all parts of Lombardy, especially by the clergy, to make pictures in their churches: and we may judge of his capacity and facility, by the great number of pictures he made, and by the preference that was given him to other painters. In the midst of these employments Hannibal solicited him to come and assist him in the Farnese gallery; and so earnestly, that he could not avoid complying with his request. He went to Rome; corrected several things in that gallery; painted a figure or two himself; and then returned to Bologna, where he died in 1619, aged 64.

CARACOL, in the manege, the half turn which a horseman makes, either to the right or left.—In the army, the horse always makes a caracol after each discharge, in order to pass the rear of the squadron.

Caracol, in *Architecture*, denotes a staircase in a helix or spiral form.

CARACOLI, a kind of metal of which the Caribbees, or natives of the Lesser Antilles, make a sort of ornament in the form of a crescent, which they also call *caracoli*.—This metal comes from the main land; and the common opinion is, that it is a compound of silver, copper, and gold, something like the Corinthian brass among the ancients. These metals are so perfectly mixed and incorporated together, that the compound which results from them, it is said, has a colour that never alters, how long soever it remains in the sea or under ground. It is somewhat brittle; and they who work at it are obliged to mix a large proportion of gold with it, to make the compound more tough and malleable.

CARACT, or Carat, the name of that weight which expresses the degree of fineness that gold is of. The word is also written *carract*, *carrat*, *karract*, and *karrat*. Its origin is contested: but the most probable opinion is that of Kennet, who derives it from *carecta*, a term which anciently denoted any weight, and came not till of later days to be appropriated to that which expresses the fineness of gold, and the gravity of diamonds.

These carats are not real determinate weights, but only imaginary. The whole mass, be the weight what it will, is conceived to be divided into 24 carats; and as many 24th parts as it contains of pure gold, it is called *gold of so many carats*, or *so many carats fine*. Thus, gold of 18 carats is a mixture, of which 18 parts are pure gold, and the other six an inferior metal, &c. This is the common way of reckoning in Europe, and at the gold mines in the Spanish West Indies, but with some variation in the subdivision of the carat; among us, it is divided into four grains; among the Germans, into 12 parts; and by the French, according to Mr Helot, into 32. The Chinese reckon by a different division called *touches*, of which the highest number, or that which denotes pure gold, is 100; so that 100 touches correspond to our 24 carats, &c.

Caract is also a certain weight which goldsmiths and jewellers use wherewith to weigh precious stones and pearls.—In this sense, the word is by some supposed to be derived from the Greek κερατιον, a fruit which the Latins call *siliqua*, and we *carob bean*; each of which may weigh above four grains of wheat, whence the Latin *siliqua* has been used for a weight of four grains. This caract weighs four grains, but they are sometimes lighter than the grains of other weights. Each of these grains is subdivided into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ $\frac{1}{16}$, &c.

CARACTACUS, a renowned king of the ancient British people called *Silures*, inhabiting South Wales. Having valiantly defended his country seven years against the Romans, he was at length defeated; and flying to Cartismunda, queen of the Brigantes (inhabitants of Yorkshire), was by her treacherously delivered up to the Romans, and led in triumph to the emperor Claudius then at York; where his noble behaviour, and heroic but pathetic speech, obtained him not only his liberty, but the esteem of the emperor, A. D. 52.

CARAGROUTH, in commerce, a silver coin of the empire, weighing nine drachms. It goes at Constantinople for 120 aspers. There are four sorts of them, which are all equally current and of the same value.

CARAITES, in the ecclesiastical history of the Jews, a religious sect among that people, whereof there are still some subsisting in Poland, Russia, Constantinople, Cairo, and other places of the Levant, whose distinguishing tenet and practice it is, to adhere closely to the words and letter of the Scripture, exclusive of allegories, traditions, and the like.

Leo of Modena, a rabbin of Venice, observes, that of all the heresies among that people, before the destruction of the temple, there is none now left but that of the *Caraim*, a name derived from *Micra*, which signifies the pure text of the Bible, because of their keeping to the Pentateuch, observing it to the letter, and rejecting all interpretations, paraphrases, and constitutions of the rabbins. Aben Ezra, and some other rabbins, treat the Caraites as Sadducees; but Leo de Juda calls them, more accurately, Saducees reformed; because they believe the immortality of the soul, paradise, hell, resurrection, &c. which the ancient Sadducees denied. He adds, however, that they were doubtless originally real Sadducees, and sprung from among them.

M. Simon, with more probability, supposes them to have risen hence; that the more knowing among the Jews opposing the dreams and reveries of the rabbins, and using the pure texts of Scripture to refute their groundless traditions, had the name of *Caraim* given them; which signifies as much as the barbarous Latin *Scripturarii*; i. e. people attached to the text of Scripture. The other Jews gave them the odious name Sadducees, from their agreement with those sectaries on the head of traditions. Scaliger, Vossius, and Span-

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Caraites. helm, rank the Caraites among the Sabeans, Magi, Manichees, and Mussulmans, but by mistake: Wolfgang, Fabricius, &c. say the Sadducees and Esseni were called Caraites, in opposition to the Pharisees; others take them for the doctors of the law so often mentioned in the Gospel: but these are all conjectures, Josephus and Philo make no mention of them; which shows them to be more modern than either of those authors. In all probability, this sect was not formed till after the collection of the second part of the Talmud, or the Gemera; perhaps not till after the compiling of the Mischna in the third century. The Caraites themselves pretend to be the remains of the ten tribes led captive by Shalmaneser. Wolfius, from the Memoirs of Mardacheus, a Caraite, refers their origin to a massacre among the Jewish doctors under Alexander Jannæus, their king, about 100 years before Christ: because Simon, son of Schetach, and the queen's brother, making his escape into Egypt, there forged his pretended traditions; and, at his return to Jerusalem, published his visions; interpolating the law after his own fancy, and supporting his novelties on the notices which God, he said, had communicated by the mouth of Moses, whose depositary he was: he gained many followers; and was opposed by others, who maintained, that all which God had revealed to Moses was written. Hence the Jews became divided into two sects, the Caraites and Traditioners: among the first Juda, son of Tabbai, distinguished himself; among the latter, Hillel. Wolfius reckons not only the Sadducees, but also the Scribes, in the number of Caraites. But the address of the Pharisees prevailed against them all; and the number of Caraites decreased: Anan, indeed, in the eighth century, retrieved their credit a little; and Rabbi Schalomon in the ninth. They succeeded pretty well till the fourteenth; but since that time they have been declining.

The Caraites are but little known; their works coming only into very few hands, even among the greatest Hebraists. Buxtorf never saw more than one; Selden two; but Mr Trigland says, he has recovered enough to speak of them with assurance. He asserts, that soon after the prophets had ceased, the Jews became divided on the subject of works, and supererogation: some maintaining their necessity from tradition; whilst others, keeping close to the written law, set them aside; and it was from these last that Caraitism commenced. He adds, that after the return from the Babylonish captivity, the observation of the law being to be re-established, there were several practices found proper for that end; and these once introduced, were looked upon as essential, and appointed by Moses; which was the origin of Pharisaism: as a contrary party, continuing to keep close to the letter, founded Caraitism.

The modern Caraites, Leo of Modena observes, have their synagogues and ceremonies; they pretend to be the sole proper Jews, or observers of the laws of Moses; calling the rest by the term *Rabbanim*, or *followers of the Rabbins*: these hate the Caraites mortally; refusing to ally or even to converse with them, and treating them as *mamzerim*, bastards; because of their rejecting the constitutions of the rabbins relating to marriages, repudiations, purifications of women, &c. This aversion is so great, that if a Caraite should become a Rabbinist, he would never be received by the other Jews.

Caraites ‖ Carara. The Caraites, however, do not absolutely reject all kinds of traditions; but only such as do not appear well grounded. Selden, who is very express on this point, in his Uxor Hebraica, observes, that, besides the mere text, they have certain interpretations, which they call hereditary, and which are proper traditions. Their theology only seems to differ from that of the other Jews, in that it is purer, and clearer of superstition; they give no credit to the explications of the Cabbalists, chimerical allegories, nor to any constitutions of the Talmud, but what are conformable to the Scripture, and may be drawn from it by just and necessary consequences.

Peringer observes of the Caraites in Lithuania, that they are very different, both in aspect, language, and manners, from the Rabbinists, wherewith the country abounds. Their mother tongue is the Turkish; and this they use in their schools and synagogues. In visage they resemble the Mahometan Tartars. Their synagogues are placed north and south; and the reason they give for it is, that Shalmaneser brought them northward: so that, in praying, to look to Jerusalem, they must turn to the south. He adds, that they admit all the books of the Old Testament; contrary to the opinion of many of the learned, who hold that they reject all but the Pentateuch.

Caleb, a Caraite, reduces the difference between them and the Rabbinists to three points: 1. In that they deny the oral law to have come from Moses, and reject the Cabbala. 2. In that they abhor the Talmud. 3. In that they observe the feasts, as the sabbaths, &c. much more rigorously than the Rabbins do. To this may be added, that they extend the degrees of affinity, wherein marriage is prohibited, almost to infinity.

CARAMANIA, a considerable province of Turkey in Asia, in the south part of Natolia. Bajazet united this province to his empire about the year 1488, and since that time it has continued in the possession of the Turks. Satalia was the capital city, but is now much decayed.

CARAMANTA, a town of South America, and capital of the province of the same name in Terra Firma, and in the audience of Santa Fe. W. Long. 72. 35. N. Lat. 5. 18. The province of Caramanta is extended on both sides the river Cauca; and is bounded on the north by the district of Carthagena, on the east by New Grenada, on the south by Popayan, and on the west by Popayan and by the audience of Panama. It is a valley surrounded on every side by very high mountains.

CARANGA, an inconsiderable island near Bombay in the East Indies. It affords nothing but some rice, fowls, and goats, for that market.

CARANNA, or KARANNA, a very scarce gum which comes from New Spain. It is said to possess many extraordinary medical virtues, but the present practice takes no notice of it.

CARANUS, the first king of Macedon, and the seventh of the race of the Heraclidæ. See MACEDONIA.

CARARA, a weight at Leghorn, and in other parts of Italy, used in the sale of wool and cod fish, equivalent to 60 pounds of that country.

CARAT.

CARAT. See CARACT.

CARAVAGGIO, MICHAEL ANGELO. See ANGELO.

CARAVAN, or KARAVANNE, in the east, signifies a company or assembly of travellers and pilgrims, and more particularly of merchants, who, for their greater security, and in order to assist each other, march in a body through the deserts, and other dangerous places, which are infested with Arabs or robbers.

There are four regular caravans which go yearly to Mecca; the first from Damascus, composed of the pilgrims from Europe and Asia; the second from Cairo, from the Mahomedans of Barbary; the third from Zibith, a place near the mouth of the Red sea, where those of Arabia and India meet; the fourth from Babylon, where the Persians assemble. Most of the inland commerce of the east is carried on by caravans. The late Czar Peter the Great established a trade between Russia and China by means of a caravan. M. Bougnon, geographer to the duke of Lorrain, has given a treatise of the caravans of merchants in Asia; wherein he shows of what they are composed; how many sorts there are; the several uses of the different sorts of animals in them; the prices given for them; the officers and men appointed to conduct them, and the pay of each, with their manner of marching, halting, fighting, retreating, &c. Caravans of this kind are large convoys of armed men, merchants, and travellers, with divers sorts of animals for the carriage of their provisions. There are commonly four chief officers of a caravan, viz. the caravan bachi, or chief; the captain guide; captain of rest; and captain of distribution. The first has absolute command over all the rest: the second is absolute in the march: the office of the third only commences when the caravan stops and makes a stay: to the fourth it belongs to dispose of every part of the corps, in case of an attack or battle; he has also the inspection over the distribution of provisions, which is made under him by several distributors, who give security to the master of the caravan, and have each of them a certain number of persons, elephants, dromedaries, &c. to take care of at their own peril. The treasurer of the caravan makes a fifth officer, who has under him several agents and interpreters, who keep journals of all that passes, for the satisfaction of those concerned in fitting out the caravan.

Any dealer is at liberty to form a company, in order to make a caravan. He in whose name it is raised, is considered as the caravan bachi, or chief of the caravan, unless he appoint some other in his place. If there are several merchants equally concerned, they elect a caravan bachi; after which, they appoint officers to conduct the caravan, and decide all controversies that may arise during the journey.

There are also sea caravans; established on the same footing, and for the same purpose: such is the caravan of vessels from Constantinople to Alexandria.

CARAVANSERA, or KARAVANSERA, a place appointed for receiving and loading the caravans.

It is commonly a large square building, in the middle of which there is a very spacious court; and under the arches or piazzas that surround it there runs a bank, raised some feet above the ground, where the merchants, and those who travel with them in any capacity, take up their lodgings as well as they can; the beasts of burden being tied to the foot of the bank. Over the gates that lead into the court, there are sometimes little rooms, which the keepers of the caravanseras let out at a very high price to such as have a mind to be private.

The caravanseras in the east are something of the nature of the inns in Europe; only that you meet with little accommodation either for man or beast, but are obliged to carry almost every thing with you: there is never a caravansera without a well, or spring of water. These buildings are chiefly owing to the charity of the Mahometans: they are esteemed sacred dwellings, where it is not permitted to insult any person, or to pillage any of the effects that are deposited there. There are also caravanseras where most things may be had for money; and as the profits of these are considerable, the magistrates of the cities to whose jurisdiction they belong take care to store them well. There is an inspector, who, at the departure of each caravan, fixes the price of the night's lodging, from which there is no appeal.

CARAVANSERASKIER, the stewart or keeper of a CARAVANSERA. He keeps an account of all the merchandises that are sold upon trust, and demands the payments of the sums due to the merchants for what has been sold in the caravansera, on the seller's paying two per cent.

CARAVEL; thus they call a small vessel on the coast of France, which goes to fish for herring on the banks. They are commonly from 25 to 30 tons burden. Those which are designed for the same fishery in the British channel are called by the French *trinquarts*; these are from 12 to 15 tons burden.

CARAWAY. See CARUM, BOTANY *Index*.

CARBONADE, or CARBONADO, in cookery; flesh, fowl, or the like, seasoned and broiled on the coals.

CARBUNCLE, in *Natural History*, a very elegant gem, whose colour is deep red, with an admixture of scarlet.

This gem was known among the ancients by the name of *anthrax*. It is usually found pure and faultless, and is of the same degree of hardness with the sapphire: it is naturally of an angular figure; and is found adhering by its base, to a heavy and ferruginous stone of the emery kind: its usual size is near a quarter of an inch in length, and two-thirds of that in diameter in its thickest parts: when held up against the sun, it loses its deep tinge, and becomes exactly of the colour of a burning charcoal, whence the propriety of the name which the ancients gave it. It bears the fire unaltered, not parting with its colour, nor becoming at all the paler by it. It is found only in the East Indies, so far as is yet known; and there but very rarely.

CARBUNCLE, or *Anthrax*, in *Medicine*, an inflammation which arises, in time of the plague, with a vesicle or blister almost like that produced by burning.

CARBUNCLE, in *Heraldry*, a charge or bearing, consisting of eight radii, four whereof make a common cross, and the other four a saltier.

Some call these radii *buttons*, or staves, because round, and enriched with buttons, or pearled like pilgrims staves, and frequently tipped or terminated with flower-de-luces;

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de-luces; others blazon them, royal sceptres, placed in saltier, pale and fesse.

CARCASSE, or CARCUS, in the art of war, an iron case, or hollow capacity, about the bigness of a bomb, of an oval figure, made of ribs of iron, filled with combustible matters, as meal powder, saltpetre, sulphur, broken glass, shavings of horn, turpentine, tallow, &c. It has two or three apertures out of which the fire is to blaze, and the design of it is to be thrown out of a mortar, to set houses on fire, and do other execution. It has the name *carcasse*, because the circles which pass from one ring or plate to the other seem to represent the ribs of a human carcase.

CARCASSONE, an ancient city of France, in Lower Languedoc, with a bishop's see. It is divided into the upper and lower town. They are both surrounded with walls; and though their situations are different, they are both watered by the river Aude. The upper town is seated on a hill, with a castle that commands it as well as the lower town. It is strong, not only by its situation on a craggy rock, but also by several large towers which are joined to its walls, and which render it of difficult access. The cathedral church is remarkable for nothing but its antiquity. The lower town is large, and built after the modern taste. The streets are very straight, and lead to a large square in the middle, from whence may be seen the four gates of the town. It contained 15,200 inhabitants in 1815. The neighbouring country is full of olive-trees; and in the mountains there is a fine marble, commonly called *marble of Languedoc*. E. Long. 2. 25. N. Lat. 43. 11.

This place bore a considerable share in that celebrated crusade undertaken against the Albigenses in the beginning of the 13th century, and which forms one of the most astonishing instances of superstition and of atrocious barbarity to be found in the annals of the world. When the royal power was nearly annihilated, during the reigns of the last kings of the Carlovingian race in France, most of the cities of Languedoc erected themselves into little independent states, governed by their own princes. Carcassone was then under the dominion of viscounts. At the time when Pope Innocent III. patronised and commanded the prosecution of hostilities against the Albigenses for the crime of heresy, Raymond the reigning viscount was included in that proscription. Simon de Montfort, general of the army of the church, invested the city of Carcassone in 1209. The inhabitants, terrified at the fate of several other places where the most dreadful massacres had been committed, demanded leave to capitulate; but this act of mercy was only extended to them under a condition equally cruel, incredible, and unparalleled in history, if we are not compelled to believe it by the unanimous testimony of all the contemporary writers. The people found in the place were all obliged, without distinction of rank or sex, to evacuate it in a state of nudity; and Agnes the viscountess was not exempted, though young and beautiful, from this ignominious and shocking punishment. "On les fit sortir tout nuds de la ville de Carcassone (says an ancient author) afin qu'ils receussent de la honte, en montrant ces parties du corps que la pureté de la langue n'exprime point, desquelles ils avoient abuse, et s'en etoient servis dans des crimes execrables." It seems by this imputation that the Albigeois were accused by their enemies of some enormities, probably unjust, and similar to those which religious enmity and prejudice have attributed to the followers of Zinzendorf in the last century.

CARCERES, in the ancient Circensian games, were inclosures in the circus, wherein the horses were restrained till the signal was given for starting, when by an admirable contrivance, they all at once flew open.

CARCHEMISH, in *Ancient Geography*, a town lying upon the Euphrates, and belonging to the Assyrians. Necho king of Egypt took it from the king of Assyria, 2 Chron. xxxv. 20. Necho left a garrison in it, which was taken and cut to pieces, in the fourth year of Jechoiachin king of Judah, by Nebuchadnezzar king of Babylon, 2 Kings xxiii. 29. Isaiah (x. 9.) speaks of Carchemish, and seems to say, that Tiglath-Pileser made a conquest of it, perhaps from the Egyptians. This is thought to be the same city with that called Circesium by the Greeks and Latins.

CARCINOMA, in *Medicine;* the same with CANCER. See MEDICINE and SURGERY *Index*.

CARD, among artificers, an instrument consisting of a block of wood, beset with sharp teeth, serving to arrange the hairs of wool, flax, hemp, and the like; there are different kinds of them, as hand-cards, stock-cards, &c. They are made as follows:

A piece of thick leather, of the size intended for the card, is strained in a frame for that purpose; and then pricked full of holes, into which the teeth or pieces of iron wire are inserted. After which the leather is nailed by the edges to a flat piece of wood, in the form of an oblong square, about a foot in length, and half a foot in breadth, with a handle placed in the middle of one of the longer sides.

The teeth are made in the following manner. The wire being drawn of the size intended, a skain or number of wires are cut into proper lengths by means of a gauge, and then doubled in a tool contrived for that purpose; after which they are bent into the proper direction by means of another tool; and then placed in the leather, as mentioned above.

CARDS, among gamesters, little pieces of fine thin pasteboard of an oblong figure, of several sizes; but most commonly in Britain, three inches and a half long and two and a half broad, on which are painted several points and figures.

The moulds and blocks for making cards are exactly like those that were used for the first printed books. They lay a sheet of wet or moist paper on the block, which is very slightly done over with a sort of ink made of lamp-black diluted in water, and mixed with some starch to give it a body. They afterwards rub it off with a round list. The court-cards are coloured by means of several patterns, styled *stane-files*. These consist of papers cut through with a penknife; and in these apertures they apply severally the various colours, as red, black, &c. These patterns are painted with oil-colours, that the brushes may not wear them out; and when the pattern is laid on the pasteboard, they slightly pass over it a brush full of colour, which leaving it within the openings, forms the face or figure of the card.

Among sharpers, divers sorts of false and fraudulent cards have been contrived; as, 1. *Marked* cards, where the

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Cards.

the aces, kings, queens, knaves, are marked on the corners of the backs with spots of different number and order, either with clear water or water tinged with pale Indian ink, that those in the secret may distinguish them. Aces are marked with single spots on two corners opposite diagonally: kings with two spots at the same corners: knaves with the same number transversed. 2. *Breef* cards, those which are longer or broader than the rest; chiefly used at whist and piquet. The broad cards are usually for kings, queens, knaves, and aces; the long for the rest. Their design is to direct the cuttings, to enable him in the secret to cut the cards disadvantageously to his adversary, and draw the person unacquainted with the fraud to cut them favourably for the sharper. As the pack is placed either endwise or sidewise to him that is to cut, the long or broad cards naturally lead him to cut them. Breef cards are sometimes made thus by the manufacturer; but, in defect of these, sharpers pare all but the breefs with a penknife or razor. 3. *Corner bend*, denotes four cards turned down finely at one corner, to serve as a signal to cut by. 4. *Middle bend*, or Kingston-bridge, is where the tricks are bent two different ways, which causes an opening or arch in the middle, to direct likewise the cutting.

Cards were invented about the year 1390, to divert Charles VI. of France, who had fallen into a melancholy disposition. The inventor proposed, by the figures of the four suits or colours, as the French call them, to represent the four classes of men in the kingdom. By the *cœurs* (hearts) are meant the *gens de choeur*, choir-men, or ecclesiastics; and therefore the Spaniards, who certainly received the use of cards from the French, have *copas*, or chalices, instead of hearts. The nobility, or prime military part of the kingdom, are represented by the ends or points of lances or pikes; and our ignorance of the meaning or the resemblance of the figure induced us to call them *spades:* The Spaniards have *espadas*, swords, in lieu of pikes, which are of similar import. By diamonds are designed the order of citizens, merchants, or tradesmen, *carreaux*, (square stones, tiles, or the like): The Spaniards have a coin, *dineros*, which answers to it: and the Dutch call the French word *carreaux*, "*streneen*," stones and diamonds, from the form. *Trefle*, the trefoil-leaf, or clover-grass (corruptly called *clubs*), alludes to the husbandmen and peasants. But how this suit came to be called *clubs* is not easily explained; unless borrowing the game from the Spaniards, who have *bastos* (staves or clubs) instead of the trefoil, we give the Spanish signification to the French figure.

The history of the four kings, which the French, in drollery, sometimes call the cards, are David, Alexander, Cæsar, and Charles; which names were then, and still are on the French *cards*. Those respectable names represent the four celebrated monarchies of the Jews, Greeks, Romans, and Franks under Charlemagne. By the queens are intended Argine, Esther, Judith, and Pallas (names retained in the French cards), typical of birth, piety, fortitude, and wisdom, the qualifications residing in each person. *Argine* is an anagram for *regina*, queen by descent. By the knaves were designed the servants to knights (for *knave* originally meant only *servant*); but French pages and valets, now indiscriminately used by various orders of persons, were formerly only allowed to persons of quality, esquires (*escuires*), shield or armour bearers. Others fancy that the knights themselves were designed by these cards; because Hogier and Labire, two names on the French cards, were famous knights at the time cards were supposed to have been invented.

Cards ‖ Cardan.

Deceptions with CARDS. See LEGERDEMAIN, sect. i.

CARDAMINE, in *Botany*, a genus of the siliquosa order, belonging to the tetradynamia class of plants; and in the natural method ranking under the 39th order *Siliquosæ*. The siliqua parts asunder with a spring, and the valves roll spirally backward; the stigma is entire, and the calyx a little gaping. Of this there are 15 species; but the most remarkable is the pratensis, with a large purplish flower. This grows naturally in many parts of Britain, and is also called *cuckow flower*. There are four varieties, viz. the single, with purple and white flowers, which are frequently intermixed in the meadows; and the double, of both colours. The single sorts are not admitted into gardens; but the double deserve a place, as making a pretty appearance during the time they are in flower. They will thrive in a moist shady border; and are propagated by parting their roots, which is best performed in autumn. They delight in a soft loamy soil, not too stiff. By some the plant is reckoned antiscorbutic.

CARDAMOM, in the *Materia Medica*. See AMOMUM.

CARDAN, JEROM, one of the most extraordinary geniuses of his age, was born at Pavia on the 24th of September 1501. As his mother was not married, she tried every method to procure an abortion, but without effect. She was three days in labour, and they were at last obliged to cut the child from her. He was born with his head covered with black curled hair. When he was four years old, he was carried to Milan, his father being an advocate in that city. At the age of 20, he went to study at the university of that city; and two years afterwards he explained Euclid. In 1524, he went to Padua, and the same year he was admitted to the degree of master of arts: in the end of the following year, he took the degree of doctor of physic. He married about the year 1531. For ten years before, his impotency had hindered him from having knowledge of a woman, which was a great mortification to him. He attributed it to the evil influences of his planet under which he was born. When he enumerates, as he frequently does, the greatest misfortunes of his life, this ten years impotency is always one. At the age of 32, he became professor of mathematics at Milan. In 1539, he was admitted a member of the college of physicians at Milan; in 1543, he read public lectures of medicine in that city, and at Pavia the year following; but discontinued them because he could not get payment of his salary, and returned to Milan. In 1552, he went into Scotland, having been sent for by the archbishop of St. Andrew's who had in vain applied to the French king's physicians, and afterwards to those of the emperor of Germany. This prelate, then 40 years old, had for ten years been afflicted with a shortness of breath, which returned every eight days for the last two years. He began to recover from the moment that Cardan prescribed for him. Cardan took his leave of him at the end of six weeks and

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Cardan.

and three days, leaving him prescriptions which in two years wrought a complete cure.

Cardan's journey to Scotland gave him an opportunity of visiting several countries. He crossed France in going thither; and returned through Germany, and the Low Countries, along the banks of the Rhine. It was on this occasion he went to London, and calculated King Edward's nativity. This tour took up about four months; after which, coming back to Milan, he continued there till the beginning of October 1552; and then went to Pavia, from whence he was invited to Bologna in 1562. He taught in this last city till the year 1570; at which time he was thrown into prison; but some months after he was sent home to his own house. He left Bologna in 1571, and went to Rome, where he lived for some time without any public employment. He was, however, admitted a member of the college of physicians, and received a pension from the pope. He died at Rome on the 21st of September, 1575, according to Thuanus. This account might be sufficient to shew the reader that Cardan was of a very fickle temper; but he will have a much better idea of his singular and odd turn of mind by examining what he himself has written concerning his own good and bad qualities. He paid himself congratulatory compliments for not having a friend in this world; but that in requittal, he was attended by an aerial spirit, emaned partly from Saturn and partly from Mercury, who was the constant guide of his actions, and teacher of every duty to which he was bound. He declared, too, that he was so irregular in his manner of walking the streets, as induced all beholders to point at him as a fool. Sometimes he walked very slowly, like a man absorbed in profound meditation; then all on a sudden quickened his steps, accompanying them with very absurd attitudes. In Bologna his delight was to be drawn about in a mean vehicle with three wheels. When nature did not visit him with any pain, he would procure to himself that disagreeable sensation by biting his lips so wantonly, or pulling his fingers to such a vehement degree, as sometimes to force the tears from his eyes: and the reason he assigned for so doing, was to moderate certain impetuous sallies of the mind, the violence of which was to him by far more insupportable than pain itself; and that the sure consequence of such a severe discipline was the enjoying the pleasure of health. He says elsewhere, that, in the greatest tortures of soul, he used to whip his legs with rods, and bite his left arm; that it was a great relief to him to weep, but that very often he could not; that nothing gave him more pleasure than to talk of things which made the whole company uneasy; that he spoke on all subjects, in season and out of season; and he was so fond of games of chance, as to spend whole days in them, to the great prejudice of his family and reputation, for he even staked his furniture and his wife's jewels.

Cardanus makes no scruple of owning that he was revengeful, envious, treacherous, a dealer in the black-art, a backbiter, a calumniator, and addicted to all the foul and detestable excesses that can be imagined; yet notwithstanding (as one would think) so humbling a declaration, there was never perhaps a vainer mortal, or one that with less ceremony expressed the high opinion he had of himself, than Cardanus was known to do, as will appear by the following proofs. "I have been admired by many nations: an infinite number of panegyrics, both in prose and verse, have been composed to celebrate my fame. I was born to release the world from the manifold errors under which it groaned. What I have found out could not be discovered either by my predecessors or my cotemporaries; and that is the reason why those authors who write any thing worthy of being remembered, scruple not to own that they are indebted to me for it. I have composed a book on the dialectic art, in which there is neither one superfluous letter nor one deficient. I finished it in seven days, which seems a prodigy. Yet where is there a person to be found, that can boast of his having become master of its doctrine in a year? And he that shall have comprehended it in that time, must appear to have been instructed by a familiar demon."

Cardan, Cardass.

The same capriciousness observable in his outward conduct is to be observed in the composition of his works. We have a multitude of his treatises in which the reader is stopped almost every moment by the obscurity of his text, or his digressions from the point in hand. In his arithmetical performances there are several discourses on the motions of the planets, on the creation, and on the tower of Babel. In his dialectic work, we find his judgment on the historians and the writers of epistles. The only apology which he makes for the frequency of his digressions is, that they were purposely done for the sooner filling up of his sheet, his bargain with the bookseller being at so much per sheet: and that he worked as much for his daily support as for the acquisition of glory. The Lyons edition of his works, printed in 1663, consists of ten volumes in folio.

It was Cardanus who revived in latter times all the secret philosophy of the Cabbala or Cabbalists, which filled the world with spirits; a likeness to whom, he asserted, we might attain by purifying ourselves with philosophy. He chose for himself, however, notwithstanding such reveries, this fine device, *Tempus mea possessio, tempus meus ager*: "Time is my sole possession, and the only fund I have to improve."

In fact, when we consider the transcendent qualities of Cardan's mind, we cannot deny his having cultivated it with every species of knowledge, and his having made a greater progress in philosophy, in the medical art, in astronomy, in mathematics, &c. than the greatest part of his cotemporaries who had applied their minds but to one of those sciences.

Scaliger affirms, that Cardan, having fixed the time of his death, abstained froom food, that this prediction might be filfilled, and that his continuance to live might not discredit his art. Cardan's father, who was a doctor of medicine, and a professor of civil and canon law, died in the same manner in the year 1524, having abstained from all sustenance for nine days. His son tells us that he had white eyes, and could see in the night time.

CARDASS, a sort of card proper for carding flocks of silk, to make cappadine of it. It is also the name which the French give to those flocks of silk.

CARDASS is also the name which, in the cloth manufactories of Languedoc, they give to a sort of large card, which is used for carding the dyed wool, designed for making cloth of mixed colours.

CARDERS,

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CARDERS, in the woollen manufactory, are persons who prepare wool, &c. for spinning, &c.

Carders, spinners, weavers, fullers, sheermen, and dyers, not performing their duty in their occupations, shall yield to the party grieved double damages; to be committed until payment. One justice to hear and determine complaints.

Carders, combers, sorters, spinners, or weavers, conveying away, embezzling, or detaining any wool or yarn, delivered by the clothier, or any other person, shall give the party grieved such satisfaction, as two justices, mayor, &c. shall think fit: if not able or willing to make satisfaction, for the first offence to be whipped, or set in the stocks in some market town, or in any other town where the offence is committed: the second offence to incur the like, or such further punishment by whipping, &c. as justices shall think proper. Conviction by one witness on oath, or confession.

CARDI, LUDOVICO. See CIVOLI.

CARDIAC, in a general sense, signifies all medicines beneficial to the heart, whether internally or externally applied. The word comes from the Greek word καρδια, *cor;* the heart being reputed the immediate seat of their operation.

CARDIACS, in a more particular sense, denote medicines which raise the spirits and give present strength and cheerfulness; these amount to the same with what are properly called *cordials*. Cardiacs are medicines anciently supposed to exert themselves immediately in comforting and strengthening the heart: but the modern physicians rather suppose them to produce the effect by putting the blood into a gentle fermentation, whereby the springs, before decayed, are repaired and invigorated, and the tone and elasticity of the fibres of the vessels restored; the consequence of which is a more easy and brisk circulation.

CARDIALGIA, in *Medicine*, a violent sensation of heat or acrimony felt towards the upper or left orifice of the stomach, though seemingly at the heart; sometimes accompanied with palpitations of the heart, fainting, and a propensity to vomit: better known by the name of *cardiac passion*, or *heart-burn*. See MEDICINE *Index*.

CARDIFF, a town of Glamorganshire, in South Wales, seated on the river Tave, in a rich and fruitful soil. It is a large, compact, well built town, having a castle, a wall, and four gates, built by Robert Fitz-Hamon, a Norman, about the year 1100. It is governed by the constable of the castle, 12 aldermen, 12 burgesses, &c. and sends one member to parliament. Here the assizes and sessions are held, besides several courts. There is a handsome bridge over the river, to which small vessels come to take in their lading. It has now only one church; St Mary's having been long since thrown down by the undermining of the river. The castle, though much decayed, makes a grand appearance even at this time; and the walls of the town are very strong and thick. The church has a fine tower-steeple, and the town-hall is a good structure. The magistrates are elected every year by the majority of the burgesses. W. Long. 3. 20. N. Lat. 51. 30. Cardiff gives the title of a British baron to the family of Bute in Scotland. Population 2457 in 1811.

CARDIGAN, the capital town of Cardiganshire, in South Wales, is seated near the mouth of the river Teivy, on the Irish channel. It contains three wards, one church, and the county gaol, and had 2129 inhabitants in 1811. It is governed by a mayor, 13 aldermen, 13 common council men, &c. Here are the ruins of a castle which was built by Gilbert de Clare, about the year 1100. It sends one member to parliament; and has two markets, held on Tuesdays and Saturdays. W. Long. 4. 38. N. Lat. 52. 15.

CARDIGANSHIRE, a county of South Wales, bounded on the north by Merionethshire and Montgomeryshire, on the east by Radnorshire and Brecknockshire, on the west by the Irish sea, and on the south by Caermarthenshire. Its length from north-west to south-east is about 44 miles, and its breadth near 20. The air, as in other parts of Wales, varies with the soil, which in the southern and western parts is more upon a level than this principality generally is, which renders the air mild and temperate. But as the northern and eastern parts are mountainous, they are consequently more barren and bleak. However, there are cattle bred in all parts; but they have neither wood nor coal. They have rich lead mines, and fish in plenty. The principal rivers are the Teivy, the Ridol, and the Istwith. This county has five market-towns, viz. Cardigan, Aberistwith, Llanbadarnvawn, Llanbedar, and Tregaron, with 77 parishes; and was computed to have upwards of 520,000 acres of land. It sends two members to parliament; one for the county, and one for Cardigan, and contained 50,260 inhabitants in 1811. See CARDIGANSHIRE, SUPPLEMENT.

CARDINAL, in a general sense, an appellation given to things on account of their pre-eminence. The word is formed of the Latin *cardo*, *a hinge;* it being on these fundamental points that all the rest of the same kind are supposed to turn. Thus, justice, prudence, temperance, and fortitude, are called the four *cardinal virtues*, as being the basis of all the rest.

CARDINAL *Flower*. See LOBELIA, BOTANY *Index*.

CARDINAL *Points*, in *Cosmography*, are the four intersections of the horizon with the meridian, and the prime vertical circle. Of these, two, viz. the intersections of the horizon and meridian, are called *North* and *South*, with regard to the poles they are directed to. The other two, viz. the intersections of the horizon and first vertical, are called *East* and *West*.

The cardinal points, therefore, coincide with the four cardinal regions of the heavens; and are 90° distant from each other. The intermediate points are called *collateral points*.

CARDINAL *Points*, in *Astrology*, are the rising and setting of the sun, the zenith, and nadir.

CARDINAL *Signs*, in *Astronomy*, are Aries, Libra, Cancer, and Capricorn.

CARDINAL *Winds* are those that blow from the cardinal points.

CARDINAL *Numbers*, in *Grammar*, are the numbers one, two, three, &c. which are indeclinable; in opposition to the ordinal numbers, first, second, third, fourth, &c.

CARDINAL, an ecclesiastical prince in the Romish church, being one who has a voice in the conclave at the election of a pope. Some say the cardinals were so called from the Latin *incardinatio*, which signifies the

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Cardinal. the adoption in any church made of a priest of a foreign church, driven thence by misfortune: and add, that the use of the word commenced at Rome and Ravenna; the revenues of the church of which cities being very great, they became the common refuge of the unhappy priests of all other churches.

The cardinals compose the pope's council or senate. In the Vatican is a constitution of Pope John, which regulates the rights and titles of the *cardinals;* and which declares, that as the pope represents Moses, so the cardinals represent the seventy elders, who, under the pontifical authority, decide private and particular differences.

Cardinals, in their first institution, were only the principal priests, or incumbents, of the parishes of Rome. In the primitive church, the chief priest of a parish, who immediately followed the bishop, was called *presbyter cardinalis,* to distinguish him from the other petty priests, who had no church nor preferment; the term was first applied to them in the year 150; others say, under Pope Silvester, in the year 300. These cardinal priests were alone allowed to baptize, and administer the eucharist. When the cardinal priests became bishops, their cardinalate became vacant; they being then supposed to be raised to a higher dignity.—Under Pope Gregory, cardinal priests, and cardinal deacons, were only such priests and deacons as had a church or chapel under their particular care: and this was the original use of the word. Leo IV. in the council of Rome, held in 853, calls them *presbyteros sui cardinis;* and their churches, *parochias cardinales.*

The cardinals continued on this footing till the eleventh century; but as the grandeur and state of his holiness became then exceedingly augmented, he would have his council of cardinals make a better figure than the ancient priests had done. It is true, they still preserved their ancient title; but the thing expressed by it was no more. It was a good while, however, before they had the precedence over the bishops, or got the election of the pope into their hands: but when they were once possessed of those privileges, they soon had the red hat and purple; and growing still in authority, they became at length superior to the bishops, by the sole quality of being cardinals.

Du Cange observes, that originally there were three kinds of churches: the first or genuine churches were properly called *parishes;* the second *deaconries,* which were chapels joined to hospitals, and served by deacons; the third were simple *oratories,* where private masses were said, and were discharged by local and resident chaplains. He adds, that to distinguish the principal or parish churches from the chapels and oratories, the name *cardinales* was given to them. Accordingly, parish churches gave titles to cardinal priests; and some chapels also, at length, gave the the title of *cardinal deacons.*

Others observe, that the term *cardinal* was given not only to priests, but also to bishops and deacons who were attached to certain churches, to distinguish them from those who only served them *en passant,* and by commission. Titular churches, or benefices, were a kind of parishes, *i. e.* churches, assigned each to a cardinal priest; with some stated district depending on it, and a font for administering of baptism, in cases where the bishop himself could not administer it. These cardinals were subordinate to the bishops; and accordingly, in councils, particularly that held at Rome in 868, subscribed after them.

It was not, however, only at Rome, that priests bore this name; for we find there were cardinal priests in France: thus, the curate of the parish of St John de Vignes is called in old charters the *cardinal priest* of that parish.

The title of *cardinal* is also given to some bishops, *quatenus* bishops, *e. g.* to those of Mentz and Milan: the archbishop of Bourges is also, in ancient writings, called *cardinal;* and the church of Bourges, a *cardinal church.* The abbot of Vendome calls himself *cardinalis natus.*

The cardinals are divided into three classes or orders; containing six bishops, fifty priests, and fourteen deacons; making in all seventy; which constitute what they call the *sacred college.* The cardinal bishops, who are, as it were, the pope's vicars, bear the titles of the bishoprics assigned to them; the rest take such titles as are given them: the number of cardinal bishops has been fixed; but that of cardinal priests and deacons, and consequently the sacred college itself, is always fluctuating. Till the year 1125, the college only consisted of fifty-two or fifty-three: the council of Constance reduced them to twenty-four; but Sixtus IV. without any regard to that restriction, raised them again to fifty-three, and Leo to sixty-five. Thus, as the number of cardinal priests was anciently fixed to twenty-eight, new titles were to be established, in proportion as new cardinals were created. As for the cardinal deacons, they were originally no more than seven for the fourteen quarters of Rome; but they were afterwards increased to nineteen, and after that were again diminished.

According to Onuphrius, it was Pope Pius IV. who first enacted, in 1562, that the pope should be chosen only by the senate of cardinals; whereas, till that time, the election was by all the clergy of Rome. Some say, the election of the pope rested in the cardinals, exclusive of the clergy, in the time of Alexander III. in 1160. Others go higher still, and say, that Nicholas II. having been elected at Sienna, in 1058, by the cardinals alone, occasioned the right of election to be taken from the clergy and people of Rome; only leaving them that of confirming him by their consent; which was at length, however, taken from them. See his decree for this purpose, issued in the Roman council of 1059, in Hardouin's Acta Conciliorum, tom. vi. pt. i. p. 1165. Whence it appears, that the cardinals who had the right of suffrage in the election of his successors, were divided by this pontiff into *cardinal bishops,* and *cardinal clerks;* meaning by the former the seven bishops who belonged to the city and territory of Rome; and by the latter, the *cardinal presbyters,* or ministers of the twenty-eight Roman parishes, or principal churches. To these were added, in process of time, under Alexander III. and other pontiffs, new members, in order to appease the tumults occasioned by the edict of Nicholas II.

At the creation of a new cardinal, the pope performs the ceremony of opening and shutting his mouth; which is done in a private consistory. The shutting his mouth implies the depriving him of the liberty of giving his opinion in congregations; and the opening his

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his mouth, which is performed 15 days after, signifies the taking off his restraint. However, if the pope happens to die during the time a cardinal's mouth is shut, he can neither give his voice in the election of a new pope, nor be himself advanced to that dignity.

The dress of a cardinal is a red soutanne, a rocket, a short purple mantle, and a red hat.

The cardinals began to wear the red hat at the council of Lyons, in 1243. The decree of Pope Urban VIII. whereby it is appointed, that the cardinals be addressed under the title of *eminence*, is of the year 1630; till then, they were called *illustrissimi*.

When cardinals are sent to the courts of princes, it is in quality of legates *à latere;* and when they are appointed governors of towns, their government is called by the name of *legation*.

Cardinal has also been applied to secular officers. Thus, the prime ministers in the court of the emperor Theodosius, are called *cardinales*. Cassiodorus, lib. vii. formul. 31. makes mention of the cardinal prince of the city of Rome; and in the list of officers of the duke of Bretagne, in 1447, we meet with one Raoul de Thorel, cardinal of Quillart, chancellor, and servant of the viscount de Rohan: which shows it to have been an inferior quality.

CARDIOID, in the higher geometry, an algebraical curve, so called from its resemblance to a heart.

CARDIOSPERMUM. See Botany *Index*.

CARDIUM, or Cockle, in *Zoology*, a genus of insects belonging to the order of *vermes testacea*. The shell consists of two equal valves, and the sides are equal. There are 21 species of this genus. Common on all sandy coasts, lodged a little beneath the sand; their place is marked by a depressed spot. They are wholesome and delicious food.

CARDONA, a handsome town of Spain, in Catalonia, with a strong castle, and the title of a duchy, and containing 2800 inhabitants. Near it is an inexhaustible mountain of salt of several colours, as red, white, carnation, and green: but when washed, it becomes white. There are also vineyards which produce excellent wine. It is seated on an eminence, near the river Cardenero. E. Long. 1. 26. N. Lat. 41. 42.

CARDUUS. See Botany *Index*.

Carduus Benedictus, Blessed thistle. See Cnicus, Botany *Index*.

CAREENING, in the sea-language, the bringing a ship to lie down on one side, in order to trim and caulk the other side.

A ship is said to be brought to the careen, when the most of her lading being taken out, she is hulled down on one side, by a small vessel, as low as necessary; and there kept by the weight of the ballast, ordnance, &c. as well as by ropes, lest her masts should be strained too much; in order that her sides and bottom may be trimmed, seams caulked, or any thing that is faulty under water mended. Hence, when a ship lies on one side when she sails, she is said to sail on the careen.

CAREER, in the manege, a place inclosed with a barrier, wherein they run the ring.

The word is also used for the race or course of the horse itself, provided it do not exceed 200 paces.

In the ancient circus, the career was the space the bigæ, or quadrigæ, were to run at full speed, to gain the prize. See Circus.

Career, in falconry, is a flight or tour of the bird, about 120 yards. If she mount more, it is called a *double career:* if less, a *semi-career*.

CARELIA, the eastern province of Finland; divided into Swedish Carelia, and Muscovite Carelia. The capital of the latter is Povenza, and of the former Weiburg.

CARENTAN, a town of France in Lower Normandy, with an ancient castle. Population 2860 in 1815. W. Long. 1. 14. N. Lat. 49. 20.

CARET, among grammarians, a character marked thus ‸; signifying that something is added on the margin, or interlined, which ought to come in where the caret stands.

CAREW, a small village or parish of Wales, in the county of Pembroke, with the remains of a fine castle. Here a tournament was held about the beginning of the sixteenth century, or earlier, by the owner Sir Keil of Thomas, which lasted five days. A cross 14 feet high, formed of a single stone, stands by the side of the road. Population 911. Distant five miles from Pembroke.

Carew, *George*, born in Devonshire in 1557, an eminent commander in Ireland, was made president of Munster by Queen Elizabeth; when, joining his forces with the earl of Thomond, he reduced the Irish insurgens, and brought the earl of Desmond to his trial. King James made him governor of Guernsey, and created him a baron. As he was a valiant commander, he was no less a polite scholar; and wrote *Pacata Hibernia*, a history of the late wars in Ireland, printed after his death, in 1633. He made several collections for a History of Henry V. which are digested into Speed's History of Great Britain. Besides these, he collected materials of Irish history in four large MSS. volumes, now in the Bodleian library, Oxford.

Carew, *Thomas*, descended from the family of Carew in Gloucestershire, was gentleman of the privy chamber to Charles I. who always esteemed him one of the most celebrated wits of his court. He was much respected by the poets of his time, particularly by Ben Johnson and Sir William Davenant; and left behind him several poems, and a masque called *Cœlum Britannicum*, performed at Whitehall on Shrove Tuesday night, 1633, by the king, and several of his nobles with their sons. Carew was assisted in the contrivance by Inigo Jones, and the music was set by Mr Henry Lawes of the king's chapel. He died in the prime of life, about the year 1639.

Carew, *Richard*, author of the "Survey of Cornwall," was the eldest son of Thomas Carew of East Anthony, and was born in 1555. When very young, he became a gentleman commoner of Christ-church college, Oxford; and at 14 years of age had the honour of disputing, extempore, with the afterwards famous Sir Philip Sydney, in the presence of the earls of Leicester, Warwick, and other nobility. After spending three years at the university, he removed to the Middle Temple, where he resided the same length of time, and then travelled into foreign parts. Not long after his return to England, he married, in 1577, Juliana Arundel, of Trerice. In 1581, Mr Carew was made justice of the peace, and in 1586 was appointed high sheriff of the county of Cornwall; about which time he was likewise queen's deputy for the militia.

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In 1589, he was elected a member of the college of Antiquaries, a distinction to which he was entitled by his literary abilities and pursuits. What particularly engaged his attention was his native county, his "Survey" of which was published, in 4to at London, in 1602. It hath been twice reprinted, first in 1723, and next in 1769. Of this work Camden hath spoken in high terms, and acknowledges his obligations to the author. In the present improved state of topographical knowledge, and since Dr Borlase's excellent publications relative to the county of Cornwall, the value of Carew's "Survey" must have been greatly diminished. Mr Gough remarks, that the history and monuments of this country were faintly touched by Carew; but it is added, that he was a person extremely capable of describing them, if the infancy of those studies at that time had afforded light and materials. Another work of our author was a translation from the Italian, entitled, "The Examination of Men's Wits. In which, by discovering the variety of natures, is showed for what profession each one is apt, and how far he shall profit therein." This was published at London in 1594, and afterwards in 1604; and though Richard Carew's name is prefixed to it, hath been principally ascribed by some persons to his father. According to Wood, Carew wrote also, "The true and ready way to learn the Latin tongue," in answer to a query, whether the ordinary method of teaching the Latin by the rules of grammar be the best mode of instructing youths in that language? This tract is involved in Mr Hartlib's book upon the same subject, and with the same title. It is certain that Carew was a gentleman of considerable abilities and literature, and that he was held in great estimation by some of the most eminent scholars of his time. He was particularly intimate with Sir Henry Spelman, who extols him for his ingenuity, virtue, and learning.

Carew, *George*, brother to the subject of the last article, was educated in the university of Oxford, after which he studied the law in the inns of court, and then travelled to foreign countries for farther improvement. On his return to his native country, he was called to the bar, and after some time was appointed secretary to Sir Christopher Hatton, lord chancellor of England. This was by the special recommendation of Queen Elizabeth herself, who gave him a prothonotaryship in the chancery, and conferred upon him the honour of knighthood. In 1597, Sir George Carew, who was then a master in chancery, was sent ambassador to the king of Poland. In the next reign, he was one of the commissioners for treating with the Scotch concerning an union between the two kingdoms; after which he was appointed ambassador to the court of France, where he continued from the latter end of the year 1605 till 1609. During his residence in that country, he formed an intimacy with Thuanus, to whom he communicated an account of the transactions in Poland whilst he was employed there, which was of great service to that admirable author in drawing up the 121st book of his history. After Sir George Carew's return from France, he was advanced to the important post of master of the court of wards, which honourable situation he did not long live to enjoy; for it appears from a letter written by Thuanus to Camden in the spring 1613, that he was then lately deceased. Sir George Carew married Thomasine, daughter of Sir Francis Godolphin, great grandfather of the lord treasurer Godolphin, and had by her two sons and three daughters. When Sir George Carew returned, in 1609, from his French embassy, he drew up, and addressed to James I. "A Relation of the State of France, with the characters of Henry IV. and the principal persons of that Court." The characters are drawn from personal knowledge and close observation, and might be of service to a general historian of that period. The composition is perspicuous and manly, and entirely free from the pedantry which prevailed in the reign of James I.; but this is the less surprising, as Sir George Carew's taste had been formed in a better era, that of Queen Elizabeth. The valuable tract we are speaking of lay for a long time in MS.; till happily falling into the hands of the earl of Hardwicke, it was communicated by him to Dr Birch, who published it, in 1749, at the end of his "Historical View of the Negotiations between the Courts of England, France, and Brussels, from 1592 to 1617." That intelligent and industrious writer justly observes, that it is a model upon which ambassadors may form and digest their notions and representations; and the late celebrated poet Mr Gray hath spoken of it as an excellent performance.

CAREX, Sedge-grass. See Botany *Index*.

CAREY, Harry, a man distinguished by both poetry and music, but perhaps more so by a certain facetiousness, which made him agreeable to every body. He published in 1720 a little collection of poems; and in 1732, six cantatas, written and composed by himself. He also composed sundry songs for modern comedies, particularly those in the "Provoked Husband:" he wrote a farce called "The Contrivances," in which were several little songs to very pretty airs of his own composition; he also made two or three little dramas for Goodman's-fields theatre, which were very favourably received. In 1729, he published by subscription his poems much enlarged: with the addition of one entitled "Namby Pamby," in which Ambrose Philips is ridiculed. Carey's talent, says his historian, lay in humour and unmalevolent satire: to ridicule the rant and bombast of modern tragedies he wrote one, to which he gave the strange title of "Chrononhotonthologos," acted in 1734. He also wrote a farce called "The Honest Yorkshireman." Carey was a thorough Englishman, and had an unsurmountable aversion to the Italian opera and the singers in it: he wrote a burlesque opera on the subject of the "Dragon of Wantley;" and afterwards a sequel to it, entitled, "The Dragoness;" both which were esteemed a true burlesque upon the Italian opera. His qualities being of the entertaining kind, he was led into more expences than his finances could bear, and thus was frequently in distress. His friends, however, were always ready to assist him by their little subscriptions to his works: and encouraged by these, he republished, in 1740, all the songs he had ever composed, in a collection, entitled, "The Musical Century, in 100 English Ballads, &c." and, in 1743, his dramatic works, in a small volume, 4to. With all his mirth and good humour, he seems to have been at times deeply affected with the malevolence of some of his own profession, who, for reasons that no one can guess at, were

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were his enemies, and this, with the pressure of his circumstances, is supposed to have occasioned his untimely end; for, about 1744, in a fit of desperation, he laid violent hands on himself, and, at his house in Warner-street, Cold-Bath Fields, put a period to a life, which, says Sir John Hawkins, had been led without reproach. It is to be noted, and it is somewhat singular in such a character, that in all his songs and poems on wine, love, and such kind of subjects, he seems to have manifested an inviolable regard for decency and good manners.

CARGADORS, a name which the Dutch give to those brokers whose business is to find freight for ships outward bound, and to give notice to the merchants, who have commodities to send by sea, of the ships that are ready to sail, and of the places for which they are bound.

CARGAPOL, or KARGAPOL, the capital of a territory of the same name, in the province of Dwina, in Muscovy. E. Long. 36. N. Lat. 63.

CARGO denotes all the merchandises and effects which are laden on board a ship.

Super-CARGO, a person employed by merchants to go a voyage, oversee the cargo, and dispose of it to the best advantage.

CARIA, in *Ancient Geography*, a country of the Hither Asia; whose limits are extended by some, while they are contracted by others. Mela and Pliny extend the maritime Caria from Jasus and Halicarnassus, to Calynda, and the borders of Lycia. The inland Caria Ptolemy extends to the Meander and beyond. *Car*, *Cariates*, *Cariatis*, *Carissa* and *Caris*, and *Caira*, are the gentilitious names; *Carius* and *Caricus* the epithets. *In Care periculum*, was a proverbial saying on a thing exposed to danger, but of no great value. The *Cares* being the Swiss of those days, were hired and placed in the front of the battle, (Cicero). *Cum Care Carissa*, denoted the behaviour of clowns. The Cares came originally from the islands to the continent, being formerly subject to Minos, and called *Leleges*: this the Cretans affirm, and the Cares deny, making themselves aborigines. They are of a common original with the Mysi and Lydi, having a common temple, of a very ancient standing, at Melassa, a town of Caria, called *Jovis Carii Delubrum*, (Herodotus). Homer calls the Carians, barbarians in language.

CARIATI, a town of Italy, in the kingdom of Naples, and province of Hither Calabria, with a bishop's see, and the title of a principality. It is two miles from the gulf of Taranto, and 37 north-east of Cosenza. E. Long. 17. 19. N. Lat. 30. 38.

CARIBBEE ISLANDS, a cluster of islands situated in the Atlantic ocean between 59 and 63 degrees of west longitude, and between 11 and 18 degrees of north latitude. They lie in the form of a bow or semicircle, stretching almost from the coast of Florida north, to near the river Oroonoque. Those that lie nearest the east have been called the *Windward Islands*, the others the *Leeward*, on account of the winds blowing generally from the eastern point in those quarters. Abbé Raynal conjectures them to be the tops of very high mountains formerly belonging to the continent, which have been changed into islands by some revolution that has laid the flat country under water. The direction of the Caribbee islands, beginning from Tobago, is nearly north and N. N. W. This direction is continued, forming a line somewhat curved towards the north-west, and ending at Antigua. In this place the line becomes at once curved; and extending itself in a straight direction to the west and north-west, meets in its course with Porto-Rico, St Domingo, and Cuba, known by the name of the *Leeward Islands*, which are separated from each other by channels of various breadths. Some of these are 6, others 15 or 20 leagues broad, but in all of them the soundings are from 100 to 120 or 150 fathoms. Between Grenada and St Vincent's there is also a small archipelago of 30 leagues, in which the soundings are not above ten fathoms. The mountains in the Caribbee islands run in the same direction as the islands themselves. The direction is so regular, that if we were to consider the tops of these mountains only, independent of their bases, they might be looked upon as a chain of hills belonging to the continent, of which Martinico would be the most northwesterly promontory. The springs of water which flow from the mountains in the Windward islands, run all in the western parts of these islands. The whole eastern coast is without any running water. No springs come down there from the mountains; and indeed they would have there been useless; for after having run over a very short tract of land, and with great rapidity, they would have fallen into the sea. In Porto Rico, St Domingo, and Cuba, there are a few rivers that discharge themselves on the northern side, and whose sources rise in the mountains running from east to west, that is, through the whole length of these islands. From the other side of the mountains facing the south, where the sea, flowing with great impetuosity, leaves behind it marks of its inundations, several rivers flow down, the mouths of which are capable of receiving the largest ships. The soil of the Caribbees consists mostly of a layer of clay or gravel of different thickness; under which is a bed of stone or rock. The nature of some of those soils is better adapted to vegetables than others. In those places where the clay is drier and more friable, and mixes with the leaves and remains of plants, a layer of earth is formed of greater depth than where the clay is moister. The sand or gravel has different properties according to its peculiar nature; wherever it is less hard, less compact, and less porous, small pieces separate themselves from it, which, though dry, preserve a certain degree of coolness useful to vegetation. This soil is called in America a *pumice-stone* soil. Wherever the clay and gravel do not go through such modifications, the soil becomes barren, as soon as the layer formed by the decomposition of the original plants is destroyed.—By a treaty concluded in January 1660, between the French and English, the Caribs were confined to the islands of St Vincent's and Dominica, where all the scattered body of this people were united, and at that time did not exceed in number 6000 men. See ST VINCENT'S and DOMINICA.

As the Caribbee islands are all between the tropics, their inhabitants are exposed, allowing for the varieties resulting from difference of situation and soil, to a perpetual heat, which generally increases from the rising of the sun till an hour after noon, and then declines in proportion as the sun declines. The variations of the temperature of the air seem to depend rather on the wind than on the changes of the seasons. In those

places

places where the wind does not blow, the air is excessively hot, and none but the easterly winds contribute to temper and refresh it; those that blow from the south and west afford little relief; but they are much less frequent and less regular than that which blows from the east. The branches of the trees exposed to the influence of the latter are forced round towards the west; but their roots are stronger, and more extended under the ground, towards the east than towards the west, and hence they are easily thrown down by strong west winds or hurricanes from that quarter. The easterly wind is scarce felt in the Caribbee islands before nine or ten o'clock in the morning, increases in proportion as the sun rises above the horizon, and decreases as it declines. Towards the evening it ceases entirely to blow on the coasts, but not on the open sea. It has also been observed, that it blows with more force and more regularity in the dog-days than at any other time of the year.

The rain also contributes to the temperature of the Caribbee islands, though not equally in them all. In those places where the easterly wind meets with nothing to oppose its progress, it dispels the clouds as they begin to rise, and causes them to break either in the woods or upon the mountains. But whenever the storms are too violent, or the blowing of the easterly wind is interrupted by the changeable and temporary effect of the southerly or westerly ones, it then begins to rain. In the other Caribbee islands, where this wind does not generally blow, the rains are so frequent and plentiful, especially in the winter season, which lasts from the middle of July to the middle of October, that, according to the most accurate observations, as much rain falls in one week as in our climates in a year. Instead of those mild refreshing showers which fall in the European climates, the rains of the Caribbee islands are torrents, the sound of which might be mistaken for hail, were not that almost totally unknown under so burning a sky. These showers indeed refresh the air; but they occasion a dampness, the effects of which are not less disagreeable than fatal. The dead must be interred within a few hours after they have expired. Meat will not keep sweet above 24 hours. The fruits decay, whether they are gathered ripe or before their maturity. The bread must be made up into biscuits, to prevent its growing mouldy. Common wines turn sour, and iron turns rusty, in a day's time. The seeds can only be preserved by constant attention and care, till the proper season returns for sowing them. When the Caribbee islands were first discovered, the corn that was conveyed there for the support of the Europeans, was so soon damaged that it became necessary to send it out in the ears. This necessary precaution so much enhanced the price of it, that few were able to purchase it. Flour was then substituted in lieu of corn; which lowered indeed the expences of transport, but had this inconvenience, that it was sooner damaged. It was imagined by a merchant, that if the flour were entirely separated from the bran, it would have the double advantage of being cheaper and keeping longer. He caused it therefore to be sifted, and put the finest flour into strong casks, and beat it close together with iron hammers, till it became so close a body that the air could scarcely penetrate it. This method was found to answer the purpose; and if, by it, the flour cannot be preserved as long as in our dry and temperate climates, it may be kept for six months, a year, or longer, according to the degree of care taken in the preparation.

However troublesome these effects of the rain may be, it is attended with some others still more formidable; namely, frequent and dreadful earthquakes.—These happening generally during the time or towards the end of the rainy season, and when the tides are highest, some ingenious naturalists have supposed that there might be a connexion between them. The waters of the sky and of the sea undermine, dig up, and ravage the earth in several different ways. Among the various shocks to which the Caribbee islands are exposed from the fury of the boisterous ocean, there is one distinguished by the name of *raz de maree*, or *whirlpool*. It constantly happens once, twice, or thrice, from July to October, and always on the western coasts, because it takes place after the time of the westerly or southerly winds, or while they blow. The waves, which at a distance seem to advance gently within 400 or 500 yards, suddenly swell against the shore, as if acted upon in an oblique direction by some superior force, and break with the greatest impetuosity. The ships which are then upon the coast, or in the roads beyond it, unable either to keep their anchors or to put out to sea, are dashed to pieces against the land, and all on board most commonly perish. The hurricane is another terrible phenomenon in these islands, by which incredible damage is occasioned; but happily it occurs not often.

The produce of the Caribbee islands is exceedingly valuable to the Europeans, consisting of sugar, rum, molasses, indigo, &c. a particular account of which is given under the name of the respective islands as they occur in the order of the alphabet.

CARIBBIANA, or CARIBIANA, the north-east coast of Terra Firma, in South America, otherwise called *New* ANDALUSIA.

CARICA, the PAPAW. See BOTANY *Index*.

The fruit of one species is by the inhabitants of the Caribbee islands eaten with pepper and sugar as melons, but is much inferior to a melon in its native country; but those which have ripened in Britain were detestable: the only use to which Mr Miller says he has known them put was, when they were about half grown, to soak them in salt water to get out the acrid juice, and then pickle them for mangos, to which they are a good substitute.

CARICATURA, in *Painting*, denotes the concealment of real beauties, and the exaggeration of blemishes, but still so as to preserve a resemblance of the object. The word is Italian; formed of *carica*, a load, burden, or the like.

CARICOUS, an epithet given to such tumours as resemble the figure of a fig. They are frequently found in the piles.

CARIES, the corruption or mortification of a bone. See MEDICINE and SURGERY *Index*.

CARIGNANO, a fortified town of Piedmont, situated on the river Po, about seven miles south of Turin. E. Long. 7. 25. N. Lat. 44. 30. It was taken in 1544 by the French; who demolished the fortifications, but spared the castle. It was also taken, and retaken, in 1691.

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CARILLONS, a species of chimes frequent in the Low Countries, particularly at Ghent, and Antwerp, and played on a number of bells in a belfrey, forming a complete series or scale of tones and semitones, like those on the harpsichord and organ. There are pedals communicating with the great bells, upon which the *carilloneur* with his feet plays the bass to sprightly airs, performed with the two hands upon the upper species of keys. These keys are projecting sticks, wide enough asunder to be struck with violence and velocity by either of the hands edgewise, without the danger of hitting the neighbouring key. The player is provided with a thick leather covering for the little finger of each hand, to guard against the violence of the stroke. These carillons are heard through a large town.

CARINA, a Latin term, properly signifying the *keel* of a ship; or that long piece of timber running along the bottom of the ship from head to stern, upon which the whole structure is built or framed.

Carina is also frequently used for the whole capacity or bulk of a ship; containing the hull or all the space below the deck. Hence the word is also sometimes used by a figure for the whole ship.

Carina is also used in the ancient architecture. The Romans gave the name *carina* to all buildings in form of a ship, as we still give the name *nave* to the middle or principal vault of our Gothic churches; because it has that figure.

Carina, among anatomists, is used to denote the *spina dorsi;* as likewise for the fibrous rudiments or embryo of a chick appearing in an incubated egg. The carina consists of the entire *vertebræ*, as they appear after ten or twelve days incubation. It is thus called, because crooked in form of the keel of a ship.—Botanists also, for the like reason, use the word *carina* to express the lower petalum of a papilionaceous flower.

Carinæ were also weepers, or women hired among the ancient Romans, to weep at funerals: they were thus called from *Caria*, the country whence most of them came.

CARINOLA, an episcopal town of Italy, in the kingdom of Naples, and Terra di Lavoro. E. Long. 15. 5. N. Lat. 41. 15.

CARINTHIA, a duchy of Germany, in the circle of Austria, bounded by the archbishopric of Saltzburg on the north, and by Carniola and the Venetian territories on the south, on the west by Tyrol, and on the east by Stiria. A part of this country was anciently called *Carnia*, and the inhabitants *Carni;* but the former afterwards obtained the name of *Carinthia*, and the latter *Carantani* or *Carinthi.* The air of this country is cold, and the soil in general mountainous and barren; but there are some fruitful dales and valleys in it, which produce wheat and other grain. The lakes, brooks, and rivers, which are very numerous, abound with fish; and the mountains yield lead and iron, and in many places are covered with woods. The river Drave, which runs across the country, is the most considerable in Carinthia. The inhabitants are partly descendants of the ancient Germans, and partly of the Sclavonians or Wends. The states are constituted as in Austria, and their assemblies are held at Clagenfurt. The archbishop of Saltzburg and the bishop of Bamberg have considerable territories in this country. Christianity was planted here in the 7th century. The only profession tolerated at present is the Roman Catholic. The bishops are those of Gurk and Lavant, who are subject to the archbishop of Saltzburg. This duchy was formerly a part of Bavaria. In the year 1282, the emperor Rodolph I. gave it to Maynard count of Tyrol, on condition that when his male issue failed, it should revert to the house of Austria; which happened in 1331. The population of Carinthia in 1812 amounted to 282,454, or about 70 persons to the square mile, Of these 138,000 were males, of whom 500 were nobles, 5000 citizens, 21,500 mechanics, and 76,500 were tenants and peasantry.

CARIPI, a kind of cavalry in the Turkish army. The caripi to the number of about 1000 are not slaves, nor bred up in the seraglio, like the rest; but are generally Moors or renegado Christians, who having followed adventures, being poor, and having their fortune to seek by their dexterity and courage, have arrived at the rank of horse guards to the Grand Signior.

CARISSA. See Botany *Index.*

CARITAS.—The *poculum caritatis*, or grace cup, was an extraordinary allowance of wine or other liquors, wherein the religious at festivals drank in commemoration of their founders and benefactors.

CARISBROOK castle, a castle situated in the middle of the isle of Wight, where King Charles I. was imprisoned. W. Long. 1. 30. N. Lat. 50. 40.

CARISTO, an episcopal city of Greece, in the eastern part of the island of Negropont, near Cape Loro. E. Long. 24. 15. N. Lat. 38. 6.

CARKE, denotes the 30th part of a sarplar of wool.

CARLE. See Churl.

CARLETON, Sir Dudley, was born in Oxfordshire, 1573, and bred in Christ-church college. He went as secretary to Sir Ralph Winwood into the Low Countries, when King James resigned the cautionary towns to the States; and was afterwards employed for 29 years as ambassador to Venice, Savoy, and the United Provinces. King Charles created him Viscount Dorchester, and appointed him one of his principal secretaries of state; in which office he died in 1651. He was esteemed a good statesman, though an honest man; and published several political works.

CARLINA, the Carline thistle. See Botany *Index.*

CARLINE, or Caroline thistle. See Carlina. It is said to have been discovered by an angel to Charlemagne, to cure his army of the plague; whence its denomination.

Carline, or *Caroline*, a silver coin current in the Neapolitan dominions, and worth about 4d. of our money.

Carlines, or Carlings, in a ship, two pieces of timber lying fore and aft, along from one beam to another, directly over the keel; serving as a foundation for the whole body of the ship. On these the ledges rest, whereon the planks of the deck and other matters of carpentry are made fast. The carlines have their ends let into the beams called *culver-tail-ways.*

Carline Trees, are timbers going athwart the ship, from the sides to the hatchway, serving to sustain the deck on both sides.

CARLINGFORD, a port town of Ireland, seated on

Carlingford, Carlisle.

on Carlington bay, in the county of Louth, and province of Leinster, 22 miles north of Drogheda. W. Long. 6. 24. N. Lat. 24. 5.

CARLISLE, the capital city of the county of Cumberland, seated on the south of the river Eden, and between the Petteral on the east, and the Caude on the west. It is surrounded by a strong stone wall, and has a pretty large castle in the western part of it, as also a citadel in the eastern part, built by Henry VIII. It flourished in the time of the Romans, as appears from the antiquities that are to be met with here, and the Roman coins that have been dug up. At the departure of the Romans this city was ruined by the Scots and Picts; and was not rebuilt till the year 680, by Egfrid, who encompassed it with a wall, and repaired the church. In the 8th and 9th centuries, the whole country was again ruined, and the city laid desolate by the incursions of the Norwegians and Danes. In this condition it remained till the time of William Rufus; who repaired the walls and the castle, and caused the houses to be rebuilt. It was fortified by Henry I. as a barrier against Scotland; he also placed a garrison in it, and made it an episcopal see. It was twice taken by the Scots, and afterwards burnt accidentally in the reign of Richard II. The cathedral, the suburbs, and 1500 houses, were destroyed at that time. It is at present in a good condition; and has three gates, the English on the south, the Scotch on the north, and the Irish on the west. It has two parishes, and as many churches, St Cuthbert's and St Mary's, the last of which is the cathedral, and is separated from the town by a wall of its own. The eastern part, which is the newest, is a curious piece of workmanship. The choir with the aisles is 71 feet broad; and has a stately east window 48 feet high and 30 broad, adorned with curious pillars. The roof is elegantly vaulted with wood; and is embellished with the arms of England and France quartered; as also with Percy's, Lucy's, Warren's, Mowbray's, and many others. In the choir are the monuments of the bishops who were buried there. This see was erected in 1133 by King Henry I. and made suffragan to the archbishop of York. The cathedral church here had been founded a short time before by Walter, deputy in these parts for King William Rufus, and by him dedicated to the Virgin Mary. He likewise built a monastery, and filled it with canons regular of St Augustine. This foundation continued till the dissolution of monasteries, when its lands were added to the see, and the maintenance of a dean, &c. placed here in their room. The church was almost ruined by the usurper Cromwell and his soldiers; and has never since recovered its former beauty, although repaired after the Restoration. This diocese contains the greatest part of the counties of Cumberland and Westmoreland, in which are only 93 parishes; but these (as all the northern are) exceeding large; and of them 18 are impropriations. Here is one archdeacon, viz. of Carlisle. The see is valued in the king's books at 530l. 4s. 11½d. but is computed to be worth annually 2800l. The clergy's tenth amounts only to 161l. 1s. 7½d. To this cathedral belong a bishop, a dean, a chancellor, an archdeacon, four prebendaries, eight minor canons, &c. and other inferior officers and servants.

The Picts wall, which was built across the country from Newcastle, terminates near this place. Carlisle was a fortified place, and still has its governor and lieutenant-governor, but no garrison. It was taken by the rebels, Nov. 15. 1745; and was retaken by the duke of Cumberland on the 10th of December following, and deprived of its gates. It is governed by a mayor, twelve aldermen, two bailiffs, &c. and has a considerable market on Saturdays. The manufactures of Carlisle are chiefly of printed linens, for which near 3000l. per annum is paid in duties. It is also noted for a great manufacture of whips, in which a great number of children are employed.—Salmons appear in the Eden in numbers, so early as the months of December and January; and the London and even Newcastle markets are supplied with early fish from this river: but it is remarkable, that they do not visit the Esk in any quantity till April; notwithstanding the mouths of the two rivers are at a small distance from each other.—Carlisle sends two members to parliament, and gives title of earl to a branch of the Howard family.

Carlisle ‖ Carlscrona.

CARLOCK, in commerce, a sort of isinglass, made with the sturgeon's bladder, imported from Archangel. The chief use of it is for clarifying wine, but is also used by the dyers. The best carlock comes from Astracan, where a great quantity of sturgeon is caught.

CARLOSTAD, or CARLSTAD, a town of Sweden in Wermeland, seated on the lake Wermer, in E. Long. 14. 4. N. Lat. 59. 16.

CARLOSTAD, or *Carlstadt*, a town of Hungary, capital of Croatia, and the usual residence of the governors of the province. It is seated on the river Kulph, in E. Long. 16. 5. N. Lat. 45. 34.

CARLOWITZ, a small town of Hungary, in Sclavonia, remarkable for a peace concluded here between the Turks and Christians in 1669. It is seated on the west side of the Danube, and contains 5600 inhabitants. E. Long. 19. 5. N. Lat. 45. 25.

CARLSCRONA, or CARLSCROON, a seaport town in the Baltic, belonging to Sweden. It derives its origin and name from Charles XI. who first laid the foundation of a new town in 1680, and removed the fleet from Stockholm to this place, on account of its advantageous situation in the centre of the Swedish seas, and the superior security of its harbour. The greatest part of Carlscrona stands upon a small rocky island, which rises gently in a bay of the Baltic; the suburbs extend over another small rock, and along the mole close to the bason where the fleet is moored. The way into the town, from the mainland, is carried over a dyke to an island, and from thence along two long wooden bridges joined by a barren rock. The town is spacious, and contains about 18,000 inhabitants. It is adorned with one or two handsome churches, and a few tolerable houses of brick; but the generality of the buildings are of wood. The suburbs are fortified towards the land by a stone wall. The entrance into the harbour, which by nature is extremely difficult from a number of shoals and rocky islands, is still further secured from the attack of an enemy's fleet by two strong forts built on two islands, under the batteries of which all vessels must pass.

Formerly vessels in this port when careened and repaired, were laid upon their sides in the open harbour,

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bour, until a dock, according to a plan given by Polheim, was hollowed in the solid rock; it was begun in 1714, and finished in 1724; but as it was too small for the admission of men of war, it has lately been enlarged, and is now capable of receiving a ship of the first rate. But new docks have been begun upon a stupendous plan, worthy of the ancient Romans. According to the original scheme, it was intended to construct 30 docks, for building and laying up the largest ships, at the extremity of the harbour. A large bason, capable of admitting two men-of war, is designed to communicate, by sluices, with two smaller basons, from each of which are to extend, like the radii of a circle, five rows of covered docks; each row is to be separated by walls of stone; and each dock to be provided with sluice gates, so as to be filled or emptied by means of pumps. Close to the docks, magazines for naval stores are to be constructed, and the whole to be inclosed with a stone-wall. The project was begun in 1757, but was much neglected until the accession of his present majesty, who warmly patronized the arduous undertaking. At the commencement of the works, 25,000l. were annually expended upon them; which sum has been lessened to about 6000l. per annum, and the number of docks reduced to 20. The first dock was completed in 1779, and it was computed that the whole number would be executed in 20 years; but they are yet unfinished.

CARLSTADT, a town of Germany, in Bavaria, seated on the river Maine. It has a strong castle. E. Long. 9. 51. N. Lat. 50. 0.

CARLTON, a town in Norfolk, held by this tenure, that they shall present 1000 herrings baked in 14 pies to the king, wherever he shall be when they first come in season.

CARLYLE, Joseph Dacre, an eminent orientalist. See Supplement.

CARMAGNOLA, a fortified town of Italy, in Piedmont, with a good castle. It is seated in a country abounding in corn, flax, and silk, near the river Po, in E. Long. 7. 32. N. Lat. 44. 43.

CARMANIA, in *Ancient Geography*, a country of Asia, to the east of Persia, having Parthia to the north, Gedrosia to the east, to the south the Persian gulf or sea in part, and in part the Indian, called the *Carmanian Sea;* distinguished into *Carmania Deserta*, and *Carmania Propria*, the former lying to the south of Parthia, and to the south of that, the *Propria*, quite to the sea. Its name is from the Syriac, *Carma*, signifying a "vine," for which that country was famous, yielding clusters three feet long. Now Kerman, or Carimania, a province of modern Persia.

CARMEL, a high mountain of Palestine, standing on the skirts of the sea, and forming the most remarkable headland on all that coast. It extends eastward from the sea as far as the plain of Jezreel, and from the city of that name quite to Cæsarea on the south. It seems to have had the name of *Carmel* from its great fertility; this word, according to the Hebrew import, signifying the *vine of God*, and is used in Scripture to denote any fruitful spot, or any place planted with fruit trees. This mountain, we are assured, was very fertile. Mr Sandys acquaints us, that, when well cultivated, it abounds with olives, vines, and variety of fruits and herbs, both medicinal and aromatic. Others,

however, represent it as rather dry and barren; which perhaps may have happened from the neglect of agriculture so common in all parts of the Turkish empire, especially where they are exposed to the incursions of the Arabs. Carmel is the name of the mountain, and of a city built on it; as well as of a heathen deity worshipped in it, but without either temple or statue; though anciently there must have been a temple, as we are told that this mountain was a favourite retreat of Pythagoras, who spent a good deal of time in the temple, without any person with him. But what hath rendered Mount Carmel most celebrated and revered both by Jews and Christians, is its having been the residence of the prophet Elijah, who is supposed to have lived there in a cave (which is there shewn), before he was taken up into heaven.

CARMELITES, an order of religious, making one of the four tribes of mendicants or begging friars; and taking its name from Mount Carmel, formerly inhabited by Elias, Elisha, and the children of the prophets; from whom this order pretends to descend in an uninterrupted succession. The manner in which they make out their antiquity has something in it too ridiculous to be rehearsed. Some among them pretend they are descendants of Jesus Christ; others go further, and make Pythagoras a Carmelite, and the ancient druids regular branches of their order. Phocos, a Greek monk, speaks the most reasonably. He says, that in his time, 1185, Elias's cave was still extant on the mountain; near which were the remains of a building which intimated that there had been anciently a monastery; that, some years before, an old monk, a priest of Calabria, by revelation, as he pretended, from the prophet Elias, fixed there, and assembled ten brothers. In 1209, Albert, patriarch of Jerusalem, gave the solitaries a rigid rule, which Papebroch has since printed. In 1217, or, according to others, 1226, Pope Honorius III. approved and confirmed it. This rule contained 16 articles; one of which confined them to their cells, and enjoined them to continue day and night in prayer; another prohibited the brethren having any property; another enjoined fasting from the feast of the holy cross till Easter, except on Sundays; abstinence at all times from flesh was enjoined by another article; one obliged them to manual labour; another imposed a strict silence on them from vespers till the tierce the next day.

The peace concluded by the emperor Frederic II. with the Saracens, in the year 1229, so disadvantageous to Christendom, and so beneficial to the infidels, occasioned the Carmelites to quit the Holy Land, under Alan the fifth general of the Order. He first sent some of the religious to Cyprus, who landed there in the year 1328, and founded a monastery in the forest of Fortania. Some Sicilians, at the same time, leaving Mount Carmel, returned to their own country, where they founded a monastery in the suburbs of Messina. Some English departed out of Syria, in the year 1240, to found others in England. Others of Provence, in the year 1244, founded a monastery in the desert of Aigualates, a league from Marseilles; and thus, the number of their monasteries increasing, they held their European general chapter in the year 1245, at their monastery of Aylesford in England.—This order is so much increased, that it has, at present,

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38 provinces, besides the congregation of Mantua, in which are 54 monasteries, under a vicar-general; and the congregations of Barefooted Carmelites in Italy and Spain, which have their peculiar general.

After the establishment of the Carmelites in Europe, their rule was in some respects altered; the first time, by Pope Innocent IV. who added to the first article a precept of chastity, and relaxed the 11th, which enjoins abstinence at all times from flesh, permitting them, when they travelled, to eat boiled flesh; this pope likewise gave them leave to eat in a common refectory, and to keep asses or mules for their use. Their rule was again mitigated by the popes Eugenius IV. and Pius II. Hence the order is divided into two branches, viz. *the Carmelites of the ancient observance*, called the *moderate*, or *mitigated;* and those *of the strict observance*, who are the *barefooted Carmelites;* a reform set on foot in 1548, by S. Theresa, a nun of the convent of Avila, in Castile: these last are divided into two congregations, that of Spain and that of Italy.

The habit of the Carmelites was at first white, and the cloak laced at the bottom with several lists. But Pope Honorius IV. commanded them to change it for that of the Minims. Their scapulary is a small woollen habit of a brown colour, thrown over their shoulders. They wear no linen shirts, but instead of them linsey-woolsey, which they change twice a-week in the summer, and once a-week in the winter.

If a monk of this order lies with a woman, he is prohibited saying mass for three or four years, is declared infamous, and obliged to discipline himself publicly once a-week. If he is again guilty of the same fault, his penance is doubled; and if a third time, he is expelled the order.

CARMEN, an ancient term among the Latins, used in a general sense to signify a verse; but more particularly to signify a spell, charm, form of expiation, or execration, couched in a few words placed in a mystic order, on which its efficacy depended. Pezron derives the word *carmen* from the Celtic *carm*, the shout of joy, or the verses which the ancient bards sung to encourage the soldiers before the combat.—*Carmen* was anciently a denomination given also to precepts, laws, prayers, imprecations, and all solemn formulæ couched in a few words placed in a certain order, though written in prose. In which sense it was that the elder Cato wrote a *Carmen de moribus*, which was not in verse but in prose.

CARMENTALIA, a feast among the ancient Romans, celebrated annually upon the 11th of January, in honour of Carmenta, or Carmentis, a prophetess of Arcadia, mother of Evander, with whom she came into Italy 60 years before the Trojan war. The solemnity was also repeated on the 15th of January, which is marked in the old calendar of *Carmentalia relata*. This feast was established on occasion of a great fecundity among the Roman dames, after a general reconciliation with their husbands, with whom they had been at variance, in regard of the use of coaches being prohibited them by an edict of the senate. This feast was celebrated by the women; he who offered the sacrifices was called *sacerdos carmentalis*.

CARMINATIVES, medicines used in colics, or other flatulent disorders, to dispel the wind.

The word comes from the Latin *carminare*, to card or teaze wool, and figuratively to attenuate and discuss wind or vapours, and promote their discharge by perspiration. Though Dr Quincy makes it more mysterious: He says it comes from the word *carmen*, taking it in the sense of an invocation or charm; and makes it to have been a general name for all medicines which operated like charms, *i. e.* in an extraordinary manner. Hence, as the most violent pains were frequently those arising from pent-up wind, which immediately cease upon dispersion, the term *carminative* became in a peculiar sense applied to medicines which gave relief in windy cases, as if they cured by enchantment: but this interpretation seems a little too far strained.

CARMINE, a powder of a very beautiful red colour bordering upon purple; and used by painters in miniature, though rarely, on account of its great price. The manner of preparing it is kept a secret by the colour-makers; neither do any of those receipts which have for a long time been published concerning the preparation of this and other colours, at all answer the purpose. See *Colour-making*.

CARMONA, a town of Italy in Friuli, and in the county of Goritz, seated on a mountain near the river Indri. It belongs to the house of Austria. E. Long. 5. 37. N. Lat. 46. 15.

Carmona, an ancient town of Spain, in Andalusia. It is seated in a fertile country, 15 miles east of Seville. W. Long. 5. 37. N. Lat. 37. 34.

CARNATIC, a province of Hindostan. See Supplement.

CARNATION. See Dianthus, Botany *Index*.

Carnation Colour, among painters, is understood of all the parts of a picture, in general, which represent flesh, or which are naked and without drapery. Titian and Correggio in Italy, and Rubens and Vandyke in Flanders, excelled in carnations.—In colouring for flesh, there is so great a variety, that it is hard to lay down any general rules for instructions therein: neither are there any regarded by those who have acquired a skill this way; the various colouring for carnations may be easily produced, by taking more or less red, blue, yellow, or bistre, whether for the first colouring or for the finishing; the colour for women should be bluish, for children a little red, both fresh and gay; and for men it should incline to yellow, especially if they are old.

Carnation, among dyers. To dye a carnation, or red rose colour, it is directed to take liquor of wheat bran a sufficient quantity, alum three pounds, tartar two ounces; boil them, and enter 20 yards of broad cloth; after it has boiled three hours, cool and wash it: take fresh clear bran liquor a sufficient quantity, madder five pounds; boil and sodden according to art. —The Bow dyers know that the solution of tin, being put in a kettle to the alum and tartar, in another process, makes the cloth, &c. attract the colour into it, so that none of the cochineal is left, but the whole is absorbed by the cloth.

CARNEADES, a celebrated Greek philosopher, was a native of Cyrene in Africa, and founder of the third academy. He was so fond of study, that he not only avoided all entertainments, but forgot even to eat at his own table; his maid servant Melissa was oblig-

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ed to put the victuals into his hand. He was an antagonist of the Stoics; and applied himself with great eagerness to refute the works of Chrysippus, one of the most celebrated philosophers of their sect. The power of his eloquence was dreaded even by a Roman senate. The Athenians being condemned by the Romans to pay a fine of 500 talents for plundering the city of Oropus, sent ambassadors to Rome, who got the fine mitigated to 100 talents. Carneades the Academic, Diogenes the Stoic, and Critolaus the Peripatetic, were charged with this embassy. Before they had an audience of the senate, they harangued to great multitudes in different parts of the city. Carneades's eloquence was distinguished from that of the others by its strength and rapidity. Cato the Elder made a motion in the senate that these ambassadors should be immediately sent back, because it was very difficult to discern the truth through the arguments of Carneades. The Athenian ambassadors (said many of the senators) were sent rather to force us to comply with their demands, than to solicit them by persuasion; meaning, that it was impossible to resist the power of that eloquence with which Carneades addressed himself to them. According to Plutarch, the youth at Rome were so charmed by the orations of this philosopher, that they forsook their exercises and other diversions, and were carried with a kind of madness to philosophy; the humour of philosophising spreading like enthusiasm. This grieved Cato, who was particularly afraid of the subtility of wit and strength of argument with which Carneades maintained either side of a question. Carneades harangued in favour of justice one day, and the next day against it, to the admiration of all who heard him, among whom were Galba and Cato, the greatest orators of Rome. This was his element; he delighted in demolishing his own work; because it served in the end to confirm his grand principle, that there are only probabilities or resemblances of truth in the mind of man; so that of two things directly opposite, either may be chosen indifferently. Quintilian remarks, that though Carneades argued in favour of injustice, yet he himself acted according to the strict rules of justice. The following was a maxim of Carneades: "If a man privately knew that his enemy, or any other person whose death might be of advantage to him, would come to sit down on grass in which there lurked an asp, he ought to give him notice of it, though it were in the power of no person whatever to blame him for being silent." Carneades, according to some, lived to be 85 years old: others make him to be 90: his death is placed in the 4th year of the 162d Olympiad.

CARNEDDE, in British antiquity, denotes heaps of stones, supposed to be druidical remains, and thrown together on occasion of confirming and commemorating a covenant, Gen. xxxi. 46. They are very common in the isle of Anglesey, and were also used as sepulchral monuments, in the manner of *tumuli;* for Mr Rowland found a curious urn in one of these carnedde. Whence it may be inferred, that the Britons had the custom of throwing stones on the deceased. From this custom is derived the Welsh proverb, *Karn ardyben* "Ill betide thee."

CARNEIA, in antiquity, a festival in honour of Apollo, surnamed Carneus, held in most cities of Greece, but especially at Sparta, where it was first instituted.

The reason of the name, as well as the occasion of the institution, is controverted. It lasted nine days, beginning on the 13th of the month Carneus. The ceremonies were an imitation of the method of living and discipline used in camps.

CARNEL.—The building of ships first with their timber and beams, and after bringing on their planks, is called *carnel work*, to distinguish it from clinch work.

Vessels also which go with mizen sails instead of main sails are by some called carnels.

CARNELIAN, in *Natural History*, a precious stone, of which there are three kinds, distinguished by three colours, a red, a yellow, and a white. The red is very well known among us; is found in roundish or oval masses, much like our common pebbles; and is generally met with between an inch and two or three inches in diameter; it is of a fine, compact, and close texture; of a glossy surface; and, in the several specimens, is of all the degrees of red, from the palest flesh-colour to the deepest blood-red. It is generally free from spots, clouds, or variegations: but sometimes it is veined very beautifully with an extremely pale red, or with white; the veins forming concentric circles, or other less regular figures, about a nucleus, in the manner of those of agates. The pieces of carnelian, which are all one colour, and perfectly free from veins, are those which our jewellers generally make use of for seals, though the variegated ones are much more beautiful. The carnelian is tolerably hard, and capable of a very good polish: it is not at all affected by acid menstruums: the fire divests it of a part of its colour, and leaves it of a pale red; and a strong and long-continued heat will reduce it to a pale dirty gray.

The finest carnelians are those of the East Indies; but there are very beautiful ones found in the rivers of Silesia and Bohemia; and we have some not despicable ones in Engand.

Though the ancients have recommended the carnelian as astringent, and attributed a number of fanciful virtues to it, we know of no other use of the stone than the cutting seals on it; to which purpose it is excellently adapted, as being not too hard for cutting, and yet hard enough not to be liable to accidents, to take a good polish, and to separate easily from the wax.

CARNERO, in *Geography*, a name given to that part of the gulf of Venice which extends from the western coast of Istria to the islands of Gressa and the coast of Morlachia.

CARNERO is likewise the name of the cape to the west of the mouth of the bay of Gibraltar.

CARNIFEX, among the Romans, the common executioner. By reason of the odiousness of his office, the carnifex was expressly prohibited by the laws from having his dwelling house within the city. In middle-ages writers carnifex also denotes a butcher.

Under the Anglo-Danish kings, the carnifex was an officer of great dignity; being ranked with the archbishop of York, Earl Goodwin, and the lord steward. Flor. Wigorn. ann. 1040, *Rex Hardecanutus, Alfricum Ebor. Archiep. Goodwinum comitem, Edricum dispensatorem,*

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torem, Thrond suum carnificem, et alios magnæ dignitatis victor Londinum misit.

CARNIOLA, a duchy of Germany, bounded on the south by the Adriatic sea, and that part of Istria possessed by the republic of Venice; on the north, by Carinthia and Stiria; on the east, by Sclavonia and Croatia; on the west, by Friuli, the county of Gorz or Goritz, and a part of the gulf of Venice; extending in length about 110 miles, and in breadth about 100. Its area is about 4700 square miles, and it contained 409,504 inhabitants in 1807. It had its ancient name *Carnia*, as well as the modern one *Carniola*, from its ancient inhabitants, the *Carni*, a tribe of Scythians, otherwise called *Japides*, whence this and the adjacent countries were also called *Japidia*.

Carniola is full of mountains, some of which are cultivated and inhabited, some covered with wood, others naked and barren, and others continually buried in snow. The valleys are very fruitful. Here are likewise mines of iron, lead, copper, and cinnabar; salt must be had from the sovereign's magazines. There are several rivers, besides many medicinal springs and inland lakes. The common people are very hardy, going barefooted in winter through the snow, with open breasts, and sleeping on a hard bench without bed or bolster. Their food is also very coarse and mean. In winter, when the snow lies deep on the ground, the mountaineers bind either small baskets, or long thin narrow boards, like the Laplanders, to their feet, on which, with the help of a stout staff or pole, they descend with great velocity from the mountains. When the snow is frozen, they make use of a sort of irons or skaits. In different parts of the country the inhabitants, especially the common sort, differ greatly in their dress, language, and manner of living. In Upper and Lower Carniola they wear long beards. The languages chiefly in use are the Sclavonian or Wendish, and German; the first by the commonalty, and the latter by people of fashion. The duchy is divided into the Upper, Lower, Middle, and Inner Carniola. The principal commodities exported hence are, iron, steel, lead, quicksilver, white and red wine, oil of olives, cattle, sheep, cheese, linen, and a kind of woollen stuff called *mahalan*, Spanish leather, honey, walnuts, and timber; together with all manner of wood work, as boxes, dishes, &c. Christianity was first planted here in the eighth century. Lutheranism made a considerable progress in it; but, excepting the Walachians or Uskokes, who are of the Greek church, and style themselves *Staraverni*, i. e. old believers, all the inhabitants at present are Roman Catholics. Carniola was long a marquisate or margravate; but in the year 1231 was erected into a duchy. Carniola was ceded to France in 1809, but was restored to Austria in 1814.

CARNIVAL, or CARNAVAL, a time of rejoicing, a season of mirth, observed with great solemnity by the Italians, particularly at Venice, holding from the twelfth day till Lent.

The word is formed from the Italian *Carnavalle*; which M. Du Cange derives from *Carn-a-val*, by reason the flesh then goes to pot, to make amends for the season of abstinence then ensuing. Accordingly, in the corrupt Latin, he observes, it was called *Carnelevamen* and *Carnisprivium*; as the Spaniards still denominate it *carnes tollendas*.

Feasts, balls, operas, concerts of music, intrigues, marriages, &c. are chiefly held in carnival time. The carnival begins at Venice the second holiday in Christmas: Then it is they begin to wear masks, and open their playhouses and gaming houses; the place of St Mark is filled with mountebanks, jack-puddings, pedlars, whores, and such like mobs, who flock thither from all parts. There have been no less than seven sovereign princes and 30,000 foreigners here to partake of these diversions.

CARNIVOROUS, an epithet applied to those animals which naturally seek and feed on flesh.

It has been a dispute among naturalists, whether man is naturally carnivorous. Those who take the negative side of the question, insist chiefly on the structure of our teeth, which are mostly incisores or molares; not such as *carnivorous* animals are furnished with, and which are proper to tear flesh in pieces: to which it may be added, that, even when we do feed on flesh, it is not without a preparatory alteration by boiling, roasting, &c. and even then that it is the hardest of digestion of all foods. To these arguments Dr Wallis subjoins another, which is, that all quadrupeds which feed on herbs or plants have a long colon, with a cæcum at the upper end of it, or somewhat equivalent, which conveys the food by a long and large progress, from the stomach downwards, in order to its slower passage and longer stay in the intestines; but that, in *carnivorous* animals, such cæcum is wanting, and instead thereof there is a more short and slender gut, and a quicker passage through the intestines. Now in man, the cæcum is very visible: a strong presumption that nature, who is still consistent with herself, did not intend him for a *carnivorous* animal.—It is true, the cæcum is but small in adults, and seems of little or no use; but in a fœtus it is much larger in proportion: And it is probable, our customary change of diet, as we grow up, may occasion this shrinking. But to these arguments Dr Tyson replies, that if man had been by nature designed not to be *carnivorous*, there would doubtless have been found, somewhere on the globe, people who do not feed on flesh; which is not the case. Neither are carnivorous animals always without a colon and cæcum; nor are all animals carnivorous which have these parts; the opossum, for instance, hath both a colon and cæcum, and yet feeds on poultry and other flesh; whereas the hedgehog, which has neither colon nor cæcum, and so ought to be carnivorous, feeds only on vegetables. Add to this, that hogs which have both, will feed upon flesh when they can get it; and rats and mice, which have large cæcums, will feed on bacon as well as bread and cheese. Lastly, the human race are furnished with teeth necessary for the preparation of all kinds of foods; from whence it would seem that nature intended we should live on all. And as the alimentary duct in the human body is fitted for digesting all kinds of foods, ought we not rather to conclude that nature did not intend to deny us any?

It is not less disputed whether mankind were *carnivorous* before the flood. St Jerome, Chrysostome, Theodore, and other ancients, maintain, that all animal food

Carnivorous || Carolina. food was then forbidden; which opinion is also strenuously supported among the moderns by Curcellæus; and refuted by Heidegger, Danzius, Bochart, &c. See ANTEDILUVIANS.

CARNOSITY is used by some authors for a little fleshy excrescence, tubercle, or wen, formed in the urethra, the neck of the bladder, or yard, which stops the passage of the urine.—Carnosities are very difficult of cure: they are not easily known but by introducing a probe into the passage, which there meets with resistance. They usually arise from some venereal malady ill managed.

CARO, ANNIBAL, a celebrated Italian poet, was born at Civita Nuovo in 1507. He became secretary to the duke of Parma, and afterwards to Cardinal Farnese. He was also made a knight of Malta. He translated Virgil's Æneid into his own language, with such propriety and elegance of expression, that he was allowed by the best judges to have equalled the original. He also translated Aristotle's rhetoric, two oratories of Gregory Nazianzen, with a discourse of Cyprian. He wrote a comedy; and a miscellany of his poems was printed at Venice in 1584. He died at Rome in 1566.

CAROLINA, a province of North America, between 31 and 36½ degrees of N. Lat. It is bounded on the east by the Atlantic, on the west by Tennessee, on the north by Virginia, and on the south by Georgia. It is divided into two states, North Carolina and South Carolina.

North CAROLINA is about 430 miles long, and in general about 100 broad; but its sea coast is about 300 miles in extent. Its area is 50,500 square miles.

To the distance of 60 miles from the sea, the country is perfectly level, with a sandy or marshy soil, except along the banks of rivers, where a vegetable mould, three or four feet deep, affords fine pasture and good crops. Beyond this level country, there is a tract 40 miles in breadth, consisting of small sand hills, interspersed with pitch pine, which is of little value for agricultural purposes. The western parts of the state are generally mountainous; but between the mountains, and at their feet, lies much fertile land fit for any species of cultivation. There are several large swamps near the sea coast.

The winter in North Carolina is mild; the summer hot and sultry; the autumn is pleasant. The changes of temperature are sudden and frequent, and vegetation is sometimes hurt by the frost. In the upper country the climate is healthy; but in the low country, along the coast, the miasms are injurious, particularly in autumn.

The principal rivers are the Roanoke, which is navigable for boats 70 miles; the Pamlico, navigable for boats 80 miles; the Neuse, navigable 160 miles for small boats, and 50 miles for sea vessels; and Cape Fear river. A line of sand banks stretching along the coast, renders it difficult to approach it except at some points. The minerals are iron ore, which is abundant, but little worked; and gold, which is found in some of the rivers, but only in trifling quantities. Of animals there are the deer, bear, cougouar, wild cat, fox, squirrel, the wild turkey, and various species of snakes. The bison and the beaver, which were formerly numerous, have now disappeared.

The population of North Carolina in 1810 was 555,500, including 168,824 slaves, and 10,266 free blacks. It is one of the most thinly peopled of the old states, having only about 11 persons to the square mile. The inhabitants are chiefly planters, who live on their plantations at a distance of two or three miles from each other. Marriages are made among them at an early age. They are hospitable and indolent in their habits, and are accused of being addicted to gambling, drinking, and horse racing. In the upper country, however, where few slaves are kept, the people are laborious, sober, and plain in their manners. The government is vested in a senate and house of commons. The former consists of a member for each county, chosen annually by persons who possess 50l. freeholds. The house of commons consists of two representatives for each county, and one for each of six towns, chosen by all the freemen of mature age. There is no established church; the prevailing denominations are Presbyterians, Moravians, Quakers, Methodists, and Baptists. A public provision is made by the state for the support of schools and a university. The agricultural products are cotton, tobacco, rice, indigo, maize, wheat, barley, &c. The wheat harvest is early in June. The manufactures are chiefly domestic, and are but inconsiderable. The commerce of the state is also but small, the whole amount of the exports in 1817 being 956,580 dollars. The value of lands and houses in the state, as ascertained by a fiscal census in 1814, was 92,157,487 dollars, being three times as great as in 1799. Newbern, the largest town in the state, contained only 2467 inhabitants in 1810.

South CAROLINA is of a triangular form, and extends along the sea coast 170 miles. Its greatest length is 340 miles, and its area is 24,080 miles. In its general appearance, soil, climate, and productions, it resembles North Carolina, but has less mountain land. Snow seldom falls, and during seven years the thermometer never rose above 93° nor fell below 17°. The annual average of rain is about 49 inches. The chief rivers are the Savannah, which is navigable for sloops 250 miles; the Santee, navigable 150 miles; the Pedee, also navigable to a considerable distance; Ashley river, Cooper river, &c. The population of South Carolina in 1810 was 415,115, including 196,365 slaves, and 4554 free blacks. The whites are distinguished by politeness, hospitality, and a nice sense of honour. They are at the same time profuse in their habits, fond of gaming, and not free from the imputation of drunkenness. Horse races, hunting, dancing, and ball-playing, are favourite amusements. The legislative power is vested in a senate and house of representatives. The senate consists of 43 members elected for four years, and renewed by halves. The representatives, 124 in number, are chosen for two years. The electors consist of all the free white males of 21 years of age. The value of lands, houses, and slaves in this state in 1814 was 123,416,512 dollars. The exports in 1817 amounted to 10,372,613 dollars; but a great proportion of the trade is in the hands of the New Englanders, the shipping belonging to the state in 1815, amounting only to 37,168 tons. There is no established church; the most numerous sects are the Presbyterians, Baptists, Methodists, Episcopalians, and Independents. Till a late period education was but little attended to. But since

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since 1795 two colleges, and a considerable number of academies and grammar schools have been established. In Charlestown, and some of the other towns, there are a number of societies of a philosophical, literary, or economical nature. The judges are appointed by the legislature during good behaviour, and are removable by impeachment. The judges of the different circuits, four in number, form the highest, or constitutional court, and meet once a year at Columbia, and at Charlestown, for the purpose of hearing and determining all motions for new trials, &c. The common and statute law of Great Britain is in force, and has been adapted by various modifications to the principles of the constitution.

Carolina was discovered by Sebastian Cabot about the year 1500, in the reign of Henry VII. but the settling of it being neglected by the English, a colony of French Protestants, by the encouragement of Admiral Coligni, were transported thither; and named the place of their first settlement *Arx Carolina*, in honour of their prince, Charles IX. of France: but in a short time that colony was destroyed by the Spaniards; and no other attempt was made by any European power to settle there till the year 1664, when 800 English landed at Cape Fear in North Carolina, and took possession of the country. In 1670, Cha. II. of Britain granted Carolina to the lords Berkeley, Clarendon, Albemarle, Craven, and Ashly, Sir George Carteret, Sir William Berkeley, and Sir John Colliton. The plan of government for this new colony was drawn up by the famous Mr Locke, who very wisely proposed a universal toleration in religious matters. The only restriction in this respect was, that every person claiming the protection of that settlement, should, at the age of 17, register himself in some particular communion. To civil liberty, however, our philosopher was not so favourable; the code of Carolina gave to the eight proprietors who founded the colony, and to their heirs, not only all the rights of a monarch, but all the powers of legislation. The court, which was composed of this sovereign body, and called the *Palatinate Court*, was invested with the right of nominating to all employments and dignities, and even of conferring nobility; but with new and unprecedented titles. They were, for instance, to create in each county two *caciques*, each of whom was to be possessed of 24,000 acres of land; and a *landgrave*, who was to have 80,000. The persons on whom these honours should be bestowed were to compose the upper house, and their possessions were made unalienable. They had only the right of farming or letting out a third part of them at the most for three lives. The lower house was composed of the deputies from the several counties and towns. The number of this representative body was to be increased as the colony grew more populous. No tenant was to pay more than about a shilling per acre, and even this rent was redeemable. All the inhabitants, however, both slaves and freemen, were under an obligation to take up arms upon the first order from the Palatine court.

It was not long before the defects of this constitution became apparent. The proprietory lords used every endeavour to establish an arbitrary government; and, on the other hand, the colonists exerted themselves with great zeal to avoid servitude. In consequence of this struggle, the whole province, distracted with tumults and dissensions, became incapable of making any progress, though great things had been expected from its particular advantages of situation. Though a toleration in religious matters was a part of the original constitution, dissensions arose likewise on that account. In 1705, Carteret, now Lord Granville, who, as the oldest of the proprietors, was sole governor of the colony, formed a design of obliging all the non-conformists to embrace the ceremonies of the church of England; and this act of violence, though disavowed and rejected by the mother country, inflamed the minds of the people. In 1720, while this animosity was still subsisting, the province was attacked by several bands of savages, driven to despair by a continued course of the most atrocious violence and injustice. These unfortunate wretches were all put to the sword: but, in 1728, the lords proprietors having refused to contribute towards the expences of an expedition, of which they were to share the immediate benefits, were deprived of their prerogative, except Lord Granville, who still retained his eighth part. The rest received a recompense of about 24,000l. The colony was taken under the immediate protection of the crown, and from that time began to flourish. The division into North and South Carolina now took place, and the settlement of Georgia commenced in 1732. See GEORGIA.

CAROLINE. See CARLINE.

CAROLINE-books, the name of four books, composed by order of Charlemagne, to refute the second council of Nice. These books are couched in very harsh and severe terms, containing 120 heads of accusation against the council of Nice, and condemning the worship of images.

CAROLOSTADIANS, or CARLOSTADIANS, an ancient sect or branch of Lutherans, who denied the real presence of Christ in the eucharist.

They were thus denominated from their leader Andrew Carolostadius, who having originally been archdeacon of Wittemberg, was converted by Luther, and was the first of all the reformed clergy who took a wife; but disagreeing afterwards with Luther, chiefly in the point of the sacrament, founded a sect apart. The Carolostadians are the same with what are otherwise denominated Sacramentarians, and agree in most things with the Zuinglians.

CAROLUS, an ancient English broad piece of gold struck under Charles I. Its value has of late been at 23s. sterling, though at the time it was coined it is said to have been rated at 20s.

CAROLUS, a small copper coin, with a little silver mixed with it, struck under Charles VIII. of France. The Carolus was worth 12 deniers when it ceased to be current. Those which are still current in trade in Lorrain, or in some neighbouring provinces, go under the name of French sols.

CAROTIDS, in *Anatomy*, two arteries of the neck, which convey the blood from the aorta to the brain; one called the right, and the other the left, carotid.

CARP, in *Ichthyology*, the English name of a species of cyprinus. See CYPRINUS, ICHTHYOLOGY *Index*.

The carp is the most valuable of all kinds of fish for stocking of ponds. It is very quick in its growth, and brings forth the spawn three times a year, so that the increase is very great. The female does not begin

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to breed till eight or nine years old; so that in breeding-ponds a supply must be kept of carp of that age. The best judges allow, that, in stocking a breed-pond, four males should be allowed to twelve females. The usual growth of a carp is two or three inches in length in a year; but, in ponds which receive the fattening of common-sewers, they have been known to grow from five inches to 18 in one year. A feeding-pond of one acre extent will very well feed 300 carp of three years old, 300 of two years, and 400 of one year old. Carp delight greatly in ponds that have marly sides; they love also clay-ponds well sheltered from the winds and grown with weeds and long grass at the edges, which they feed on in the hot months. Carp and tench thrive very fast in ponds and rivers near the sea, where the water is a little brackish; but they are not so well tasted as those which live in fresh water.

CARPATES, or ALPES BASTARNICÆ, in *Ancient Geography*, a range of mountains, running out between Poland, Hungary, and Transylvania. Now called the Carpathian mountains.

CARPATHIUM MARE, (Horace, Ovid); the sea that washes the island Carpathus.

CARPATHUS, an island on the coast of Asia, two hundred stadia in compass, and an hundred in length. Its name is said to be from its situation on the coast of Caria. It lies between Rhodes and Crete, in the sea which, from this island, is called the Carpathian sea, and has to the north the Ionian, to the south the Egyptian, to the west the Cretan and African seas. It is two hundred furlongs in compass, and a hundred in length. It had anciently, according to Strabo, four cities; according to Scylax, only three. Ptolemy mentions but one, which he calls Posidium. This island is now called Scarpanto.

CARPÆA, a kind of dance anciently in use among the Athenians and Magnesians, performed by two persons, the one acting a labourer, the other a robber. The labourer, laying by his arms, goes to ploughing and sowing, still looking warily about him as if afraid of being surprised: the robber at length appears; and the labourer, quitting his plough, betakes himself to his arms, and fights in defence of his oxen. The whole was performed to the sound of flutes, and in cadence. Sometimes the robber was overcome and sometimes the labourer; the victor's reward being the oxen and plough. The design of the exercise was to teach and accustom the peasants to defend themselves against the attacks of ruffians.

CARPENTER, a person who practises CARPENTRY. The word is formed from the French *charpentier*, which signifies the same, formed of *charpente*, which denotes timber; or rather from the Latin *carpentarius*, a maker of *carpenta*, or carriages.

CARPENTER of a Ship, an officer appointed to examine and keep in order the frame of a ship, together with her masts, yards, boats, and all other wooden machinery. It is his duty in particular to keep the ship *tight;* for which purpose he ought frequently to review the decks and sides, and to caulk them when it is necessary. In the time of battle, he is to examine up and down, with all possible attention, in the lower apartments of the ship, to stop any holes that may have been made by shot, with wooden plugs provided of several sizes.

CARPENTRAS, an episcopal town of France, in the department of Vaucluse, and capital of Venaissin. It is subject to the pope; and is seated on the river Auson, at the foot of a mountain. E. Long. 5. 6. N. Lat. 44. 4.

CARPENTRY, the art of cutting, framing, and joining large pieces of wood, for the uses of building. It is one of the arts subservient to architecture, and is divided into house-carpentry and ship carpentry: the first is employed in raising, roofing, flooring of houses, &c. and the second in the building of ships †, barges, &c. The rules in carpentry are much the same with those of JOINERY: only carpentry is used in the larger and coarser work, and joinery in the smaller and curious. See CENTRE, ROOF, and *STRENGTH of Materials*. See also CARPENTRY, SUPPLEMENT.

† See *Ship-building*.

CARPENTUM, in *Antiquity*, a name common to divers sorts of vehicles, answering to coaches as well as waggons, or even carts, among us. The carpentum was originally a kind of car or vehicle in which the Roman ladies were carried; though in after times it was also used in war. Some derive the word from *carro;* others from *Carmenta* the mother of Evander, by a conversion of the *m* into *p*.

CARPET, a sort of covering of stuff, or other materials, wrought with the needle or on a loom, which is part of the furniture of a house, and commonly spread over tables, or laid on the floor.

Persian and Turkey carpets are those most esteemed; though at Paris there is a manufactory after the manner of Persia, where they make them little inferior, not to say finer, than the true Persian carpets. They are velvety, and perfectly imitate the carpets which come from the Levant. There are also carpets of Germany, some of which are made of woollen stuffs, as serges, &c. and called square carpets: others are made of wool also, but wrought with the needle, and pretty often embellished with silk; and, lastly, there are some made of dog's hair. We have likewise carpets made in Britain, which are used either as floor-carpets, or to cover chairs, &c. It is true, we are not arrived at the like perfection in this manufacture with our neighbours the French; but may not this be owing to the want of a like public encouragement?

CARPET-Knights, a denomination given to gown-men and others, of peaceable professions, who, on account of their birth, office, or merits to the public, or the like, are, by the prince, raised to the dignity of knighthood.

They take the appellation *carpet*, because they usually receive their honours from the king's hands in the court, kneeling on a carpet. By which they are distinguished from knights created in the camp, or field of battle, on account of their military prowess. Carpet knights possess a medium between those called *truck* or *dunghill knights*, who only purchase or merit the honour by their wealth, and *knights-bachelors*, who are created for their services in the war.

CARPI, a principality of Modena in Italy, lying about four leagues from that city. It formerly belonged to the house of Pio; the elder sons of which bore the title of *princes of St Gregory*. In the beginning of the 14th century, *Manfroy* was the first prince of Carpi; but in the 16th, the emperor Charles V. gave the principality to Alfonzo duke of Ferrara.

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This nobleman, in recompense, gave to Albert Pio, to whom the principality of Carpi belonged of right, the town of Sassuola and some other lands. Albert was, however, at last obliged to retire to Paris; where, being stripped of all his estates, he died in 1338, with the reputation of being one of the best and bravest men of his age. The family of Pio is yet in being, and continues attached to the French court. Some of them have even been raised to the purple, and still make a figure in Europe.

CARPI, a town of Italy in the duchy of Modena, and capital of the last-mentioned principality. It has a strong castle, and is situated in E. Long. 11. 12. N. Lat. 44. 45.

CARPI, a town of the Veronese in Italy, memorable for a victory gained by the Imperialists over the French in 1701. It is subject to the Venetians; and is situated on the river Adige, in E. Long. 11. 39. N. Lat. 45. 10.

CARPI, *Ugo da*, an Italian painter, of no very considerable talents in that art, but remarkable for being the inventor of that species of engraving on wood, distinguished by the name of chiaro-scuro, in imitation of drawing. This is performed by using more blocks than one; and Ugo da Carpi usually had three; the first for the outline and dark shadows, the second for the lighter shadows, and the third for the half tint. In that manner he struck off prints after several designs, and cartoons of Raphael; particularly one of the Sibyl, a Descent from the Cross, and the History of Simon the Sorcerer. He died in 1500. This art was brought to a still higher degree of perfection by Balthazar Peruzzi of Siena, and Parmigiano, who published several excellent designs in that manner.

CARPI, *Girolamo da*, history and portrait painter, was born at Ferrara in 1501, and became a disciple of Garofala. When he quitted that master, he devoted his whole time, thoughts, and attention, to study the works of Correggio, and to copy them with a most critical care and observation: in which labour he spent several years at Parma, Modena, and other cities of Italy, where the best works of that exquisite painter were preserved. He acquired such an excellence in the imitation of Correggio's style, and copying his pictures, that many paintings finished by him were taken for originals, and not only admired, but were eagerly purchased by the connoisseurs of that time. Nor is it improbable that several of the paintings of Girolamo de Carpi pass at this day for the genuine work of Correggio himself. He died in 1556.

CARPINUS, the HORNBEAM. See BOTANY *Index*.

CARPOBALSAM, in the *Materia Medica*, the fruit of the tree which yields the true oriental balsam. The carpobalsam is used in Egypt, according to Prosper Alpinus, in all the intentions in which the balsam itself is applied: but the only use the Europeans make of it is in Venice treacle and mithridate: and in these not a great deal, for cubebs and juniper-berries are generally substituted in its place.

CARPOCRATIANS, a branch of the ancient Gnostics, so called from *Carpocrates*, who in the second century revived and improved upon the errors of Simon Magus, Menander, Saturinos, and other Gnostics. He owned, with them, one sole principle and father of all things, whose name as well as nature was unknown. The word, he taught, was created by angels, vastly inferior to the first principle. He opposed the divinity of Jesus Christ; making him a mere man, begotten carnally on the body of Mary by Joseph, though possessed of uncommon gifts which set him above other creatures. He inculcated a community of women; and taught, that the soul could not be purified, till it had committed all kinds of abominations, making that a necessary condition of perfection.

CARPOLITI, or FRUIT-STONE ROCKS of the Germans, are composed of a kind of jasper, of the nature of the amygdaloides, or almond-stones. Bertrand asserts that the latter are those which appear to be composed of elliptical pieces like petrified almonds, though, in truth, they are only small oblong pieces of calcareous stone rounded by attrition, and sometimes small mussel-shells connected by a stony concretion. The name of Carpolithi, however, is given in general by writers on fossils to all sorts of stony concretions that have any resemblance to fruit of whatever kind.

CARPUS, the WRIST. See ANATOMY *Index*.

CARR, a kind of rolling throne, used in triumphs, and at the splendid entries of princes. See CHARIOT.

The word is from the ancient Gaulish, or Celtic, *Carr;* mentioned by Cæsar, in his Commentaries, under the name *Carrus*. Plutarch relates, that Camillus having entered Rome in triumph, mounted on a carr drawn by four white horses, it was looked on as too haughty an innovation.

CARR is also used for a kind of light open chariot. The carr, on medals, drawn either by horses, lions, or elephants, usually signifies either a triumph or an apotheosis: sometimes a procession of the images of the gods at solemn supplication, and sometimes of those of some illustrious family at a funeral. The carr covered, and drawn by mules, only signifies a consecration, and the honour done any one of having his image carried at the gates of the circus. See CONSECRATION, &c.

CARRAC, or CARRACA, a name given by the Portuguese to the vessels they send to Brasil and the East Indies, being very large, round built, and fitted for fight as well as burden. Their capacity lies in their depth, which is very extraordinary. They are narrower above than underneath, and have sometimes seven or eight floors; they carry about 2000 tons, and are capable of lodging 2000 men; but of late they are little used. Formerly they were also in use among the knights of Rhodes, as well as among the Genoese, and other Italians. It is a custom among the Portuguese, when the carracs return from India, not to bring any boat or sloop for the service of the ship beyond the island of St Helena; at which place they sink them on purpose, in order to take from the crew all hopes or possibility of saving themselves, in case of shipwreck.

CARRARA MARBLE, among our artificers, the name of a species of white marble, which is called *marmor lunense*, and *ligustrium* by the ancients: it is distinguished from the Parian, now called the statuary marble, by being harder and less bright.

CARRAVEIRA, a town of Turkey in Europe, with

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with a Greek archbishop's see. E. Long. 22. 25. N. Lat. 40. 27.

CARRIAGE, a vehicle serving to convey persons, goods, merchandises, and other things, from one place to another.

For the construction and mechanical principles of wheel-carriages, see MECHANICS.

CARRIAGE of a Cannon, the frame or timber-work on which it is mounted, serving to point it for shooting, or to carry it from one place to another. It is made of two planks of wood, commonly of one-half the length of the gun, called the *cheeks*, and joined by three wooden transums, strengthened with three bolts of iron. It is mounted on two wheels, but on a march has two fore-wheels with limbers added. The principal parts of a carriage are the cheeks, transum, bolts, plates, trainbands, bridges, bed, hooks, trunnion holes, and capsquare.

Block-CARRIAGE, a cart made on purpose for carrying mortars and their beds from place to place.

Truck-CARRIAGE, two short planks of wood, supported on two axletrees, having four trucks of solid wood for carrying mortars or guns upon battery, where their own carriages cannot go. They are drawn by men.

CARRICK, the southern division of the shire of Ayr in Scotland. It borders on Galloway; stretches 32 miles in length; and is a hilly country fit for pasturage. The chief rivers are the Stinchar and Girvan, both abounding with salmon. Here are also several lakes and forests, and the people on the coast employ themselves in the herring-fishery, though they have no harbour of any consequence. The only towns of this district are Girvan and Ballantrae; the former at the mouth of the river of the same name, and the latter at the mouth of the Stinchar; and Maybole, an inland town. The Prince of Wales, as Prince of Scotland, is Earl of Carrick.

CARRICK on the Sure, a town of Ireland, in the county of Tipperary and province of Munster. W. Long. 7. 14. N. Lat. 52. 16.

CARRICK-Fergus, a town of Ireland, in the county of Antrim and province of Ulster. It is a town and county in itself, and sends one member to parliament. It contains 3400 inhabitants; has a good harbour; and is governed by a mayor, recorder, and sheriffs.—It has, however, been of far greater consequence than at present, as appears from the mayor having been admiral of a considerable extent of coast in the counties of Down and Antrim, and the corporation enjoying the customs paid by all vessels within these bounds, the creeks of Belfast and Bangor excepted. This grant was repurchased, and the customhouse transferred to Belfast.—Here is the skeleton of a fine house built by Lord Chichester in the reign of James I. an old Gothic church with many family monuments, and a very large old castle. The town was formerly walled round, and some part of the wall still remains entire.—Carrick-Fergus is seated on a bay of the same name in the Irish Channel; and is noted for being the landing place of King William in 1690. Here also Thurot made a descent in 1759, took possession of the castle, and carried away hostages for the ransom of the town; but being soon after pursued by Commodore Elliot, his three ships were taken, and he himself was killed.

CARRIER, is a person that carries goods for others for hire. A common carrier, having the charge and carriage of goods, is to answer for the same, or the value, to the owner. And where goods are delivered to a carrier, and he is robbed of them, he shall be charged and answer for them, because of the hire. If a common carrier, who is offered his hire, and who has convenience, refuses to carry goods, he is liable to an action, in the same manner as an innkeeper who refuses to entertain a guest. See ASSUMPSIT.

One brought a box to a carrier, with a large sum of money, and the carrier demanded of the owner what was in it; he answered, that it was filled with silks, and such like goods; upon which the carrier took it, and was robbed, and adjudged to make it good; but a special acceptance, as, *provided there is no charge of money*, would have excused the carrier.—A person delivered to a carrier's book-keeper two bags of money sealed up, to be carried from London to Exeter, and told him that it was 200l. and took his receipt for the same, with promise of delivery for 10s. per cent. carriage and risk; though it be proved that there was 400l. in the bags, if the carrier be robbed, he shall answer only for 200l. because there was a particular undertaking for that sum and no more; and his reward, which makes him answerable, extends no farther. If a common carrier loses goods which he is intrusted to carry, a special action on the case lies against him, on the custom of the realm, and not trover; and so of a common carrier by boat. An action will lie against a porter, carrier, or barge-man, upon his bare receipt of the goods, if they are lost through negligence. Also a lighter-man spoiling goods he is to carry, by letting water come to them, action of the case lies against him, on the common custom. *Jacob's Law Dict.*

CARRIER-Pigeon, or *Courier-pigeon*, a sort of pigeon used, when properly trained, to be sent with letters from one place to another. See COLUMBA.

Though you carry these birds hood-winked, 20, 30, nay, 60 or 100 miles, they will find their way in a very little time to the place where they were bred. They are trained to this service in Turkey and Persia; and are carried first, while young, short flights of half a mile, afterwards more, till at length they will return from the farthest part of the kingdom. Every bashaw has a basket of these pigeons bred in the seraglio, which, upon any emergent occasion, as an insurrection, or the like, he dispatches, with letters braced under the wings, to the seraglio; which proves a more speedy method, as well as a more safe one, than any other; he sends out more than one pigeon, however, for fear of accidents. Lithgow assures us, that one of these birds will carry a letter from Babylon to Aleppo, which is 30 days journey, in 48 hours. This is also a very ancient practice. Hirtius and Brutus, at the siege of Modena, held a correspondence with one another by means of pigeons. And Ovid tells us, that Taurosthenes, by a pigeon stained with purple, gave notice to his father of his victory at the Olympic games, sending it to him at Ægina.

In modern times, the most noted were the pigeons of Aleppo, which served as couriers at Alexandretta and Bagdad. But this use of them has been laid aside for the last 30 or 40 years, because the Curd robbers killed

Carrier-Pigeon, Carron.

killed the pigeons. The manner of sending advice by them was this: they took pairs which had young ones, and carried them on horseback to the place from whence they wished them to return, taking care to let them have a full view. When the news arrived, the correspondent tied a billet to the pigeon's foot, and let her loose. The bird, impatient to see its young, flew off like lightning, and arrived at Aleppo in ten hours from Alexandretta, and in two days from Bagdad. It was not difficult for them to find their way back, since Aleppo may be discovered at an immense distance. This pigeon has nothing peculiar in its form, except its nostrils, which, instead of being smooth and even, are swelled and rough.

CARRON, a small but remarkable river in Scotland, rising about the middle of the isthmus between the friths of Forth and Clyde. Both its source, and the place where it emptieth itself into the sea, are within the shire of Stirling, which it divides into two nearly equal parts. The whole length of its course, which is from west to east, is not above 14 miles. It falls into the frith of Forth about three miles to the north-east of Falkirk. The stream thereof is but small, and scarcely deserves the notice of a traveller; yet there is no river in Scotland, and few in the whole island of Britain, whose banks have been the scene of so many memorable transactions. When the Roman empire was in all its glory, and had its eastern frontiers upon the Euphrates, the banks of Carron were its boundaries upon the north-west; for the wall of Antoninus *, which was raised to mark the limits of that mighty empire, stood in the neighbourhood of this river, and ran parallel to it for several miles.

* See *Antoninus's Wall.*

Near the middle of its course, in a pleasant valley, stand two beautiful mounts, called the *Hills of Dunipace*, which are taken notice of by most of the Scotish historians as monuments of great antiquity. The whole structure of these mounts is of earth; but they are not both of the same form and dimensions. The most easterly one is perfectly round, resembling an oven, and about fifty feet in height; and that this is an artificial work does not admit of the least doubt; but we cannot affirm the same, with equal certainty, of the other, though it has been generally supposed to be so too. It bears no resemblance to the eastern one either in shape or size. At the foundation it is nearly of a triangular form; but the superstructure is quite irregular; nor does the height thereof bear any proportion to the extent of its base. These mounts are now planted with firs, which, with the parish-church of Dunipace standing in the middle between them, and the river running hard by, give this valley a very romantic appearance. The common account given of those mounts is, that they were erected as monuments of a peace concluded in that place between the Romans and the Caledonians, and that their name partakes of the language of both people; *Dun* signifying a hill in the old language of this island, and *Pax* "peace," in the language of Rome. The compound word, *Dunipace*, signifies "the hills of peace." And we find in history, that no less than three treaties of peace were at different periods entered into between the Romans and Caledonians; the first by Severus about the year 210; the second soon after, by his son Caracalla; and the third, by the usurper Carausius about the year 280; but of which of these treaties Dunipace is a monument, we do not pretend to determine. If the concurring testimony of historians and antiquaries did not agree in giving this original to these mounts, we would be tempted to conjecture that they are sepulchral monuments. Human bones and urns have been discovered in earthen fabrics of this kind in many parts of this island, and the little mounts or barrows which are scattered in great numbers about Stonhenge in Salisbury plain are generally supposed to have been the sepulchres of the ancient Britons. See BARROWS.

Carron.

From the valley of Dunipace, the river runs for some time in a deep and hollow channel, with steep banks on both sides; here it passes by the foundations of the ancient Roman bridge; not far from which, as is generally thought, was the scene of the memorable conference betwixt the Scotish patriot William Wallace and Robert Bruce, father to the king of that name, which first opened the eyes of the latter to a just view both of his own true interest and that of his country.

After the river has left the village and bridge of Larbert, it soon comes up to another smaller valley, through the midst of which it has now worn out to itself a straight channel, whereas, in former ages, it had taken a considerable compass, as appears by the track of the old bed which is still visible. The high and circling banks upon the south side give to this valley the appearance of a spacious bay; and, according to the tradition of the country, there was once an harbour here; nor does the tradition seem altogether groundless, pieces of broken anchors having been found here, and some of them within the memory of people yet alive. The stream tides would still flow near the place, if they were not kept back by the dam-head built across the river at Stenhouse; and there is reason to believe, that the frith flowed considerably higher in former ages than it does at present. In the near neighbourhood of this valley, upon the south, stand the ruins of ancient Camelon: which, after it was abandoned by the Romans, was probably inhabited, for some ages, by the natives of the country.

Another ancient monument, called *Arthur's Oven*, once stood upon the banks of the Carron: but was, with a spirit truly Gothic, entirely demolished about 40 years ago. The corner of a small inclosure between Stenhouse and the Carron iron-works, is pointed out as the place of its situation. This is generally supposed to have been a Roman work: though it is not easy to conceive what could be their motive for erecting such a fabric, at so great a distance from any other of their works, and in a spot which at that time must have been very remote and unfrequented. The form of it is said to have been perfectly round, and rising perpendicular for some yards at first, but afterwards gradually contracted, till it terminated in a narrow orifice at the top. Antiquaries are not agreed whether it had been a temple, or a trophy, or a mausoleum; but the most common opinion is, that it had been a temple, and Buchanan thinks, a temple of Terminus. Hector Boetius says, that there were benches of stone all around it upon the inside; and that there had been a large stone

Carron, Carron-Works.

stone for sacrificing upon, or an altar, upon the south side.

As the Carron extends over the half of the isthmus, and runs so near the ancient boundaries of the Roman empire, the adjacent country fell naturally to be the scene of many battles and rencounters. Historians mention a bloody battle fought near the river between the Romans and the confederate army of the Scots and Picts in the beginning of the 5th century. The scenes of some of Ossian's poems were, in the opinion of the translator, upon the banks of this river. Here Fingal fought with Caracal, the son of the king of the world, supposed to have been the same with Caracalla, the son of the Roman emperor Severus. Here also young Oscar, the son of Ossian, performed some of his heroic exploits. Hereabout was the stream of Crona, celebrated in the ancient compositions of the Gaelic bard; possibly that now called the water of Bonny, which runs in the neighbourhood of the Roman wall, and dischargeth itself into the Carron at Dunipace. In those poems, mention is made of a green vale upon the banks of this river, with a tomb standing in the middle of it, where young Oscar's party and the warriors of Caros met. We only take notice of this as it strengthens the conjecture hazarded above, that the mounts of Dunipace, especially the more easterly of them, were sepulchral monuments.—About the distance of half a mile from the river, and near the town of Falkirk, lies the field of that battle which was fought by William Wallace and the English in the beginning of the 14th century. It goes by the name of *Graham's muir*, from the valiant John Graham, who fell there, and whose grave-stone is still to be seen in the church-yard of Falkirk.

The river Carron, though it has long since ceased to roll its stream amidst the din of arms, still preserves its fame, by lending its aid to trade and manufactures; (see the next article.)—The river is navigable for some miles near its mouth, and a considerable trade is carried on upon it by small craft; for the convenience of which, its channel has of late years been straightened and much shortened, and the great Canal * has its entrance from it.

* See the article *Canal*.

Carron-Works, a large iron-foundery, two miles north from Falkirk in Scotland. They are conveniently situated on the banks of the Carron, three miles above its entry into the frith of Forth. Above 100 acres of land have been converted into reservoirs and pools, for water diverted from the river, by magnificent dams built above two miles above the works, which after turning 18 large wheels for the several purposes of the manufacture, falls into a tide-navigation that conveys their castings to the sea.

These works are among the greatest of the kind in Europe, and were established in 1760. At present, the buildings are of vast extent; and the machinery, constructed by Mr Smeaton, is the first in Britain, both in elegance and correctness: there are 2000 men employed, and there are about twenty furnaces which consume 200 tons of coals a-week; 6500 tons of iron are smelted annually from the mineral with pit-coal, and cast into cannon, cylinders, &c.—In the founding of cannon, those works have lately arrived at such perfection, that they make above 5000 pieces a year, many of which are exported to foreign states; and their guns of *new construction* are the lightest and neatest now in use, not excepting brass guns; the 32 pounder ship-gun weighing 42 hundred weight, the 6 pounder 8 hundred-weight and one-half, and the other calibers in proportion.

Carron-Works ‖ Carrucate.

The present proprietors are a chartered company, with a capital of 150,000l. sterling, a common seal, &c. but their stock is confined to a very few individuals.

CARRONADE, a short kind of ordnance, capable of carrying a large ball, and useful in close engagements at sea. It takes its name from Carron, the place where this sort of ordnance was first made, or the principle applied to an improved construction. See the article GUNNERY.

CARROT. See DAUCUS, BOTANY *Index*.

Deadly CARROT. See THAPSIA, BOTANY *Index*.

CARROUSAL, a course of horses and chariots, or a magnificent entertainment exhibited by princes on some public rejoicing. It consists in a cavalcade of several gentlemen, richly dressed and equipped after the manner of ancient cavaliers, divided into squadrons, meeting in some public place, and practising justs, tournaments, &c.—The last carrousals were in the reign of Louis XIV.—The word comes from the Italian word *carosello*, a diminutive of *carro*, "chariot." Tertullian ascribes the invention of carrousals to Circe; and will have them instituted in honour of the Sun, her father; whence some derive the word from *carrus*, or *carrus solis*. The Moors introduced ciphers, liveries, and other ornaments of their arms, with trappings, &c. for their horses. The Goths added crests, plumes, &c.

CARRUCA, in *Antiquity*, a splendid kind of carr, or chariot, mounted on four wheels, richly decorated with gold, silver, ivory, &c. in which the emperors, senators, and people of condition, were carried. The word comes from the Latin *carrus*, or British *carr*, which is still the Irish name for any wheel-carriage.

CARRUCA, or *Caruca*, is also used in middle-age writers for a plough.

CARRUCA, or *Caruca*, also was sometimes used for *carrucata*. See CARRUCATE.

CARRUCAGE (*carucagium*), a kind of tax anciently imposed on every plough, for the public service, See CARRUCATE and HIDAGE.

CARRUCAGE, *Carucage*, or *Caruage*, in husbandry, denotes the ploughing of ground, either ordinary, as for grain, hemp, and flax; or extraordinary, as for woad, dyers weed, rape, and the like.

CARRUCATE, (*carrucata*), in our ancient laws and history, denotes a plough land, or as much arable ground as can be tilled in one year with one plough.

In Doomsday Inquisition, the arable land is estimated in carrucates, the pasture in hides, and meadow in acres. Skene makes the *carrucata* the same with *hilda*, or *hida terræ*; Littleton the same with soc.

The measure of a carrucate appears to have differed in respect of place as well as time. In the reign of Richard I. it was estimated at 60 acres, and in another charter of the same reign at 100 acres: in the time of Edward I. at 180 acres; and in the 23d of Edward III. a carrucate of land in Burcester contained 112 acres, and in Middleton 150 acres.

By a statute under William III. for charging persons

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sons to the repair of the highways, a plough-land is rated at fifty pounds per annum, and may contain houses, mills, wood, pasture, &c.

CARRYING, in falconry, signifies a hawk's flying away with the quarry. Carrying is one of the ill qualities of a hawk, which she acquires either by dislike of the falconer, or not being sufficiently broke to the lure.

CARRYING, among huntsmen. When a hare runs on rotten ground (or even sometimes in a frost), and it sticks to her feet, they say she carries.

CARRYING, among riding-masters. A horse is said to carry low, when having naturally an ill-shaped neck, he lowers his head too much. All horses that arm themselves carry low, but a horse may carry low without arming. A French branch or gigot is prescribed as a remedy against carrying low.

A horse is said to carry well, when his neck is raised or arched, and he holds his head high and firm, without constraint.

Carrying Wind, a term used by our dealers in horses to express such a one as frequently tosses his nose as high as his ears, and does not carry handsomely. This is called *carrying wind;* and the difference between carrying in the wind, and beating upon the hand, is this: that the horse who beats upon the hand, shakes the bridle and resists it, while he shakes his head; but the horse that carries in the wind puts up his head without shaking, and sometimes beats upon the hand. The opposite to carrying in the wind, is arming and carrying low: and even between these two there is a difference in wind.

CARS, or KARS, a considerable and strong town of Asia, in Armenia, seated on a river of the same name, with a castle almost impregnable. E. Long. 43. 50. N. Lat. 41. 30.

CARSE, or *Carse of Gowry*, a district of Perthshire in Scotland. It lies on the north side of the Tay, and extends 14 miles in length from Dundee to Perth, and is from two to four in breadth. It is a rich plain country, cultivated like a garden, and producing as good harvests of wheat as any in Great Britain. It abounds with all the necessaries of life: but, from its low damp situation, the inhabitants are subject to agues, and the commonalty are in great want of firing. In this district, not far from the Tay, stands the house of Errol, which formerly belonged to the earls of that name, the chiefs of the ancient family of Hay, hereditary constables of Scotland.

CARSTAIRS, WILLIAM, an eminent Scots divine, whose merit and good fortune called him to act in great scenes, and to associate with men to whose society and intercourse his birth gave him few pretensions to aspire. A small village in the neighbourhood of Glasgow was the place of his nativity. His father, of whom little is known, exercised the functions of a clergyman.

Young Carstairs turned his thoughts to the profession of theology; and the persecutions and oppressions of government, both in regard to civil and religious liberty, having excited his strongest indignation, it became a matter of prudence that he should prosecute his studies in a foreign university. He went accordingly to Utrecht; and his industry and attention being directed with skill, opened up and unfolded those faculties which he was about to employ with equal honour to his country and himself.

During his residence abroad, he became acquainted with Pensionary Fagel, and entered with warmth into the interest of the Prince of Orange. On his return to Scotland to produce a licence to teach doctrines which he had studied with the greatest care, he became disgusted with the proud and insolent conduct of Archbishop Sharp, and prepared to revisit Holland; where he knew that religious liberty was respected, and where he hoped he might better his condition by the connections he had formed.

His expectations were not vain. His prudence, his reserve, and his political address, were strong recommendations of him to the Prince of Orange; and he was employed in personal negotiations in Holland, England, and Scotland. Upon the elevation of his master to the English throne, he was appointed the king's chaplain for Scotland, and employed in settling the affairs of that kingdom. William, who carried politics into religion, was solicitous that episcopacy should prevail there as universally as in England. Carstairs, more versant in the affairs of his native country, saw all the impropriety of this project, and the danger that would arise from the enforcing of it. His reasonings, his remonstrances, his entreaties, overcame the firmness of King William. He yielded to considerations founded alike in policy and in prudence; and to Carstairs Scotland is indebted for the full establishment of its church in the Presbyterian form of government.

The death of King William was a severe affliction to him; and it happened before the prince had provided for him with the liberality he deserved. He was continued, however, in the office of chaplain for Scotland by Queen Anne; and he was invited to accept the principality of the university of Edinburgh. He was one of the ministers of the city, and four times moderator of the General Assembly. Placed at the head of the church, he prosecuted its interest with zeal and with integrity. Nor were his influence and activity confined to matters of religion. They were exerted with success in promoting the culture of the arts and sciences. The universities of Scotland owe him obligations of the highest kind. He procured, in particular, an augmentation of the salaries of their professors; a circumstance to which may be ascribed their reputation, as it enabled them to cultivate with spirit the different branches of knowledge.

A zeal for truth, a love of moderation and order, prudence, and humility, distinguished Principal Carstairs in an uncommon degree. His religion had no mixture of austerity; his secular transactions were attended with no imputation of artifice; and the versatility of his talents made him pass with ease from a court to a college. He was among the last who suffered torture before the privy council, in order to make him divulge the secrets entrusted to him, which he firmly resisted; and after the Revolution, that inhuman instrument the thumb-screw was given to him in a present by the council.—This excellent person died in 1715; and in 1744 his *State papers and Letters*, with an account of his life, were published in one vol. 4to. by the Rev. Dr M'Cormick.

CARSUCAI, Rainier, a Jesuit, born at Citerna in Tuscany, in 1647, was the author of a Latin poem, entitled *Ars bene scribendi*, which is esteemed both for the elegance of the style and for the excellent precepts it contains. He also wrote some good epigrams. He died in 1709.

CARTAMA, a town of Spain in the kingdom of Grenada, formerly very considerable. It is seated at the foot of a mountain, near the river Guadala-Medina, in W. Long. 4. 28. N. Lat. 36. 40.

CART, a land carriage with two wheels, drawn commonly by horses, to carry heavy goods, &c. from once place to another. The word seems formed from the French *charrette*, which signifies the same, or rather the Latin *carreta*, a diminutive of *carrus*. See Carr.

In London and Westminster carts shall not carry more than twelve sacks of meal, seven hundred and fifty bricks, one chaldron of coals, &c. on pain of forfeiting one of the horses. (6 Geo. I. cap. 6.) By the laws of the city, carr-men are forbidden to ride either on their carts or horses. They are to lead or drive them on foot through the streets, on the forfeiture of ten shillings. (Stat. 1. Geo. I. cap. 57.) Criminals used to be drawn to execution on a cart. Bawds and other malefactors are whipped at the cart's tail.

Scripture makes mention of a sort of carts or drags used by the Jews to do the office of threshing. They were supported on low thick wheels, bound with iron, which were rolled up and down on the sheaves, to break them, and force out the corn. Something of the like kind also obtained among the Romans, under the denomination of *plaustra*, of which Virgil makes mention. (Georg. I.)

Tardaque Eleusinæ matris volventia plaustra,
Tribulaque, traheæque.——

On which Servius observes, that *trahea* denotes a cart without wheels, and *tribula* a sort of cart armed on all sides with teeth, chiefly used in Africa for threshing corn. The Septuagint and St Jerome represent these carts as furnished with saws, insomuch that their surface was beset with teeth. David having taken Rabbah, the capital of the Ammonites, ordered all the inhabitants to be crushed to pieces under such carts, moving on wheels set with iron teeth; and the king of Damascus is said to have treated the Israelites of the land of Gilead in the same manner.

Cart-Bote, in *Law*, signifies wood to be employed in making and repairing instruments of husbandry.

Carts of War, a peculiar kind of artillery anciently in use among the Scots. They are thus described in an act of parliament, A. D. 1456: "It is thought speidfull, that the king may requiest to certain of the great burrous of the land that are of ony myght, to mak carts of weir, and in ilk cart two gunnis, and ilk ane to have two chalmers, with the remnant of the graith that effeirs thereto, and an cunnand man to shut thame." By another act, A. D. 1471, the prelates and barons are commanded to provide such carts of war against their old enemies the English.

CARTE, Thomas, the historian, was the son of Mr Samuel Carte, prebendary of Lichfield, and born in 1686. When he was reader in the abbey-church at Bath, he took occasion in a 30th of January sermon, 1714, to vindicate Charles I. with respect to the Irish massacre, which drew him into a controversy with Mr Chandler the dissenting minister; and on the accession of the present royal family he refused to take the oaths to government, and put on a lay habit. He is said to have acted as a kind of secretary to Bishop Atterbury before his troubles: and in the year 1722, being accused of high treason, a reward of 1000l. was offered for apprehending him: but Queen Caroline, the great patroness of learned men, obtained leave for him to return home in security. He published, 1. An edition of Thuanus, in seven volumes, folio. 2. The life of the first duke of Ormond, three volumes, folio. 3. The History of England, four volumes, folio. 4. A Collection of Original Letters and Papers concerning the affairs of England, two volumes octavo; and some other works. He died in April 1754. His History of England ends in 1654. His design was to have brought it down to the Revolution; for which purpose he had taken great pains in copying every thing valuable that could be met with in England, Scotland, France, Ireland, &c.—He had (as he himself says, p. 43. of his Vindication of a full answer to a letter from a bystander), "read abundance of collections relating to the time of King Charles II. and had in his power a series of memoirs from the beginning to the end of that reign, in which all those intrigues and turns at court, at the latter end of that king's life, which Bishop Burnet, with all his *gout* for tales of secret history, and all his genius for conjectures, does not pretend to account for, are laid open in the clearest and most convincing manner by the person who was most affected by them, and had the best reason to know them."—At his death, all his papers came into the hands of his widow, who afterwards married Mr Jernegan, a member of the church of Rome. They are now deposited in the Bodleian library, having been delivered by Mr Jernegan to the university, 1778, for a valuable consideration. Whilst they were in this gentleman's possession, the earl of Hardwick paid 200l. for the perusal of them. For a consideration of 300l. Mr Macpherson had the use of them; and from these and other materials, compiled his history and state papers. Mr Carte was a man of a strong constitution and indefatigable application. When the studies of the day were over, he would eat heartily; and in conversation was cheerful and entertaining.

Carte Blanche, a sort of white paper signed at the bottom with a person's name, and sometimes also sealed with his seal, giving another person power to superscribe what conditions he pleases. Much like this is the French *blanc signe*, a paper without writing, except a signature at the bottom, given by contending parties to arbitrators or friends, to fill up with the conditions they judge reasonable, in order to end the difference.

CARTEL, an agreement between two states for the exchange of their prisoners of war.

Cartel signifies also a letter of defiance or a challenge to decide a controversy either in a tournament or in a single combat. See Duel.

Cartel Ship, a ship commissioned in time of war to exchange the prisoners of any two hostile powers; also to carry any particular request or proposal from one to another:

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another: for this reason the officer who commands her is particularly ordered to carry no cargo, ammunition, or implements of war, except a single gun for the purpose of firing signals.

CARTES, Rene des, descended of an ancient family in Touraine in France, was one of the most eminent philosophers and mathematicians in the 17th century. At the Jesuits College at La Fleche, he made a very great progress in the learned languages and polite literature, and became acquainted with Father Marsenne. His father designed him for the army; but his tender constitution then not permitting him to expose himself to such fatigues, he was sent to Paris, where he launched into gaming, in which he had prodigious success. Here Marsenne persuaded him to return to study; which he pursued till he went to Holland, in May 1616, where he engaged as a volunteer among the Prince of Orange's troops. While he lay in garrison at Breda, he wrote a *treatise on music*, and laid the foundation of several of his works. He was at the siege of Rochelle in 1628; returned to Paris; and, a few days after his return, at an assembly of men of learning in the house of Monsignor Bagni, the pope's nuncio, was prevailed upon to explain his sentiments with regard to philosophy, when the nuncio urged him to publish his system. Upon this he went to Amsterdam, and from thence to Franeker, where he began his *metaphysical meditations*, and drew up his *discourse on meteors*. He made a short tour to England; and not far from London, made some observations concerning the declination of the magnet. He returned to Holland, where finished his *treatise on the world*.

His books made a great noise in France; and Holland thought of nothing but discarding the old philosophy, and following his. Voetius being chosen rector of the university of Utrecht, procured his philosophy to be prohibited, and wrote against him; but he immediately published a vindication of himself. In 1647, he took a journey into France, where the king settled a pension of 3000 livres upon him. Christina, queen of Sweden, having invited him into that kingdom, he went thither, where he was received with the greatest civility by her majesty, who engaged him to attend her every morning at five o'clock, to instruct her in philosophy, and desired him to revise and digest all his writings which were unpublished, and to form a complete body of philosophy from them. She likewise proposed to allow him a revenue, and to form an academy, of which he was to be the director. But these designs were broken off by his death in 1650. His body was interred at Stockholm, and 17 years afterwards removed to Paris, where a magnificent monument was erected to him in the church of St Genevive du Mont. The great Dr Halley, in a paper concerning optics observes, that though some of the ancients mention refraction as an effect of transparent mediums, Des Cartes was the first who discovered the laws of refraction, and reduced dioptrics to a science. As to his philosophy, Dr Keill, in his introduction to his examination of Dr Burnet's theory of the earth, says, that Des Cartes was so far from applying geometry to natural philosophy, that his whole system is one continued blunder on account of his negligence in that point; the laws observed by the planets in their revolutions round the sun not agreeing with his theory of vortices. His philosophy has accordingly given way to the more acurate discoveries and demonstrations of the Newtonian system.

CARTESIANS, a sect of philosophers, who adhered to the system of Des Cartes, founded on the two following principles, the one metaphysical, the other physical. The metaphysical one is, *I think, therefore I am*: the physical principle is, that *nothing exists but substance*. Substances he makes of two kinds; the one a substance that thinks, the other a substance extended; whence actual thought, and actual extension, are the essence of substance.

The essence of matter being thus fixed in extension, the Cartesians conclude that there is no vacuum nor any possibility thereof in nature; but that the universe is absolutely full: mere space is excluded by this principle; because extension being implied in the idea of space, matter is so too. Upon these principles the Cartesians explained mechanically how the world was formed, and how the present celestial phenomena came to take place. See Astronomy *Index*.

CARTHAGE, a famed city of antiquity, the capital of Africa Propria; and which for many years disputed with Rome the sovereignty of the world. According to Velleius Paterculus, this city was built 65, according to Justin and Trogus 72, according to others 100 or 140 years, before the foundations of Rome were laid. It is on all hands agreed that the Phœnicians were the founders. 1 When founded.

The beginning of the Carthaginian history, like that of all other nations, is obscure and uncertain. In the 7th year of Pygmalion king of Tyre, his sister Elisa, or Dido, is said to have fled, with some of her companions and vassals, from the cruelty and avarice of her brother, who had put to death her husband Sichæus in order to get possession of his wealth. 2 Elisa or Dido escapes from her brother.

She first touched at the island of Cyprus, where she met with a priest of Jupiter, who was desirous of attending her; to which she readily consented, and fixed the priesthood in his family. At that time it was a custom in the island of Cyprus, for the young women to go on certain stated days, before marriage, to the sea side, there to look for strangers, that might possibly arrive on their coasts, in order to prostitute themselves for gain, that they might thereby acquire a dowry. Out of these the Tyrians selected 80, whom they carried along with them. From Cyprus they sailed directly for the coast of Africa: and at last safely landed in the province called *Africa Propria*, not far from Utica, a Phœnician city of great antiquity. The inhabitants received their countrymen with great demonstrations of joy, and invited them to settle among them. The common fable is, that the Phœnicians imposed upon the Africans in the following manner: They desired, for their intended settlement, only as much ground as an ox's hide would encompass. This request the Africans laughed at: but were surprised, when, upon their granting it, they saw Elisha cut the hide into the smallest shreds, by which means it surrounded a large territory; in which she built the citadel called *Byrsa*. The learned, however, are now unanimous in exploding this fable: and it is certain that the Carthaginians for many years paid an annual tribute to the Africans for the ground they possessed. 3 Builds the citadel Byrsa.

The new city soon became populous and flourishing,

Carthage. by the accession of the neighbouring Africans, who came thither at first with a view of traffic. In a short time it became so considerable, that *Jarbas*, a neighbouring prince, thought of making himself master of it without any effusion of blood. In order to this, he desired that an embassy of ten of the most noble Carthaginians might be sent him; and, upon their arrival, proposed to them a marriage with Dido, threatening war in case of a refusal. The ambassadors, being afraid to deliver this message, told the queen that Jarbas desired some person might be sent him who was capable of civilizing his Africans; but that there was no possibility of finding any of her subjects who would leave his relations for the conversation of such barbarians. For this they were reprimanded by the queen: who told them that they ought to be ashamed of refusing to live in any manner for the benefit of their country. Upon this, they informed her of the true nature of their message from Jarbas: and that, according to her own decision, she ought to sacrifice herself for the good of her country. The unhappy queen,
4 She kills herself. rather than submit to be the wife of such a barbarian, caused a funeral pile to be erected, and put an end to her life with a dagger.

This is Justin's account of the death of Queen Dido, and is the most probable; Virgil's story of her amour with Æneas being looked upon as fabulous, even in the days of Macrobius, as we are informed by that historian. How long monarchical government continued in Carthage, or what happened to this state in its infancy, we are altogether ignorant, by reason of the Punic archives being destroyed by the Romans; so that there is a chasm in the Carthaginian history for above 300 years. It however appears, that from the very beginning the Carthaginians applied themselves to maritime affairs, and were formidable by sea
5 Spanish mines of vast service to the Carthaginians. in the time of Cyrus and Cambyses. From Diodorus Siculus and Justin, it appears that the principal support of the Carthaginians were the mines of Spain, in which country they seem to have established themselves very early. By means of the riches drawn from these mines, they were enabled to equip such formidable fleets as we are told they fitted out in the time of Cyrus or Cambyses. Justin insinuates, that the first Carthaginian settlement in Spain happened when the city of Gades, now Cadiz, was but of late standing, or even its infancy. The Spaniards finding this new colony begin to flourish, attacked it with a numerous army, insomuch that the inhabitants were obliged to call in the Carthaginians to their aid. The latter very readily granted their request, and not only repulsed the Spaniards, but made themselves masters of almost the whole province in which their new city stood. By this success, they were encouraged to attempt the conquest of the whole country: but having to do with very warlike nations, they could not push their conquests to any great length at first; and it appears, from the accounts of Livy and Polybius, that the greatest part of Spain remained unsubdued till the time of Hamilcar, Asdrubal, and Hannibal.

6 First treaty between Carthage and Rome. About 503 years before the birth of Christ, the Carthaginians entered into a treaty with the Romans. It related chiefly to matters of navigation and commerce. From it we learn that the whole island of Sardinia, and part of Sicily, were then subject to Carthage; that they were very well acquainted with the coasts of Italy, and had made some attempts upon them before this time: and that, even at this early period, a spirit of jealousy had taken place between the two republics. Some time near this period, the Carthaginians had a mind to discontinue the tribute they had hitherto paid the Africans for the ground on which their city stood. But, notwithstanding all their power, they were at present unsuccessful; and at last were obliged to conclude a peace, one of the articles of which was, that the tribute should be continued.

By degrees the Carthaginians extended their power over all the islands in the Mediterranean, Sicily excepted; and for the entire conquest of this, they made vast preparations, about 480 years before Christ. Their army consisted of 300,000 men; their fleet was composed of upwards of 2000 men of war, and 3000 transports; and with such an immense armament, they made no doubt of conquering the whole island in a single campaign. In this, however, they found themselves miserably deceived. Hamilcar their general having landed his numerous forces, invested Himera, a city of considerable importance. He carried on his attacks with the greatest assiduity; but was at last attacked in his trenches by Gelon and Theron, the tyrants of Syracuse and Agrigentum, who gave the Carthaginians one of the greatest overthrows mentioned in history. An hundred and fifty thousand were killed in the battle and pursuit, and all the rest taken prisoners; so that of so mighty an army not a single person escaped. Of the 2000 ships of war and 3000 transports, of which the Carthaginian fleet consisted, eight ships only, which then happened to be out at sea, made their escape: these immediately set sail for Carthage; but were all cast away, and every soul perished, except a few who were saved in a small boat, and at last reached Carthage with the dismal news of the total loss of the fleet and army. No words can express the consternation of the Carthaginians upon receiving the news of so terrible a disaster. Ambassadors were immediately dispatched to Sicily, with orders to conclude a peace upon any terms. They put to sea without delay; and landing at Syracuse, threw themselves at the conqueror's feet. They begged Gelon, with many tears, to receive their city into favour, and grant them a peace on whatever terms he should choose to prescribe. He granted their request, upon condition that Carthage should pay him 2000 talents of silver to defray the expences of the war; that they should build two temples, where the articles of the treaty should be lodged and kept as sacred; and that for the future they should abstain from human sacrifices. This was not thought a dear purchase of a peace for which there was such occasion; and to show their gratitude for Gelon's moderation, the Carthaginians complimented his wife Demerata with a crown of gold worth 100 talents.

7 Sicily invaded by the Carthaginians.

8 They are utterly destroyed.

9 Peace concluded.

From this time we find little mention of the Carthaginians for 70 years. Some time during this period, however, they had greatly extended their dominions in Africa, and likewise shaken off the tribute which gave them so much uneasiness. They had warm disputes with the inhabitants of Cyrene, the capital of Cyrenaica, about a regulation of the limits of 10 Dispute with the Cyreneans.

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Carthage.

of their respective territories. The consequence of these disputes was a war, which reduced both nations so low, that they agreed first to a cessation of arms, and then to a peace. At last it was agreed, that each state should appoint two commissaries, who should set out from their respective cities on the same day, and that the spot on which they met should be
11 Story of the *Philæni*. the boundary of both states. In consequence of this, two brothers called *Philæni* were sent out from Carthage, who advanced with great celerity, while those from Cyrene were much more slow in their motions. Whether this proceeded from accident or design, or perfidy, we are not certainly informed; but be this as it will, the Cyreneans, finding themselves greatly outstripped by the Philæni, accused them of breach of faith, asserting that they had set out before the time appointed, and consequently that the convention between their principals was broken. The Philæni desired them to propose some expedient whereby their differences might be accommodated; promising to submit to it whatever it might be. The Cyreneans then proposed, either that the Philæni should retire from the place where they were, or that they should be buried alive upon the spot. With this last condition the brothers immediately complied, and by their death gained a large extent of territory to their country. The Carthaginians ever after celebrated this as a most brave and heroic action; paid them divine honours; and endeavoured to immortalize their names by erecting two altars there, with suitable inscriptions upon them.

12 Sicily invaded anew. About the year before Christ 412, some disputes happening between the Egestines and Selinuntines, inhabitants of two cities in Sicily, the former called in the Carthaginians to their assistance; and occasioned a new invasion of Sicily by that nation. Great preparations were made for this war: Hannibal, whom they had appointed general, was empowered to raise an army equal to the undertaking, and equip a suitable fleet. They also appointed certain funds for defraying all the expences of the war, intending to exert their whole force to reduce the island under their subjection.

13 Emporium and Selinis taken; The Carthaginian general having landed his forces, immediately marched for Selinis. In his way he took Emporium, a town situated on the river Mazara; and having arrived at Selinis, he immediately invested it. The besieged made a very vigorous defence: but at last the city was taken by storm, and the inhabitants were treated with the utmost cruelty. All were massacred by the savage conqueror, except the women who fled to the temples; and these escaped, not through the merciful disposition of the Carthaginians, but because they were afraid, that if driven to despair they would set fire to the temples, and by that means consume the treasure they expected to find in those places. Sixteen thousand were massacred; 2250 escaped to Agrigentum; and the women and children, about 5000 in number, were carried away captives. At the same time the temples were plundered, and the city razed to the ground.

14 as likewise Himera. After the reduction of Selinis, Hannibal laid siege to Himera: that city he desired above all things to become master of, that he might revenge the death of his grandfather Hamilcar, who had been slain before it by Gelon. His troops, flushed with their late success, behaved with undaunted courage: but finding his battering engines not to answer his purposes sufficiently, he undermined the wall, supporting it with large beams of timber, to which he afterwards set fire, and thus laid part of it flat on the ground. Notwithstanding this advantage, however, the Carthaginians were several times repulsed with great slaughter; but at last they became masters of the place, and treated it in the same manner as they had done Selinis. After this, Hannibal, dismissing his Sicilian and Italian allies, returned to Africa.

The Carthaginians were now so much elated, that they meditated the reduction of the whole island. But as the age and infirmities of Hannibal rendered him incapable of commanding the forces alone, they joined in commission with him Imilcar, the son of Hanno, one of the same family. On the landing of the Carthaginian army, all Sicily was alarmed, and the principal cities put themselves into the best state of defence they were able. The Carthaginians immediately marched to Agrigentum, and began to batter the walls with great fury. The besieged, however, defended themselves with incredible resolution, in a sally burnt all the machines raised against their city, and repulsed the enemy with great slaughter. The Syracusans, in the mean time, being alarmed at the danger of Agrigentum, sent an army to its relief. On their approach they were immediately attacked by the Carthaginians; but after a sharp dispute the latter were defeated, and forced to fly to the very walls of Agrigentum, with the loss of 6000 men. Had the Agrigentine commanders now sallied out, and fallen upon the fugitives, in all probability the Carthaginian army must have been destroyed; but, either through fear or corruption, they refused to stir out of the place, and this occasioned the loss of it. Immense booty was found in the city; and the Carthaginians behaved with their usual cruelty, putting all the inhabitants to the sword, not excepting even those who had fled to the temples. 15 Agrigentum besieged; 16 and taken.

The next attempt of the Carthaginians was designed against the city of Gela; but the Geleans, being greatly alarmed, implored the protection of Syracuse; and, at their request, Dionysius was sent to assist them with 2000 foot and 400 horse. The Geleans were so well satisfied with his conduct, that they treated him with the highest marks of distinction; they even sent ambassadors to Syracuse to return thanks for the important services done them by sending him thither; and soon after he was appointed generalissimo of the Syracusan forces and those of their allies against the Carthaginians. In the mean time Imilcar, having razed the city of Agrigentum, made an incursion into the territories of Gela and Comarina; which having ravaged in a dreadful manner, he carried off such immense quantity of plunder, as filled his whole camp. He then marched against the city; but though it was but indifferently fortified, he met with a very vigorous resistance; and the place held out for a long time without receiving any assistance from its allies. At last Dionysius came to its assistance with an army of 50,000 foot and 1000 horse. With these he attacked the Carthaginian camp, but was repulsed with great loss; after which he called a council of war, the result of whose deliberations was, that since the enemy 17 Gela besieged.

was

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Carthage. was so much superior to them in strength, it would be highly imprudent to put all to the issue of a battle; and therefore that the inhabitants should be persuaded to abandon the country, as the only means of saving their lives. In consequence of this, a trumpet was sent to Imilcar to desire a cessation of arms till the next day, in order, as was pretended, to bury the dead; but in reality to give the people of Gela an opportunity of making their escape. Towards the beginning of the night the bulk of the citizens left the place; and he himself with the army followed them about midnight. To amuse the enemy, he left 2000 of his light-armed troops behind him, commanding them to make fires all night, and set up loud shouts, as though the army still remained in the town. At day-break these took the same route as their companions, and pursued their march with great celerity. The Carthaginians, finding the city deserted by the greatest part of its inhabitants, immediately entered it, putting to death all who had remained; after which, Imilcar having thoroughly plundered it, moved towards Camarina. The inhabitants of this city had been likewise drawn off by Dionysius, and it underwent the same fate with Gela.

18 Abandoned by its inhabitants.

19 Peace concluded.

Notwithstanding these successes, however, Imilcar finding his army greatly weakened, partly by the casualties of war, and partly by a plague, which broke out in it, sent a herald to Syracuse to offer terms of peace. His unexpected arrival was very agreeable to the Syracusans, and a peace was immediately concluded upon the following terms, viz. That the Carthaginians, besides their ancient acquisitions in Sicily, should still possess the countries of the Silicani, the Selinuntines, the Himereans, and Agrigentines; that the people of Gela and Camarina should be permitted to reside in their respective cities, which yet should be dismantled, upon their paying an annual tribute to the Carthaginians; that all the other Sicilians should preserve their independency except the Syracusans, who should continue in subjection to Dionysius.

20 Dionysius breaks the treaty.

The tyrant of Syracuse, however, had concluded this peace with no other view than to gain time, and to put himself in condition to attack the Carthaginian territories with greater force. Having accomplished this, he acquainted the Syracusans with his design, and they immediately approved of it: upon which he gave up to the fury of the populace the persons and possessions of the Carthaginians who resided in Syracuse, and traded there on the faith of treaties. As there were many of their ships at that time in the harbour, laden with cargoes of great value, the people immediately plundered them; and, not content with this, ransacked all their houses in a most outrageous manner. This example was followed throughout the whole island; and in the mean time Dionysius dispatched a herald to Carthage, with a letter to the senate and people, telling them, that if they did not immediately withdraw their garrisons from all the Greek cities in Sicily, the people of Syracuse would treat them as enemies. With this demand, however, he did not allow them to comply; for without waiting for any answer from Carthage, he advanced with his army to Mount Eryx, near which stood the city of Motya, a Carthaginian colony of great importance; and this he immediately invested. But soon after, leaving his brother Leptines to carry on the attack, he himself went with the greatest part of his forces to reduce the cities in alliance with the Carthaginians. He destroyed their territories with fire and sword, cut down all their trees; and then sat down before Egesta and Entella, most of the other towns having opened their gates at his approach: but these baffling his utmost efforts, he returned to Motya, and pushed on the siege of that place with the utmost vigour.

The Carthaginians, in the mean time, though alarmed at the message sent them by Dionysius, and though reduced to a miserable situation by the plague which had broke out in their city, did not despond, but sent officers to Europe, with considerable sums, to raise troops with the utmost diligence. Ten galleys were also sent from Carthage to destroy all the ships that were found in the harbour of Syracuse. The admiral, according to his orders, entered the harbour in the night, without being discerned by the enemy; and having sunk most of the ships he found there, returned without the loss of a man.

21 Syracusan ships destroyed.

22 Motya taken by the Greeks.

All this while the Motyans defended themselves with incredible vigour; while their enemies, desirous of revenging the cruelties exercised upon their countrymen by the Carthaginians, fought like lions. At last the place was taken by storm, and the Greek soldiers began a general massacre. For some time Dionysius was not able to restrain their fury: but at last he proclaimed that the Motyans should fly to the Greek temples; which they accordingly did, and a stop was put to the slaughter; but the soldiers took care thoroughly to plunder the town, in which they found a great treasure.

The following spring, Dionysius invaded the Carthaginian territories, and made an attempt upon Egesta: but here he was again disappointed. The Carthaginians were greatly alarmed at his progress; but, next year, notwithstanding a considerable loss sustained in a sea-fight with Leptines, Himilco their general landed a powerful army at Panormus, seized upon Eryx, and then advancing towards Motya, made himself master of it before Dionysius could send any forces to its relief. He next advanced to Messana, which he likewise besieged and took; after which most of the Siculi revolted from Dionysius.

23 Greeks defeated at sea by the Carthaginians.

Notwithstanding this defection, Dionysius, finding his forces still amount to 30,000 foot and 3000 horse, advanced against the enemy. At the same time Leptines was sent with the Syracusan fleet against that of the Carthaginians, but with positive orders not to break the line of battle upon any account whatever. But, notwithstanding these orders, he thought proper to divide his fleet, and the consequence of this was a total defeat; above 100 of the Syracusan galleys being sunk or taken, and 20,000 of their men killed in the battle or in the pursuit. Dionysius, disheartened by this misfortune, returned with his army to Syracuse, being afraid that the Carthaginian fleet might become masters of that city, if he should advance to fight the land army. Himilco did not fail immediately to invest the capital; and had certainly become master of it, and consequently of the whole island, had not a most malignant pestilence obliged him to desist from all further operations. This dreadful malady made great havock among his forces both by sea and land; and, to complete

24 Syracuse besieged by the Carthaginians.

Carthage. plete his misfortunes, Dionysius attacked him unexpectedly, totally ruined his fleet, and made himself master of his camp.

25 Himilco obliged to return. Himilco, finding himself altogether unable to sustain another attack, was obliged to come to a private agreement with Dionysius; who for 300 talents consented to let him escape to Africa with the shattered remains of his fleet and army. The unfortunate general arrived at Carthage, clad in mean and sordid attire, where he was met by a great number of people bewailing their sad and inauspicious fortune. Himilco joined them in their lamentations; and, being unable to survive his misfortunes, put an end to his own life. He had left Mago in Sicily, to take care of the Carthaginian interests in the best manner he could. In order to this, Mago treated all the Sicilians subject to Carthage with the greatest humanity; and, having received a considerable number of soldiers from Africa, he at last formed an army with which he ventured a battle; in this he was defeated, and driven out of the field, with the loss of 800 men; which obliged him to desist from farther attempts of that nature.

26 Another invasion of Sicily. Notwithstanding all these terrible disasters, the Carthaginians could not forbear making new attempts upon the island of Sicily; and about the year before Christ 392, Mago landed in it with an army of 80,000 men. This attempt, however, was attended with no better success than before: Dionysius found means to reduce him to such straits for want of provisions, that he was obliged to sue for peace. This continued for nine years, at the end of which the war was renewed with various success. It continued with little interruption till the year before Christ 376, when the Syracusan state being rent by civil dissensions, the Carthaginians thought it a proper time to exert themselves, in order to become masters of the whole island. They fitted out a great fleet, and entered into alliance with Icetas, tyrant of Leontini, who pretended to have taken Syracuse under his protection. By this treaty, the two powers engaged to assist each other, in order to expel Dionysius II. after which they were to divide

27 Syracusans assisted by the Corinthians. the island between them. The Syracusans applied for succours to the Corinthians: and they readily sent them a body of troops under the command of Timoleon, an experienced general. By a stratagem, he got his forces landed at Taurominium. The whole of them did not exceed 1200 in number; yet with these he marched against Icetas, who was at the head of 5000 men: his army he surprised at supper, put 300 of them to the sword, and took 600 prisoners. He then marched to Syracuse, and broke into one part of the town before the enemy had any notice of his approach: here he took post, and defended himself with such resolution, that he could not be dislodged by the united power of Icetas and the Carthaginians.

28 Foolish conduct of the Carthaginian admiral. In this place he remained for some time, in expectation of a reinforcement from Corinth; till the arrival of which he did not judge it practicable to extend his conquests.—The Carthaginians, being apprised that the Corinthian succours were detained by tempestuous weather at Thurium, posted a strong squadron, under Hanno their admiral, to intercept them in their passage to Sicily. But that commander, not imagining the Corinthians would attempt a passage to Sicily in such a stormy season, left his station at Thurium, and ordering his seamen to crown themselves with garlands, and adorn their vessels with bucklers both of the Greek and Carthaginian form, sailed to Syracuse in a triumphant manner. Upon his arrival there, he gave the troops in the citadel to understand that he had taken the succours Timoleon expected, thinking by this means to intimidate them to surrender. But, while he thus trifled away his time, the Corinthians marched with great expedition to Rhegium, and, taking the advantage of a gentle breeze, were easily wafted over into

Sicily. Mago, the Carthaginian general, was no sooner informed of the arrival of this reinforcement, than he was struck with terror, though the whole Corinthian army did not exceed 4000 men; and soon after, fearing a revolt of his mercenaries, he weighed anchor, in spite of all the remonstrances of Icetas, and set sail for Africa. Here he no sooner arrived, than, overcome with grief and shame for his unparalleled cowardice, he laid violent hands on himself. His body was hung upon a gallows or cross, in order to deter succeeding generals from forfeiting their honour in so flagrant a manner. 29 Cowardice of Mago.

After the flight of Mago, Timoleon carried all before him. He obliged Icetas to renounce his alliance with the state of Carthage, and even deposed him, and continued his military preparations with the greatest vigour. On the other hand, the Carthaginians prepared for the ensuing campaign with the greatest alacrity. An army of 70,000 men was sent over with a fleet of 200 ships of war, and 1000 transports laden with warlike engines, armed chariots, horses, and all other sorts of provisions. This immense multitude, however, was overthrown on the banks of the Crimesus by Timoleon: 10,000 were left dead on the field of battle; and of these above 3000 were native Carthaginians of the best families in the city. Above 15,000 were taken prisoners; all their baggage and provisions, with 200 chariots, 1000 coats of mail, and 10,000 shields, fell into Timoleon's hands. The spoil, which consisted chiefly of gold and silver, was so immense, that the whole Sicilian army was three days in collecting it and stripping the slain. After this signal victory, he left his mercenary forces upon the frontiers of the enemy, to plunder and ravage the country; while he himself returned to Syracuse with the rest of his army, where he was received with the greatest demonstrations of joy. Soon after, Icetas, grown weary of his private station, concluded a new peace with the Carthaginians; and, having assembled an army, ventured an engagement with Timoleon: but in this he was utterly defeated; and himself, with Eupolemus his son, and Euthymus general of his horse, were brought bound to Timoleon by their own soldiers. The two first were immediately executed as tyrants and traitors, and the last murdered in cold blood; Icetas's wives and daughters were likewise cruelly put to death after a public trial. In a short time after, Mamercus, another of the Carthaginian confederates, was overthrown by Timoleon, with the loss of 2000 men. 30 Exploits of Timoleon.

These misfortunes induced the Carthaginians to conclude a peace on the following terms: That all the Greek cities should be set free; that the river Halycus should be the boundary between the territories of both parties; that the natives of cities subject to the Carthaginians 31 Peace concluded.

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Carthage. Carthaginians should be allowed to withdraw, if they pleased, to Syracuse or its dependencies, with their families and effects; and, lastly, that Carthage should not, for the future, give any assistance to the remaining tyrants against Syracuse.

32 War renewed. About 316 years before Christ, we find the Carthaginians engaged in another bloody war with the Sicilians, on the following occasion; Sosistratus, who had usurped the supreme authority at Syracuse, having been forced by Agathocles to raise the siege of Rhegium, returned with his shattered troops to Sicily. But soon after this unsuccessful expedition he was obliged to abdicate the sovereignty and quit Syracuse. With him were expelled above 600 of the principal citizens, who were suspected of having formed a design to overturn the plan of government which then prevailed in the city. As Sosistratus and the exiles thought themselves ill treated, they had recourse to the Carthaginians, who readily espoused their cause. Hereupon the Syracusans, having recalled Agathocles, who had before been banished by Sosistratus, appointed him commander in chief of all their forces, principally on account of the known aversion he bore that tyrant. The war, however, did not then continue long; for Sosistratus and the exiles were quickly received again into the city, and peace was concluded with Carthage:

33 Agathocles raises himself to the throne of Syracuse. The people of Syracuse, however, finding that Agathocles wanted to make himself absolute, exacted an oath from him, that he would do nothing to the prejudice of the democracy. But, notwithstanding this oath, Agathocles pursued his purpose, and by a general massacre of the principal citizens of Syracuse, raised himself to the throne. For some time he was obliged to keep the peace he had concluded with Carthage; but at last, finding his authority established, and that his subjects were ready to second his ambitious designs, he paid no regard to his treaties, but immediately made war on the neighbouring states, which he had expressly agreed not to do, and then carried his arms into the very heart of the island. In these expeditions he was attended with such success, that in two years time he brought into subjection all the Greek part of Sicily. This being accomplished, he committed great devastations in the Carthaginian territories, their general Hamilcar not offering to give him the least disturbance. This perfidious conduct greatly incensed the people of those districts against Hamilcar, whom they accused before the senate. He died, however, in Sicily; and Hamilcar the son of Gisco was appointed to succeed him in the command of the forces. The last place that held out against Agathocles was Messana, whither all the Syracusan exiles had retired. Pasiphilus, Agathocles's general, found means to cajole the inhabitants into a treaty: which Agathocles, according to custom, paid no regard to, but, as soon as he was in possession of the town, cut off all those who had opposed his government. For, as he intended to prosecute the war with the utmost vigour against Carthage, he thought it a point of good policy to destroy as many of his Sicilian enemies as possible.

34 Defeated by the Carthaginians, and besieged in Syracuse. The Carthaginians in the mean time having landed a powerful army in Sicily, an engagement soon ensued, in which Agathocles was defeated with the loss of 7000 men. After this defeat he was obliged to shut himself up in Syracuse, which the Carthaginians immediately invested, and most of the Greek states in the island submitted to them.

Agathocles, seeing himself stripped of almost all his dominions, and his capital itself in danger of falling into the hands of the enemy, formed a design, which, were it not attested by writers of undoubted authority, would seem absolutely incredible. This was no less than to transfer the war into Africa, and lay siege to the enemy's capital, at a time when he himself was besieged, and only one city left to him in all Sicily. Before he departed, however, he made all the necessary preparations for the defence of the place, and appointed his brother Antandrus governor of it. He also gave permission to all who were not willing to stand the fatigues of a siege to retire out of the city. Many of the principal citizens, Justin says 1600, accepted of this offer: but they were no sooner got out of the place, than they were cut off by parties posted on the road for that purpose. Having seized upon their estates, Agathocles raised a considerable sum, which was intended in some measure to defray the expence of the expedition: however, he carried with him only 50 talents to supply his present wants, being well assured that he should find in the enemy's country whatever was necessary for his subsistence. As the Carthaginians had a much superior fleet, they for some time kept the mouth of the harbour blocked up; but at last a fair opportunity offered; and Agathocles hoisting sail, by the activity of his rowers soon got clear both of the port and city of Syracuse. The Carthaginians pursued him with all possible expedition; but notwithstanding their utmost efforts, Agathocles got his troops landed with very little opposition. 35 He invades Africa.

Soon after his forces were landed, Agathocles burnt his fleet, probably that his soldiers might behave with the greater resolution, as they saw no possibility of flying from their danger. He first advanced to a place called the Great City. This, after a feeble resistance, he took and plundered. From hence he marched to Tunis, which surrendered on the first summons; and Agathocles levelled both places with the ground. 36 He burns his fleet.

The Carthaginians were at first thrown into the greatest consternation; but, soon recovering themselves, the citizens took up arms with so much alacrity, that in a few days they had on foot an army of 40,000 foot and 1000 horse, with 2000 armed chariots. The command of this army they entrusted to Hanno and Bomilcar, two generals between whom there subsisted a great animosity. This occasioned the defeat of their whole army, with the loss of their camp, though all the forces of Agathocles did not exceed 14,000 in number. Among other rich spoils the conqueror found many chariots of curious workmanship, which carried 20,000 pair of fetters and manacles that the enemy had provided for the Sicilian prisoners. After this defeat, the Carthaginians, supposing themselves to have fallen under the displeasure of their deities on account of their neglecting to sacrifice children of noble families to them, resolved to expiate this guilt. Accordingly 200 children of the first rank were sacrificed to their bloody gods, besides 300 other persons who voluntarily offered themselves to pacify the wrath of these deities. 37 Carthaginians defeated. 38 Their method of appeasing their deities.

After these expiations, Hamilcar was recalled from Sicily.

Carthage.

39 Hamilcar makes an assault on Syracuse.

Sicily. When the messengers arrived, Hamilcar commanded them not once to mention the victory of Agathocles; but, on the contrary, to give out among the troops that he had been entirely defeated, his forces all cut off, and his fleet destroyed by the Carthaginians. This threw the Syracusans into the utmost despair; however, one Eurymnon, an Etolian, prevailed upon Antandrus not to consent to a capitulation, but to stand a general assault. Hamilcar being informed of this, prepared his battering engines, and made all the necessary preparations to storm the town without delay. But while matters remained in this situation, a galley, which Agathocles had caused to be built immediately after the battle, got into the harbour of Syracuse, and acquainted the inhabitants with the certainty of Agathocles's victory. Hamilcar, observing that the garrison flocked down to the port on this occasion, and expecting to find the walls unguarded, ordered his soldiers to erect scaling ladders, and begin the intended assault. The enemy having left the ramparts quite exposed, the Carthaginians mounted them without being discerned, and had almost possessed themselves of an entire part lying between two towers, when the patrole discovered them. Upon this, a warm dispute ensued; but at last the Carthaginians were repulsed with loss. Hamilcar, therefore, finding it in vain to continue the siege after such glad tidings had restored life and soul to the Syracusans, drew off his forces, and sent a detachment of 5000 men to reinforce the troops in Africa. He still entertained hopes, however, that he might oblige Agathocles to quit Africa, and return to the defence of his own dominions. He spent some time in making himself master of such cities as sided with the Syracusans; and, after having brought all their allies under subjection, returned again to Syracuse, hoping to surprise it by an attack in the night-time. But being attacked while advancing through narrow passes, where his numerous army had not room to act, he was defeated with great slaughter, and himself taken prisoner, carried into Syracuse, and put to death.

40 He raises the siege.

41 Is defeated, and taken prisoner, and put to death.

42 Agrigentines attempt the sovereignty of Sicily.

In the mean time the Agrigentines, finding that the Carthaginians and Syracusans had greatly weakened each other by this war, thought it a proper opportunity to attempt the sovereignty of the whole island. They therefore commenced a war against both parties; and prosecuted it with such success, that in a short time they wrested many places of note both out of the hands of the Syracusans and Carthaginians.

43 Success of Agathocles in Africa.

In Africa the tyrant carried every thing before him. He reduced most of the places of any note in the territory of Carthage; and hearing that Elymas king of Libya had declared against him, he immediately entered Libya Superior, and in a great battle overthrew that prince, putting to the sword a good part of his troops, and the general who commanded them; after which he advanced against the Carthaginians with such expedition, that he surprised and defeated them with the loss of 2000 killed, and a great number taken prisoners. He next prepared for the siege of Carthage itself; and, in order thereto advanced to a post within five miles of that city. On the other hand, notwithstanding the great losses they had already sustained, the Carthaginians, with a powerful army, encamped between him and their capital. In this situation Agathocles received advice of the defeat of the Carthaginian forces before Syracuse, and the head of Hamilcar their general. Upon this he immediately rode up to the enemy's camp, and showing them the head, gave them an account of the total destruction of their army before Syracuse. This threw them into such consternation, that in all human probability Agathocles would have made himself master of Carthage, had not an unexpected mutiny arisen in his camp, which gave the Carthaginians an opportunity of recovering from their terror.

The year following an engagement happened, in which neither party gained any great advantage: but soon after, the tyrant, notwithstanding all his victories, found himself unable to carry on the war alone: and therefore endeavoured to gain over to his interest Ophellas, one of the captains of Alexander the Great. In this he perfectly succeeded; and to succour his new ally the more effectually, Ophellas sent to Athens for a body of troops. Having finished his military preparations, Ophellas found his army to consist of 10,000 foot and 600 horse, all regular troops, besides 100 chariots, and a body of 10,000 men, attended by their wives and children, as though he had been going to plant a new colony. At the head of these forces he continued his march towards Agathocles for 18 days; and then encamped at Automale, a city about 3000 stadia distant from the capital of his dominions. From thence he advanced through the Regio Syrtica; but found himself reduced to such extremities, that his army was in danger of perishing for want of bread, water, and other provisions. They were also greatly annoyed by serpents and wild beasts, with which that desert region abounded. The serpents made the greatest havock among the troops; for, being of the same colour with the earth, and extremely venomous, many soldiers, who trod upon them without seeing them, were stung to death. At last, after a very fatiguing march of two months, he approached Agathocles, and encamped at a small distance from him, to the no small terror of the Carthaginians, who apprehended the most fatal consequences from this junction. Agathocles at first caressed him, and advised him to take all possible care of his troops that had undergone so many fatigues; but soon after cut him off by treachery, and then by fair words and promises persuaded his troops to serve under himself.

44 He makes an alliance with Ophellas;

45 whom he treacherously murders.

Agathocles, now finding himself at the head of a numerous army, assumed the title of king of Africa, intending soon to complete his conquests by the reduction of Carthage. He began with the siege of Utica, which was taken by assault. After this he marched against Hippo Diarrhytus, the Biserta of the moderns, which was also taken by storm; and after this most of the people bordering upon the sea coasts, and even those who inhabited the inland parts of the country, submitted to him. But in the midst of this career of success, the Sicilians formed an association in favour of liberty; which obliged the tyrant to return home, leaving his son Archagathus to carry on the war in Africa.

46 Is obliged to return home.

Archagathus, after his father's departure, greatly extended the African conquests. He sent Eumachus at the head of a large detachment to invade some of the neighbouring provinces, while he himself, with the

47 Success of Archagathus.

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Carthage.

the greatest part of his army, observed the motions of the Carthaginians. Eumachus falling into Numidia, first took the great city of Tocas, and conquered several of the Numidian cantons. Afterwards he besieged and took Phillina; which was attended with the submission of the Asphodelodians, a nation, according to Diodorus, as black as the Ethiopians. He then reduced several cities; and being at last elated with such a run of good fortune, resolved to penetrate into the most remote parts of Africa. Here he at first met with success; but hearing that the barbarous nations were advancing in a formidable body to give him battle, he abandoned his conquests, and retreated with the utmost precipitation towards the sea coasts, after having lost abundance of men.

48 He is reduced to the utmost distress.

This unfortunate expedition made a great alteration for the worse in the affairs of Archagathus. The Carthaginians being informed of Eumachus's bad success, resolved to exert themselves in an extraordinary manner to repair their former losses. They divided their forces into three bodies: one of these they sent to the sea coasts, to keep the towns there in awe; another they dispatched into the mediterranean parts, to preserve the allegiance of the inhabitants there; and the last body they ordered to the Upper Africa, to support their confederates in that country. Archagathus, being apprised of the motions of the Carthaginians, divided his forces likewise into three bodies. One of these he sent to observe the Carthaginian troops on the sea coasts, with orders to advance afterwards into the Upper Africa; another under the command of Æschrion, one of his generals, he posted at a proper distance in the heart of the country, to have an eye both on the enemy there and the barbarous nations; and with the last, which he led in person, he kept near Carthage, preserving a communication with the other two, in order to send them succours, or recal them, as the exigency of affairs should require.—The Carthaginian troops sent into the heart of the country, were commanded by Hanno, a general of great experience, who being informed of the approach of Æschrion, laid an ambuscade for him, into which he was drawn, and cut off with 4000 foot and 200 horse. Himilco, who commanded the Carthaginian forces in Upper Africa, having advice of Eumachus's march, immediately advanced against him. An engagement ensued, in which the Greeks were almost totally cut off, or perished with thirst after the battle; out of 8000 foot only 30, and of 800 horse only 40, having the good fortune to make their escape.

Archagathus receiving the melancholy news of these two defeats, immediately called in the detachments he had sent out to harass the enemy, which would otherwise have been instantly cut off. He was, however, in a short time hemmed in on all sides, in such a manner as to be reduced to the last extremity for want of provisions, and ready every moment to be swallowed up by the numerous forces which surrounded him. In this deplorable situation Agathocles received an express from Archagathus, acquainting him of the losses he had sustained, and the scarcity of provisions he laboured under. Upon this the tyrant, leaving the care of the Sicilian war to one Leptines, by a stratagem got 18 Etruscan ships that came to his assistance out of the harbour; and then engaging the Carthaginian squadron which lay in its neighbourhood, took five of their ships, and made all their men prisoners. By this means he became master of the port, and secured a passage into it for the merchants of all nations, which soon restored plenty to that city, where the famine before had begun to make great havock. Supplying himself, therefore, with a sufficient quantity of necessaries for the voyage he was going to undertake, he immediately set sail for Africa.

49 Agathocles arrives in Africa.

Upon his arrival in this country, Agathocles reviewed his forces, and found them to consist of 6000 Greeks, as many Samnites, Celtes, and Etruscans; besides 10,000 Africans, and 1500 horse. As he found his troops almost in a state of despair, he thought this a proper time for offering the enemy battle. The Carthaginians, however, did not think proper to accept the challenge; especially as, by keeping close in their camp, where they had plenty of every thing, they could starve the Greeks to a surrender without striking a stroke. Upon this Agathocles attacked the Carthaginian camp with great bravery, made a considerable impression upon it, and might perhaps have carried it, had not his mercenaries deserted him almost at the first onset. By this piece of cowardice he was forced to retire with precipitation to his camp, whither the Carthaginians pursued him very closely, doing great execution in the pursuit.

50 Attacks the enemy without success.

51 Disaster in the Carthaginian camp.

The next night, the Carthaginians sacrificed all the prisoners of distinction as a grateful acknowledgment to the gods for the victory they had gained. While they were employed in this inhuman work, the wind, suddenly rising, carried the flames to the sacred tabernacle near the altar, which was entirely consumed, as well as the general's tent, and those of the principal officers adjoining to it. A dreadful alarm took place through the whole camp, which was heightened by the great progress the fire made. For the soldiers tents consisting of very combustible materials, and the wind blowing in a most violent manner, the whole camp was almost entirely reduced to ashes; and many of the soldiers, endeavouring to carry off their arms, and the rich baggage of their officers, perished in the flames. Some of those who made their escape met with a fate equally unhappy; for, after Agathocles had received the last blow, the Africans deserted him, and were in that instant coming over in a body to the Carthaginians. These, the persons who were flying from the flames took to be the whole Syracusan army advancing in order of battle to attack their camp. Upon this a dreadful confusion ensued. Some took to their heels; others fell down in heaps one upon another; and others engaged their comrades, mistaking them for the enemy. Five thousand men lost their lives in this tumult, and the rest thought proper to take refuge within the walls of Carthage; nor could the appearance of daylight, for some time, dissipate their terrible apprehensions. In the mean time the African deserters, observing the great confusion the Carthaginians were in, and not knowing the meaning of it, were so terrified, that they thought proper to return to the place from whence they came. The Syracusans, seeing a body of troops advancing towards them in good order, concluded that the enemy were

52 Another in that of Agathocles.

were marching to attack them, and therefore immediately cried out, "To arms." The flames ascending out of the Carthaginian camp into the air, and the lamentable outcries proceeding from thence, confirmed them in this opinion, and greatly heightened their confusion. The consequence was much the same as in the Carthaginian camp; for coming to blows with one another instead of the enemy, they scarce recovered their senses upon the return of light, and the intestine fray was so bloody that it cost Agathocles 4000 men.

53 He escapes privately.

The last disaster so disheartened the tyrant, that he immediately set about contriving means for making his escape privately; and this he at last, though with great difficulty, effected. After his departure, his two sons were immediately put to death by the soldiers, who, choosing a leader from among themselves, made peace with the Carthaginians upon the following conditions: 1. That the Greeks should deliver up all the places they held in Africa, receiving from them 300 talents: 2. That such of them as were willing to serve in the Carthaginian army should be kindly treated, and receive the usual pay; and, 3. That the rest should be transported to Sicily, and have the city of Selinus for their habitation.

54 Causes of the first Punic war.

From this time to that of their first war with the Romans, we find nothing remarkable in the history of the Carthaginians. The first Punic war, as it is commonly called, happened about 255 years before Christ. At that time the Carthaginians were possessed of extensive dominions in Africa; they had made considerable progress in Spain; were masters of Sardinia, Corsica, and all the islands on the coast of Italy; and had extended their conquests to a great part of Sicily. The occasion of the first rupture between the two republics was as follows: The Mamertines being vanquished in battle, and reduced to great straits by Hiero king of Syracuse, had resolved to deliver up Messina, the only city they now possessed, to that prince, with whose mild government and strict probity they were well acquainted. Accordingly, Hiero was advancing at the head of his troops to take possession of the city, when Hannibal, who at that time commanded the Carthaginian army in Sicily, prevented him by a stratagem. He came to meet Hiero, as it were, to congratulate him on his victory; and amused him, while some of the Carthaginian troops filed off towards Messina. Hereupon the Mamertines, seeing their city supported by a new reinforcement, were divided into several opinions. Some were for accepting the protection of Carthage; others were for surrendering to the king of Syracuse; but the greater part were for calling in the Romans to their assistance. Deputies were accordingly dispatched to Rome, offering the possession of the city to the Romans, and in the most moving terms imploring protection. This, after some debate, was agreed to; and the consul Appius Claudius received orders to attempt a passage to Sicily at the head of a powerful army. Being obliged to stay some time at Rome, however, one Caius Claudius, a person of great intrepidity and resolution, was dispatched with a few vessels to Rhegium. On his arrival there, he observed the Carthaginian squadron to be so much superior to his own, that he thought it would be little better than madness to attempt at that time to transport forces to Sicily. He crossed the straits, however, and had a conference with the Mamertines, in which he prevailed upon them all to accept of the protection of Rome; and on this he made the necessary preparations for transporting his forces. The Carthaginians, being informed of the resolution of the Romans, sent a strong squadron of galleys under the command of Hanno to intercept the Roman fleet; and accordingly the Carthaginian admiral, coming up with them near the coast of Sicily, attacked them with great fury. During the engagement, a violent storm arose, which dashed many of the Roman vessels against the rocks, and did a vast deal of damage to their squadron; by which means Claudius was forced to retire to Rhegium, and this he accomplished with great difficulty. Hanno restored all the vessels he had taken; but ordered the deputies sent with them to expostulate with the Roman general upon the infraction of the treaties subsisting between the two republics. This expostulation, however just, produced an open rupture: Claudius soon after possessing himself of Messina.

55 Hanno intercepts the Roman fleet.

Such was the beginning of the first Punic war, which is said to have lasted 24 years. The first year, the Carthaginians and Syracusans laid siege to Messina; but not acting in concert, as they ought to have done, were overthrown by the consul Appius Claudius; and this defeat so much disgusted Hiero with the Carthaginians, that he soon after concluded an alliance with the Romans. After this treaty, having no enemy to contend with but the Carthaginians, the Romans made themselves masters of all the cities on the western coast of Sicily, and at the end of the campaign carried back most of their troops with them to take up their winter quarters in Italy.

56 Carthaginians and Syracusans defeated by the Romans.

The second year, Hanno the Carthaginian general fixed his principal magazine at Agrigentum. This place was very strong by nature, had been rendered almost impregnable by the new fortification raised by the Carthaginians during the preceding winter, and was defended by a numerous garrison, commanded by one Hannibal, a general of great experience in war. For five months the Romans attempted to reduce the place by famine, and had actually brought the inhabitants to great distress, when a Carthaginian army of 50,000 foot, 6000 horse, and 60 elephants, landed at Lilybæum, and from thence marched to Heraclea, within 20 miles of Agrigentum. There the general received a deputation from some of the inhabitants of Erbessa, where the Romans had their magazines, offering to put the town into his hands. It was accordingly delivered up; and by this means the Romans became so much distressed, that they had certainly been obliged to abandon their enterprise, had not Hiero supplied them with provisions. But all the assistance he was able to give could not long have supported them, as their army was so much weakened by disorders occasioned by famine, that out of 100,000 men, of whom it originally consisted, scarce a fourth part remained fit for service, and could no longer subsist on such parsimonious supplies. But in the mean time Hannibal acquainted Hanno that the city was reduced to the utmost distress; upon which he resolved to venture an engagement, which he had before declined. In this the Romans were victorious, and the city surrendered

57 Agrigentum taken by the Romans.

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Carthage. rendered at discretion, though Hannibal with the greatest part of the garrison, made their escape. This ended the campaign; and the Carthaginians being greatly chagrined at their bad success, fined Hanno of an immense sum of money, and deprived him of his command, appointing Hamilcar to succeed him in the command of the land army, and Hannibal in that of the fleet.

58 They build a fleet, The third year, Hannibal received orders to ravage the coast of Italy; but the Romans had taken care to post detachments in such places as were most proper to prevent his landing, so that the Carthaginian found it impossible to execute his orders. At the same time, the Romans, perceiving the advantages of being masters of the sea, set about building 120 galleys. While this was doing, they made themselves masters of most of the inland cities, but the Carthaginians reduced or kept steady in their interest most of the maritime ones; so that both parties were equally successful during this campaign.

The fourth year, Hannibal by a stratagem made himself master of 17 Roman galleys; after which he committed great ravages on the coast of Italy, whither he had advanced to take a view of the Roman fleet.

59 and defeat the Carthaginians at sea. But he was afterwards attacked in his turn, lost the greatest part of his ships, and with great difficulty made his own escape. Soon after he was totally defeated by the consul Duillius, with the loss of 80 ships taken, 13 sunk, 7000 men killed, and as many taken prisoners. After this victory Duillius landed in Sicily, put himself at the head of the land forces, relieved Segesta, besieged by Hamilcar, and made himself master of Macella, though defended by a numerous garrison.

60 Sicilians defeated by the Carthaginians. The fifth year a difference arose between the Romans and their Sicilian allies, which came to such a height that they encamped separately. Of this Hamilcar availed himself, and attacking the Sicilians in their entrenchments, put 4000 of them to the sword. He then drove the Romans from their posts, took several cities from them, and overran the greatest part of the country. In the mean time, Hannibal, after his defeat, sailed with the shattered remains of his fleet to Carthage: but, in order to secure himself from punishment, he sent one of his friends with all speed, before the event of the battle was known there, to acquaint the senate, that the Romans had put to sea with a good number of heavy ill-built vessels, each of them carrying some machine, the use of which the Carthaginians did not understand; and asked whether it was the opinion of the senate that Hannibal should attack them? These machines were the *corvi*, which were then newly invented, and by means of which, chiefly, Duillius had gained the victory. The senate were unanimous in their opinion that the Romans should be attacked; upon which the messenger acquainted them with the unfortunate event of the battles. As the senators had already declared themselves for the engagement, they spared their general's life, and, according to Polybius, even continued him in the command of the fleet. In a short time, being reinforced by a good number of galleys, and attended by some officers of great merit, he sailed for the coast of Sardinia. He had not been long here before he was surprised by the Romans, who carried off many of his ships, and took great numbers of his men prisoners. This so incensed the rest, that they seized their unfortunate admiral, and crucified him; but who was his immediate successor does not appear.

61 Corsica and Sardinia reduced by the Romans. The sixth year, the Romans made themselves masters of the islands of Corsica and Sardinia. Hanno, who commanded the Carthaginian forces in the latter, defended himself at a city called Olbia with incredible bravery; but being at last killed in one of the attacks, the place was surrendered, and the Romans soon became masters of the whole island.

62 The Roman army in great danger. The seventh year, the Romans took the town of Mytestratum, in Sicily, from whence they marched towards Camarina, but in their way were surrounded in a deep valley, and in the most imminent danger of being cut off by the Carthaginian army.

63 Rescued by the bravery of a legionary tribune. In this extremity, a legionary tribune, by name *M. Calpurnius Flamma*, desired the general to give him 300 chosen men, promising, with this small company, to find the enemy such employment as should oblige them to leave a passage open for the Roman army. He performed his promise with a bravery truly heroic; for having seized, in spite of all opposition, an eminence, and intrenched himself on it, the Carthaginians, jealous of his design, flocked from all quarters to drive him from his post. But the brave tribune kept their whole army in play, till the consul, taking advantage of the diversion, drew his army out of the bad situation into which he had imprudently brought it. The legions were no sooner out of danger, than they hastened to the relief of their brave companions: but all they could do was to save their bodies from the insults of their enemies; for they found them all dead on the spot, except Calpurnius, who lay under a heap of dead bodies all covered with wounds, but still breathing. His wounds were immediately dressed, and it fortunately happened that none of them proved mortal; and for this glorious enterprise he received a crown of *gramen*. After this the Romans reduced several cities, and drove the enemy quite out of the territory of the Agrigentines; but were repulsed with great loss before Lipara.

64 Carthaginians defeated at sea by the Romans. The eighth year, Regulus, who commanded the Roman fleet, observing that of the Carthaginians lying along the coast in disorder, sailed with a squadron of ten galleys, to observe their number and strength, ordering the rest of the fleet to follow him with all expedition. But as he drew too near the enemy, he was surrounded by a great number of Carthaginian galleys. The Romans fought with their usual bravery; but being overpowered with numbers, were obliged to yield. The consul, however, found means to make his escape, and join the rest of the fleet; and then had his full revenge of the enemy, 18 of their ships being taken, and eight sunk.

65 Regulus invades Africa. The ninth year, the Romans made preparations for invading Africa. Their fleet for this purpose consisted of 330 galleys, each of them having on board 120 soldiers and 300 rowers. The Carthaginian fleet consisted of 360 sail, and was much better manned than that of the Romans. The two fleets met near Ecnomus, a promontory in Sicily; where, after a bloody engagement, which lasted the greater part of the day, the Carthaginians were entirely defeated, with the loss of 30 galleys sunk, and 63 taken, with all their men.

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Carthage. men. The Romans lost only 24 galleys, which were all sunk.—After this victory, the Romans having refitted their fleet, set sail for the coast of Africa with all expedition. The first land they got sight of was Cape Hermea, where the fleet lay at anchor for some time, waiting till the galleys and transports came up. From thence they coasted along till they arrived before Clupea, a city to the east of Carthage, where they made their first descent.

66 Carthaginians in great consternation.

No words can express the consternation of the Carthaginians on the arrival of the Romans in Africa. The inhabitants of Clupea were so terrified, that, according to Zonaras, they abandoned the place, which the Romans immediately took possession of. Having left there a strong garrison to secure their shipping, and keep the adjacent territory in awe, they moved nearer Carthage, taking a great number of towns; they likewise plundered a prodigious number of villages, laid vast numbers of noblemen's seats in ashes, and took above 20,000 prisoners. In short, having plundered and ravaged the whole country, almost to the gates of Carthage, they returned to Clupea loaded with the immense booty they had acquired in the expedition.

67 Success of Regulus.

The tenth year, Regulus pushed on his conquests with great rapidity. To oppose his progress, Hamilcar was recalled from Sicily, and with him Bostar and Asdrubal were joined in command. Hamilcar commanded an army just equal to that of Regulus. The other two commanded separate bodies, which were to join him or act apart as occasion required. But, before they were in a condition to take the field, Regulus, pursuing his conquests, arrived on the banks of the *Bagrada*, a river which empties itself into the sea at a small distance from Carthage. Here he had a monstrous serpent to contend with, which, according to the accounts of those days, infected the waters of the river, poisoned the air, and killed all other animals with its breath alone. When the Romans went to draw water, this huge dragon attacked them; and twisting itself round their bodies, either squeezed them to death, or swallowed them alive. As its hard and thick scales were proof against their darts and arrows, they were forced to have recourse to the balistæ, which they made use of in sieges to throw great stones, and to beat down the walls of besieged cities. With these they discharged showers of huge stones against this new enemy, and had the good luck with one of them, to break his back-bone; which disabled him from twisting and winding his immense body, and by that means gave the Romans an opportunity of approaching and dispatching him with their darts. But his dead body corrupted the air and the water of the river; and spread so great an infection over the whole country, that the Romans were obliged to decamp. We are told that Regulus sent to Rome the skin of this monster, which was 120 feet long; and that it was hung up in a temple, where it was preserved to the time of the Numantine war.

68 He kills a monstrous serpent.

69 Defeats the Carthaginians;

Having passed this river, he besieged *Adis*, or *Adda*, not far from Carthage, which the enemy attempted to relieve; but as they lay encamped among hills and rocks, where their elephants, in which the main strength of their army consisted, could be of no use, Regulus attacked them in their camp, killed 17,000 of them, and took 5000 prisoners, and 18 elephants. Upon the fame of this victory, deputations came from all quarters, insomuch that the conqueror in a few days became master of 80 towns: among which were the city and port of Utica. This increased the alarm at Carthage; which was reduced to despair, when Regulus laid siege to Tunis, a great city about nine miles from the capital. The place was taken in sight of the Carthaginians, who, from their walls, beheld all the operations of the siege, without making the least attempt to relieve it. And to complete their misfortunes, the Numidians, their neighbours, and implacable enemies, entered their territories, committing every where the most dreadful devastations, which soon occasioned a great scarcity of provisions in the city. The public magazines were soon exhausted; and, as the city was full of selfish merchants, who took advantage of the public distress, to sell provisions at an exorbitant price, a famine ensued, with all the evils which attend it.

70 and reduces them to the utmost despair.

71 His proposals of peace rejected.

In this extremity Regulus advanced to the very gates of Carthage; and, having encamped under the walls, sent deputies to treat of a peace with the senate. The deputies were received with inexpressible joy; but the conditions they proposed were such that the senate could not hear them without the greatest indignation. They were, 1. That the Carthaginians should relinquish all claims to Sardinia, Corsica, and Sicily. 2. That they should restore to the Romans all the prisoners they had taken from them since the beginning of the war. 3. That if they cared to redeem any of their own prisoners, they should pay so much a head for them as Rome should judge reasonable. 4. That they should for ever pay the Romans an annual tribute. 5. That for the future they should fit out but one man of war for their own use, and 50 triremes to serve in the Roman fleet, at the expence of Carthage, when required by any of the future consuls. These extravagant demands provoked the senators, who loudly and unanimously rejected them; the Roman deputies, however, told them that Regulus would not alter a single letter of the proposals, and that they must either conquer the Romans or obey them.

72 Xanthippus appointed to command the Carthaginian army.

In this extreme distress, some mercenaries arrived from Greece, among whom was a Lacedemonian, by name Xanthippus, a man of great valour and experience in war. This man having informed himself of the circumstances of the late battle, declared publicly, that their overthrow was more owing to their own misconduct than to the superiority of the enemy. This discourse being spread abroad, came at last to the knowledge of the senate; and by them, and even by the desire of the Carthaginian generals themselves, Xanthippus was appointed commander in chief of their forces. His first care was to discipline his troops in a proper manner. He taught them how to march, encamp, widen and close their ranks, and rally after the Lacedemonian manner under their proper colours. He then took the field with 12,000 foot, 4000 horse, and 100 elephants. The Romans were surprised at the sudden alteration they observed in the enemy's conduct; but Regulus, elated with his last success, came and encamped at a small distance from the Carthaginian army in a vast plain, where their elephants and

Carthage. and horse had room to act. The two armies were parted by a river, which Regulus boldly passed, by which means he left no room for a retreat in case of any misfortune. The engagement began with great fury; but ended in the total defeat of the Romans, who, except 2000 that escaped to Clupea, were all killed or taken prisoners, and among the latter was Regulus himself. The loss of the Carthaginians scarce exceeded 800 men.

73 The Romans utterly defeated, and Regulus taken.

The Carthaginians remained on the field of battle till they had stripped the slain; and then entered their metropolis, which was almost the only place left them, in great triumph. They treated all their prisoners with great humanity, except Regulus; but as for him, he had so insulted them in his prosperity, that they could not forbear showing the highest marks of their resentment. According to Zonaras and others, he was thrown into a dungeon, where he had only sustenance allowed him barely sufficient to keep him alive. Nay, his cruel masters, to heighten his other torments, ordered a huge elephant (at the sight of which animal, it seems, he was greatly terrified) to be constantly placed near him; which prevented him from enjoying any tranquillity or repose.

74 He is cruelly used.

75 Carthaginians defeated by sea and land.

The eleventh year of this war, the Carthaginians, elated with their victory over Regulus, began to talk in a very high strain, threatening Italy itself with an invasion. To prevent this, the Romans took care to garrison all their maritime towns, and fitted out a new fleet. In the mean time, the Carthaginians besieged Clupea and Utica in vain, being obliged to abandon their enterprise upon hearing that the Romans were equipping a fleet of 350 sail. The Carthaginians having with incredible expedition refitted their old vessels, and built a good number of new ones, met the Roman fleet off Cape Hermea. An engagement ensued, in which the Carthaginians were utterly defeated; 104 of their ships being sunk, 30 taken, and 15,000 of their soldiers and rowers killed in the action. The Romans pursued their course to Clupea, where they were no sooner landed, than they found themselves attacked by the Carthaginian army, under the two Hannos, father and son. But, as the brave Xanthippus no longer commanded their army, notwithstanding the Lacedemonian discipline he had introduced among them, they were routed at the very first onset, with the loss of 9000 men, and among them many of their chief lords.

76 Romans obliged to abandon Africa.

Notwithstanding all their victories, however, the Romans found themselves now obliged, for want of provisions, to evacuate both Clupea and Utica, and abandon Africa altogether. Being desirous of signalizing the end of their consulate by some important conquest in Sicily, the consuls steered for that island, contrary to the advice of their pilots, who represented their danger, on account of the season being so far advanced. Their obstinacy proved the destruction of the whole fleet; for a violent storm arising, out of 370 vessels only 80 escaped shipwreck, the rest being swallowed up by the sea, or dashed against the rocks. This was by far the greatest loss that Rome had ever sustained; for besides the ships that were cast away with their crews, a numerous army was destroyed, with all the riches of Africa, which had been by Regulus amassed and deposited in Clupea, and were now from thence transporting to Rome. The whole coast from Pachinum to Camerina was covered with dead bodies and wrecks of ships; so that history can scarce afford an example of such a dreadful disaster.

77 Their fleet totally destroyed by a storm.

The twelfth year, the Carthaginians hearing of this misfortune of the Romans, renewed the war in Sicily with fresh fury, hoping the whole island, which was now left defenceless, would fall into their hands. Carthalo, a Carthaginian commander, besieged and took Agrigentum. The town he laid in ashes, and demolished the walls, obliging the inhabitants to fly to Olympium. Upon the news of this success, Asdrubal was sent to Sicily with a large reinforcement of troops, and 150 elephants. They likewise fitted out a squadron, with which they retook the island of Corcyra, and marched a strong body of forces into Mauritania and Numidia, to punish the people of those countries for showing a disposition to join the Romans. In Sicily the Romans possessed themselves of Cephalodium and Panormus, but were obliged by Carthalo to raise the siege of Drepanum with great loss.

78 Agrigentum taken and destroyed by the Carthaginians.

The 13th year, the Romans sent out a fleet of 260 galleys, which appeared off Lilybæum in Sicily; but finding this place too strong, they steered from thence to the eastern coast of Africa, where they made several descents, surprised some cities, and plundered several towns and villages. They arrived safe at Panormus, and in a few days set sail for Italy, having a fair wind till they came off Cape Palinurus, where so violent a storm overtook them, that 160 of their galleys and a great number of their transports were lost; upon which the Roman senate made a decree, that for the future no more than 50 vessels should be equipped; and that these should be employed only in guarding the coast of Italy, and transporting the troops into Sicily.

79 The Romans fit out a new fleet.

80 Which is again destroyed.

The 14th year, the Romans made themselves masters of Himera and Lipara in Sicily; and the Carthaginians conceiving new hopes of conquering that island, began to make fresh levies in Gaul and Spain, and to equip a new fleet. But their treasures being exhausted, they applied to Ptolemy king of Egypt, intreating him to lend them 2000 talents: but he, being resolved to stand neuter, refused to comply with their request; telling them that he could not, without breach of fidelity, assist one friend against another. However, the republic of Carthage making an effort, equipped a fleet of 200 sail, and raised an army of 30,000 men, horse and foot, and 140 elephants, appointing Asdrubal commander in chief both of the fleet and army. The Romans, then, finding the great advantages of a fleet, resolved to equip one, notwithstanding all former disasters; and while the vessels were building, two consuls were chosen, men of valour and experience, to supersede the acting ones in Sicily. Metellus, however, one of the former consuls, being continued with the title of proconsul, found means to draw Asdrubal into a battle on disadvantageous terms near Panormus, and then sallying out upon him, gave him a most terrible overthrow. Twenty thousand of the enemy were killed, and many elephants. A hundred and four elephants were taken with their leaders, and sent to Rome, where they were hunted and put to death in the circus.

81 They fit out another.

82 Carthaginians utterly defeated.

The 15th year, the Romans besieged Lilybæum;

Carthage.

and the siege continued during the rest of the first Punic war, and was the only thing remarkable that happened during that time *. The Carthaginians, on the first news of its being besieged, sent Regulus with some deputies to Rome to treat of a peace; but, instead of forwarding the negotiation, he hindered it: and notwithstanding he knew the torments prepared for him at Carthage, could not be prevailed upon to stay at Rome, but returning to his enemies country, was put to a most cruel death. During this siege, the Roman fleet under Claudius Pulcher was utterly defeated by Adherbal the Carthaginian admiral. Ninety of the Roman galleys were lost in the action, 8000 of their men either killed or drowned, and 20,000 taken and sent prisoners to Carthage; and the Carthaginians gained this signal victory without the loss of a single ship, or even a single man. Another Roman fleet met with a still severer fate. It consisted of 120 galleys, 800 transports, and was laden with all sorts of military stores and provisions. Every one of these vessels was lost by a storm, with all they contained, not a single plank being saved that could be used again; so that the Romans found themselves once more deprived of their whole naval force.

83 Lilybæum besieged by the Romans.

* See *Lilybæum*.

84 They are defeated at sea by the Carthaginians.

85 A Roman fleet utterly destroyed by a storm.

86 Hamilcar Barcas sent into Sicily.

In the mean time, the Carthaginian soldiery having shown a disposition to mutiny, the senate sent over Hamilcar Barcas, father of the famous Hannibal, to Sicily. He received a charte blanch from the senate to act as he thought proper; and, by his excellent conduct and resolution, showed himself the greatest general of his age. He defended Eryx, which he had taken by surprise, with such vigour, that the Romans would never have been able to make themselves masters of it, had they not fitted out a new fleet at the expence of private citizens, which, having utterly defeated that of the Carthaginians, Hamilcar, notwithstanding all his valour, was obliged to yield up the place which he had so long and so bravely defended. The following articles of peace were immediately drawn up between the two commanders. 1. The Carthaginians shall evacuate all the places which they have in Sicily, and entirely quit that island. 2. They shall, in 20 years, pay the Romans, at equal payments every year, 2200 talents of silver, that is, 437,250l. sterling. 3. They shall restore the Roman captives and deserters without ransom, and redeem their own prisoners with money. 4. They shall not make war upon Hiero king of Syracuse, or his allies. These articles being agreed to, Hamilcar surrendered Eryx upon condition that all his soldiers should march out with him, upon his paying for each of them 18 *Roman denarii*. Hostages were given on both sides, and deputies were sent to Rome to procure a ratification of the treaty by the senate. After the senators had thoroughly informed themselves of the state of affairs, two more articles were added, viz. 1. That 1000 talents should be paid immediately, and the 2200 in the space of 10 years at equal payments. 2. That the Carthaginians should quit all the little islands about Italy and Sicily, and never more come near them with ships of war, or raise mercenaries in those places. Necessity obliged Hamilcar to consent to these terms; but he returned to Carthage with a hatred to the Romans which he did not even suffer to die with him, but transmitted to his son the great Hannibal.

87 Peace with the Romans.

The Carthaginians were no sooner got out of this bloody and expensive war than they found themselves engaged in another, which was like to have proved fatal to them. It is called by ancient historians the *Libyan war*, or the *war with the mercenaries*. The principal occasion of it was, that when Hamilcar returned to Carthage, he found the republic so much impoverished, that, far from being able to give these troops the largesses and rewards promised them, it could not pay them their arrears. He had committed the care of transporting them to one *Gisco*, who, being an officer of great penetration, as though he had foreseen what would happen, did not ship them off all at once, but in small and separate parties, that those who came first might be paid off and sent home before the arrival of the rest. The Carthaginians at home, however, did not act with the same prudence. As the state was almost entirely exhausted by the late war, and the immense sum of money, in consequence of the peace, paid to the Romans, they judged it would be a laudable action to save something to the public. They did not therefore pay off the mercenaries in proportion as they arrived, thinking it more proper to wait till they all came together, with a view of obtaining some remission of their arrears. But, being soon made sensible of their wrong conduct on this occasion, by the frequent disorders these barbarians committed in the city, they with some difficulty prevailed upon the officers to take up their quarters at Sicca, and canton their troops in that neighbourhood. To induce them to this, however, they gave them a sum of money for their present subsistence, and promised to comply with their pretensions when the remainder of their troops arrived from Sicily. Here, being wholly immersed in idleness, to which they had long been strangers, a neglect of discipline ensued, and of course a petulant and licentious spirit immediately took place. They were now determined not to acquiesce in receiving their bare pay, but to insist upon the rewards Hamilcar had promised them, and even to compel the state of Carthage to comply with their demands by force of arms. The senate being informed of the mutinous disposition of the soldiery, dispatched Hanno, one of the suffetes, to pacify them. Upon his arrival at Sicca, he expatiated largely upon the poverty of the state, and the heavy taxes with which the citizens of Carthage were loaded; and therefore, instead of answering their high expectations, he desired them to be satisfied with receiving part of their pay, and remit the remainder to serve the pressing exigencies of the republic. The mercenaries being highly provoked, that neither Hamilcar, nor any other of the principal officers, who commanded them in Sicily, and were the best judges of their merit, made their appearance on this occasion, but only Hanno, a person utterly unknown, and above all others utterly disagreeable to them, immediately had recourse to arms. Assembling therefore in a body, to the number of 20,000, they advanced to Tunis, and immediately encamped before that city.

88 Causes of the war with the mercenaries.

89 Imprudent conduct of Hanno.

The Carthaginians, being greatly alarmed at the approach of so formidable a body to Tunis, made large concessions to the mercenaries, in order to bring them back to their duty; but, far from being softened, they grew more insolent upon these concessions, taking

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Carthage. taking them for the effects of fear; and therefore were altogether averse to thoughts of accommodation. The Carthaginians, making a virtue of necessity, showed a disposition to satisfy them in all points, and agreed to refer themselves to the opinion of some general in Sicily, which they had all along desired; leaving the choice of such commander entirely to them. Gisco was accordingly pitched upon to mediate this affair, the mercenaries believing Hamilcar to have been a principal cause of the ill treatment they met with, since he never appeared amongst them, and, according to the general opinion, had voluntarily resigned his commission. Gisco soon arrived at Tunis with money to pay the troops; and, after conferring with the officers of the several nations, apart, he harangued them in such a manner, that a treaty was upon the point of being concluded, when Spendius and Mathos, two of the principal mutineers, occasioned a tumult in every part of the camp. Spendius was by nation a Campanian, who had been a slave at Rome, and had fled to the Carthaginians. The apprehensions he was under of being delivered to his old master, by whom he was sure to be hanged or crucified, prompted him to break off the accommodation. Mathos was an African, and free born; but as he had been active in raising the rebellion, and was well acquainted with the implacable disposition of the Carthaginians, he knew that a peace must infallibly prove his ruin. He therefore joined with Spendius, and insinuated to the Africans the danger of concluding a treaty at that juncture, which could not but leave them singly exposed to the rage of the Carthaginians. This so incensed the Africans, who were much more numerous than the troops of any other nation, that they immediately assembled in a tumultuous manner. The foreigners soon joined them, being inspired by Spendius with an equal degree of fury. Nothing was now to be heard but the most horrid oaths and imprecations against Gisco and the Carthaginians. Whoever offered to make any remonstrance, or lend an ear to temperate counsels, was stoned to death by the enraged multitude. Nay, many persons lost their lives barely for attempting to speak, before it could be known whether they were in the interest of Spendius or the Carthaginians.

In the midst of these commotions, Gisco behaved with great firmness and intrepidity. He left no methods untried to soften the officers and calm the minds of the soldiery; but the torrent of sedition was now so strong, that there was no possibility of keeping it within bounds. They therefore seized upon the military chest, dividing the money among themselves in part of their arrears, put the person of Gisco under an arrest, and treated him as well as his attendants with the utmost indignity. Mathos and Spendius, to destroy the remotest hopes of an accommodation with Carthage, applauded the courage and resolution of their men, loaded the unhappy Gisco and his followers with irons, and formally declared war against the Carthaginians. All the cities of Africa, to whom they had sent deputies to exhort them to recover their liberty, soon came over to them, except Utica and Hippo Diarrhytus. By this means, their army being greatly increased, they divided it into two parts, with one of which they moved towards Utica, whilst the other marched to Hippo, in order to besiege both places. The Carthaginians, in the mean time, found themselves ready to sink under the pressure of their misfortunes. After they had been harassed 24 years by a most cruel and destructive foreign war, they entertained some hopes of enjoying repose. The citizens of Carthage drew their particular subsistence from the rents or revenues of their lands, and the public expences from the tribute paid from Africa; all which they were not only deprived of at once, but, what was worse, had it directly turned against them. They were destitute of arms and forces either by sea or land; had made no preparations for the sustaining of a siege, or the equipping of a fleet. They suffered all the calamities incident to the most ruinous civil war; and, to complete their misery, had not the least prospect of receiving assistance from any foreign friend or ally. Notwithstanding their deplorable situation, however, they did not despond, but pursued all the measures necessary to put themselves into a posture of defence. Hanno was appointed commander in chief of all their forces; and the most strenuous efforts were made, not only to repel all the attempts of the mutineers, but even to reduce them by force of arms.

90 The mercenaries declare war.

In the mean time Mathos and Spendius laid siege to Utica and Hippacra at once; but as they were carried on by detachments drawn from the army for that purpose, they remained with the main body of their forces at Tunis, and thereby cut off all communication betwixt Carthage and the continent of Africa. By this means the capital was kept in a kind of blockade. The Africans likewise harassed them by perpetual alarms, advancing to the very walls of Carthage by day as well as by night, and treating with the utmost cruelty every Carthaginian that fell into their hands.

91 They are defeated by Hanno.

Hanno was dispatched to the relief of Utica with a good body of forces, 100 elephants, and a large train of battering engines. Having taken a view of the enemy, he immediately attacked their intrenchments, and after an obstinate dispute forced them. The mercenaries lost a vast number of men; and consequently the advantages gained by Hanno were so great, that they might have proved decisive, had he made a proper use of them: but becoming secure after his victory, and his troops being everywhere off their duty, the mercenaries, having rallied their forces, fell upon him, cut off many of his men, forced the rest to fly into the town, retook and plundered the camp, and seized all the provisions, military stores, &c. brought to the relief of the besieged. Nor was this the only instance of Hanno's military incapacity. Notwithstanding he lay encamped in the most advantageous manner near a town called *Gorza*, at which place he twice overthrew the enemy, and had it in his power to have totally ruined them, he yet neglected to improve those advantages, and even suffered the mercenaries to possess themselves of the isthmus which joined the peninsula on which Carthage stood, to the continent of Africa.

92 He is in his turn defeated.

93 Hamilcar Barcas appointed to command against them.

These repeated mistakes induced the Carthaginians once more to place Hamilcar Barcas at the head of their forces. He marched against the enemy with 10,000 men, horse and foot, being all the troops the Carthaginians

Carthage. Carthaginians could then assemble for their defence; a full proof of the low state to which they were at that time reduced. As Mathos, after he had possessed himself of the isthmus, had posted proper detachments in two passes on two hills facing the continent, and guarded the bridge over the Bagrada, which through Hanno's neglect he had taken, Hamilcar saw little probability of engaging him upon equal terms, or indeed of coming at him. Observing, however, that on the blowing of certain winds, the mouth of the river was choked up with sand, so as to become passable, though with no small difficulty, as long as these winds continued; he halted for some time at the river's mouth, without communicating his design to any person. As soon as the wind favoured his intended project, he passed the river privately by night, and immediately after his passage, he drew up the troops in order of battle; and advancing into the plain where his elephants were capable of acting, moved towards Mathos who was posted at the village near the bridge. This daring action greatly surprised and intimidated the Africans. However, Spendius receiving intelligence of the enemy's motions, drew a body of 10,000 men out of Mathos's camp, with which he attended Hamilcar on one side, and ordered 15,000 from Utica to observe him on the other, thinking by this means to surround the Carthaginians, and cut them all off at one stroke. By feigning a retreat, Hamilcar found means to engage them at a disadvantage, and gave them a total overthrow, with the loss of 6000 killed and 2000 taken prisoners. The rest fled, some to the town at the bridge, and others to the camp at Utica. He did not give them time to recover from their defeat, but pursued them to the town near the bridge before mentioned; which he entered without opposition, the mercenaries flying in great confusion to Tunis; and upon this many towns submitted of their own accord to the Carthaginians, whilst others were reduced by force.

94 He defeats them.

Notwithstanding these disasters, Mathos pushed on the siege of Hippo with great vigour, and appointed Spendius and Autaritus, commanders of the Gauls, with a strong body to observe the motions of Hamilcar. These two commanders, therefore, at the head of a choice detachment of 6000 men drawn out of the camp at Tunis, and 2000 Gallic horse, attended the Carthaginian general, approaching him as near as they could with safety, and keeping close to the skirts of the mountains. At last Spendius, having received a strong reinforcement of Africans and Numidians, and possessing himself of all the heights surrounding the plain in which Hamilcar lay encamped, resolved not to let slip so favourable an opportunity of attacking him. Had a battle now ensued, Hamilcar and his army must in all probability have been cut off; but, by the desertion of one Naravasus, a young Numidian nobleman, with 2000 men, he found himself enabled to offer his enemies battle. The fight was obstinate and bloody; but at last the mercenaries were entirely overthrown, with the loss of 10,000 men killed and 4000 taken prisoners. All the prisoners that were willing to enlist in the Carthaginian service Hamilcar received among his troops, supplying them with the arms of the soldiers who had fallen in the engagement. To the rest he gave full liberty to go where they pleased, upon condition that they should never for the future bear arms against the Carthaginians; informing them, at the same time, however, that as many violators of this agreement as fell into his hands must expect to find no mercy.

95 Mercenaries again defeated.

Mathos and his associates, fearing that this affected lenity of Hamilcar might occasion a defection among the troops, thought that the best expedient would be to put them upon some action, so execrable in its nature that no hopes of reconciliation might remain. By their advice, therefore, Gisco, and all the Carthaginian prisoners were put to death; and when Hamilcar sent to demand the remains of his countrymen, he received for answer, that whoever presumed hereafter to come upon that errand, should meet with Gisco's fate: after which they came to a resolution to treat with the same barbarity all such Carthaginians as should fall into their hands. In return for this enormity, Hamilcar threw all the prisoners that fell into his hands to be devoured by wild beasts; being convinced that compassion served only to make his enemies more fierce and untractable.

96 They put to death all the Carthaginian prisoners.

The war was now carried on generally to the advantage of the Carthaginians; nevertheless, the malecontents still found themselves in a capacity to take the field with an army of 50,000 men. They watched Hamilcar's motions, but kept on the hills, carefully avoiding to come down into the plains, on account of the Numidian horse and Carthaginian elephants. Hamilcar, being much superior in skill to any of their generals, at last shut them up in a post, so situated, that it was impossible to get out of it. Here he kept them strictly besieged: and the mercenaries, not daring to venture a battle, began to fortify their camp, and surrounded it with ditches and intrenchments. They were soon pressed by famine so sorely, that they were obliged to eat one another: but they were driven desperate by the consciousness of their guilt, and therefore did not desire any terms of accommodation. At last being reduced to the utmost extremity of misery, they insisted that Spendius, Autaritus, and Zarxas, their leaders, should in person have a conference with Hamilcar, and make proposals to him. Peace was accordingly concluded upon the following terms, viz. That ten of the ringleaders of the malecontents should be left entirely to the mercy of the Carthaginians, and that the troops should all be disarmed, every man retiring only in a single coat. The treaty was no sooner concluded, than Hamilcar, by virtue of the first article, seized upon the negotiators themselves; and the army being informed that their chiefs were under arrest, had immediately recourse to arms, as suspecting they were betrayed; but Hamilcar, drawing out his army in order of battle, surrounded them, and either cut them to pieces, or trod them to death with his elephants. The number of wretches who perished on this occasion amounted to above 40,000.

97 They are besieged by Hamilcar.

98 40,000 of them destroyed.

After the destruction of the army, Hamilcar invested Tunis, whither Mathos had retired with all his remaining forces. Hamilcar had another general, named *Hannibal*, joined in the command with him. Hannibal's quarters was on the road leading to Carthage, and Hamilcar on the opposite side. The army was no sooner encamped, than Hamilcar caused Spendius, and the rest of the prisoners, to be led out in

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in the view of the besieged, and crucified near the walls. Mathos, however, observing that Hannibal did not keep so good a guard as he ought to have done, made a sally, attacked his quarters, killed many of his men, took several prisoners, among whom was Hannibal himself, and plundered his camp. Taking the body of Spendius from the cross, Mathos immediately substituted Hannibal in its room; and 30 Carthaginian prisoners of distinction were crucified around him. Upon this disaster, Hamilcar immediately decamped, and posted himself along the sea coast, near the mouth of the river Bagrada.

99 Hannibal taken and crucified by Mathos.

The senate, though greatly terrified by this unexpected blow, omitted no means necessary for their preservation. They sent 30 senators, with Hanno at their head, to consult with Hamilcar about the proper measures for putting an end to this unnatural war, conjuring, in the most pressing manner, Hanno to be reconciled to Hamilcar, and to sacrifice his private resentment to the public benefit. This, with some difficulty, was effected; and the two generals came to a full resolution to act in concert for the good of the public. The senate, at the same time, ordered all the youth capable of bearing arms to be pressed into the service: by which means a strong reinforcement being sent to Hamilcar, he soon found himself in a condition to act offensively. He now defeated the enemy in all rencounters, drew Mathos into frequent ambuscades, and gave him one notable overthrow near Leptis. This reduced the rebels to the necessity of hazarding a decisive battle, which proved fatal to them. The mercenaries fled almost at the first onset; most of their army fell in the field of battle, and in the pursuit. Mathos, with a few, escaped to a neighbouring town, where he was taken alive, carried to Carthage, and executed; and then by the reduction of the revolted cities an end was put to this war, which, from the excesses of cruelty committed in it, according to Polybius, went among the Greeks by the name of the *inexpiable war*.

100 Mathos entirely defeated and taken prisoner.

During the Libyan war, the Romans, upon some absurd pretences, wrested the island of Sardinia from the Carthaginians; which the latter, not being able to resist, were obliged to submit to. Hamilcar, finding his country not in a condition to enter into an immediate war with Rome, formed a scheme to put it on a level with that haughty republic. This was by making an entire conquest of Spain, by which means the Carthaginians might have troops capable of coping with the Romans. In order to facilitate the execution of this scheme, he inspired both his son-in-law Asdrubal, and his son Hannibal with an implacable aversion to the Romans, as the great opposers of his country's grandeur. Having completed all the necessary preparations, Hamilcar, after having greatly enlarged the Carthaginian dominions in Africa, entered Spain, where he commanded nine years, during which time he subdued many warlike nations, and amassed an immense quantity of treasure, which he distributed partly amongst his troops, and partly amongst the great men at Carthage; by which means he supported his interests with these two powerful bodies. At last, he was killed in a battle, and was succeeded by his son-in-law Asdrubal. This general fully answered the expectations of his countrymen; greatly enlarged their dominions in Spain; and built the city of New Carthage, now Carthagena. He made such progress in his conquests that the Romans began to grow jealous. They did not, however, choose at present to come to an open rupture, on account of the apprehensions they were under of an invasion from the Gauls. They judged it most proper, therefore, to have recourse to milder methods; and prevailed upon Asdrubal to conclude a new treaty with them. The articles of it were, 1. That the Carthaginians should not pass the Iberus. 2. That the Saguntines, a colony of Zacynthians, and a city situated between the Iberus and that part of Spain subject to the Carthaginians, as well as the other Greek colonies there, should enjoy their ancient rights and privileges.

101 Hamilcar's scheme to equal Carthage with Rome.

102 His death.

103 Asdrubal's treaty with the Romans.

Asdrubal, after having governed the Carthaginian dominions in Spain for eight years, was treacherously murdered by a Gaul, whose master he had put to death. Three years before this happened, he had written to Carthage, to desire that young Hannibal, then twenty-two years of age, might be sent to him. This request was complied with, notwithstanding the opposition of Hanno: and, from the first arrival of the young man in the camp, he became the darling of the whole army. The great resemblance he bore to Hamilcar rendered him extremely agreeable to the troops. Every talent and qualification he seemed to possess, that contribute towards forming a great man. After the death of Asdrubal, he was saluted general by the army with the highest demonstration of joy. He immediately put himself in motion; and in the first campaign conquered the Olcades, a nation seated near the Iberus. The next year he subdued the Vaccæi, another nation in that neighbourhood. Soon after, the Carpætani, one of the most powerful nations in Spain, declared against the Carthaginians. Their army consisted of 100,000 men, with which they proposed to attack Hannibal on his return from the Vaccæi; but by a stratagem they were utterly defeated, and the whole nation obliged to submit.

104 He is murdered.

105 Succeeded by Hannibal, who makes vast conquests in Spain.

Nothing now remained to oppose the progress of the Carthaginian arms but the city of Saguntum. Hannibal, however, for some time, did not think proper to come to a rupture with the Romans by attacking that place. At last he found means to embroil some of the neighbouring cantons, especially the Turdetani, or, as Appian calls them, the *Torboletæ*, with the Saguntines, and thus furnished himself with a pretence to attack their city. Upon the commencement of the siege, the Roman senate dispatched two ambassadors to Hannibal, with orders to proceed to Carthage, in case the general refused to give them satisfaction. They were scarcely landed, when Hannibal, who was carrying on the siege of Saguntum with great vigour, sent them word that he had something else to do than to give audience to ambassadors. At last, however, he admitted them: and, in answer to their remonstrances, told them, that the Saguntines had drawn their misfortunes upon themselves, by committing hostilities against the allies of Carthage; and at the same time desired the deputies, if they had any complaints to make of him, to carry them to the senate of Carthage. On their arrival in that capital, they demanded that Hannibal might be delivered up to the Romans to be punished according to his deserts; and

106 He attacks Saguntum.

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and this not being complied with, war was immediately declared between the two nations.

107 and takes it.

The Saguntines are said to have defended themselves for eight months with incredible bravery. At last, however, the city was taken, and the inhabitants were treated with the utmost cruelty. After this conquest, Hannibal put his African troops into winter quarters at New Carthage; but, in order to gain their affection, he permitted the Spaniards to retire to their respective homes.

108 He sets out for Italy.

The next campaign, having taken the necessary measures for securing Africa and Spain, he passed the Iberus, subdued all the nations betwixt that river and the Pyrenees, appointed Hanno commander of all the new conquered district, and immediately began his march for Italy. Upon mustering his forces, after they had been weakened by sieges, desertion, mortality, and a detachment of 10,000 foot and 1000 horse, left with Hanno to support him in his new post, he found them to amount to 50,000 foot and 9000 horse, all veteran troops, and the best in the world. As they had left their heavy baggage with Hanno, and were all light-armed, Hannibal easily crossed the Pyrenees; passed by Ruscino, a frontier town of the Gauls, and arrived on the banks of the Rhone without opposition. This river he passed, notwithstanding of some opposition from the Gauls; and was for some time in doubt whether he should advance to engage the Romans, who, under Scipio, were bending their march that way, or continue his march for Italy. But to the latter he was soon determined by the arrival of Magilus, prince of the Boii, who brought rich presents with him, and offered to conduct the Carthaginian army over the Alps. Nothing could have happened more favourable to Hannibal's affairs than the arrival of this prince, since there was no room to doubt the sincerity of his intentions. For the Boii bore an implacable enmity to the Romans, and had even come to an open rupture with them, upon the first news that Italy was threatened with an invasion from the Carthaginians.

109 He crosses the Alps.

It is not known with certainty where Hannibal began to ascend the Alps. As soon as he began his march, the petty kings of the country assembled their forces in great numbers; and, taking possession of the eminences over which the Carthaginians must necessarily pass, they continued harassing them, and were no sooner driven from one eminence than they seized on another, disputing every foot of land with the enemy, and destroyed great numbers of them by the advantage they had of the ground. Hannibal, however, having found means to possess himself of an advantageous post, defeated and dispersed the enemy, and soon after took their capital city; where he found the prisoners, horses, &c. that had before fallen into the hands of the enemy, and likewise corn sufficient to serve the army for three days. At last, after a most fatiguing march of nine days, he arrived at the top of the mountains. Here he encamped, and halted two days, to give his wearied troops some repose, and to wait for the stragglers. As the snow had lately fallen in great plenty, and covered the ground, this sight terrified the Africans and Spaniards, who were much affected with the cold. In order, therefore, to encourage them, the Carthaginian general led them to the top of the highest rock on the side of Italy, and thence gave them a view of the large and fruitful plains of Insubria, acquainting them that the Gauls, whose country they saw, were ready to join them. He also pointed out to them the place whereabout Rome stood, telling them, that by climbing the Alps they had scaled the walls of that rich metropolis; and, having thus animated his troops, he decamped, and began to descend the mountains. The difficulties they met with in their descent were much greater than those that had occurred while they ascended. They had indeed no enemy to contend with, except some scattered parties that came to steal rather than to fight; but the deep snows, the mountains of ice, craggy rocks, and frightful precipices, proved more terrible than any enemy. After they had for some days marched through narrow, steep, and slippery ways, they came at last to a place which neither elephants, horses, nor men could pass. The way, which lay between two precipices, was exceeding narrow; and the declivity, which was very steep, had become more dangerous by the falling away of the earth. Here the guides stopped; and the whole army being terrified, Hannibal proposed at first to march round about, and attempt some other way; but all places round him being covered with snow, he found himself reduced to the necessity of cutting a way into the rock itself, through which his men, horses, and elephants, might descend. This work was accomplished with incredible labour; and then Hannibal, having spent nine days in ascending, and six in descending the Alps, gained at length Insubria; and, notwithstanding all the disasters he had met with by the way, entered the country with all the boldness of a conqueror.

Hannibal, on his entry into Insubria, reviewed his army; when he found that of the 50,000 foot, with whom he set out from New Carthage five months and 15 days before, he had now but 20,000, and that his 9000 horse were reduced to 6000. His first care, after he entered Italy, was to refresh his troops; who, after so long a march, and such inexpressible hardships, looked like as many skeletons raised from the dead, or savages born in a desert. He did not, however, suffer them to languish long in idleness; but, joining the Insubrians, who were at war with the Taurinians, laid siege to Taurinum, the only city in the country, and in three days time became master of it, putting all who resisted to the sword. This struck the neighbouring barbarians with such terror, that of their own accord they submitted to the conqueror, and supplied his army with all sorts of provisions. 110 Taurinum taken.

Scipio, the Roman general, in the mean time, who had gone in quest of Hannibal on the banks of the Rhone, was surprised to find his antagonist had crossed the Alps, and entered Italy. He therefore returned with the utmost expedition. An engagement ensued near the river Ticinus, in which the Romans were defeated. The immediate consequence was, that Scipio repassed that river, and Hannibal continued his march to the banks of the Po. Here he staid two days, before he could cross that river over a bridge of boats. He then sent Mago in pursuit of the enemy, who, having rallied their scattered forces, and repassed the Po, were encamped at Placentia. Afterwards having concluded a treaty with several of the Gallic cantons, 111 The Romans defeated near the Ticinus.

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Carthage. cantons, he joined his brother with the rest of the army, and again offered battle to the Romans: but this they thought proper to decline; and at last the consul being intimidated by the desertion of a body of Gauls, abandoned his camp, passed the Trebia, and posted himself on an eminence near that river. Here he drew lines round his camp, and waited the arrival of his colleague with the forces from Sicily.

Hannibal being apprised of the consul's departure, sent out the Numidian horse to harass him on his march; himself moving with the main body to support them in case of need. The Numidians arriving before the rear of the Roman army had quite passed the Trebia, put to the sword or made prisoners all the stragglers they found there. Soon after Hannibal coming up, encamped in sight of the Roman army on the opposite bank. Here having learned the character of the consul Sempronius, lately arrived, he soon brought him to an engagement, and entirely defeated him. Ten thousand of the enemy retired to Placentia; but the rest were either killed or taken prisoners. The Carthaginians pursued the flying Romans as far as the Trebia, but did not think proper to repass that river on account of the excessive cold.

112 They are again defeated.

Hannibal, after this action upon the Trebia, ordered the Numidians, Celtiberians, and Lusitanians, to make incursions into the Roman territories, where they committed great devastations. During his state of inaction, he endeavoured to win the affections of the Gauls, and likewise of the allies of the Romans; declaring to the Gallic and Italian prisoners, that he had no intention of making war upon them, being determined to restore them to their liberty, and protect them against the Romans: and to confirm them in their good opinion of him, he dismissed them all without ransom.

113 They are utterly defeated near the lake Thrasymenus.

Next year having crossed the Apennines, and penetrated into Etruria, Hannibal received intelligence that the new consul Flaminius lay encamped with the Roman army under the walls of Aretium. Having learned the true character of this general, that he was of a haughty, fierce, and rash disposition, he doubted not of being soon able to bring him to a battle. To inflame the impetuous spirit of Flaminius, the Carthaginian general took the road to Rome, and, leaving the Roman army behind him, destroyed all the country through which he passed with fire and sword; and as that part of Italy abounded with all the elegancies as well as necessaries of life, the Romans and their allies suffered an incredible loss on this occasion. The rash consul was inflamed with the utmost rage on seeing the ravages committed by the Carthaginians; and therefore immediately approached them with great temerity, as if certain of victory. Hannibal in the mean time kept on, still advancing towards Rome, having Crotona on the left hand, and the lake Thrasymenus on the right; and at last, having drawn Flaminius into an ambuscade, entirely defeated him. The general himself, with 15,000 of his men, fell on the field of battle. A great number was likewise taken prisoners; and a body of 6000 men, who had fled to a town in Etruria, surrendered to Maherbal the next day. Hannibal lost only 1500 men on this occasion, most of whom were Gauls; though great numbers, both of his soldiers and of the Romans, died of their wounds. Carthage.

Being soon after informed that the consul Servilius had detached a body of 4000, or, according to Appian, 8000 horse from Ariminum, to reinforce his colleague in Etruria, Hannibal sent out Maherbal, with all the cavalry, and some of the infantry, to attack him.—The Roman detachment consisted of chosen men, and was commanded by Centenius a patrician. Maherbal had the good fortune to meet with him, and after a short dispute entirely defeated him. Two thousand of the Romans were laid dead on the spot; the rest, retiring to a neighbouring eminence, were surrounded by Maherbal's forces, and obliged next day to surrender at discretion; and this disaster, happening within a few days after the defeat at the lake Thrasymenus, almost gave the finishing stroke to the Roman affairs.

114 A Roman detachment cut to pieces or taken.

The Carthaginian army was now so much troubled with a scorbutic disorder, owing to the unwholesome encampments they had been obliged to make, and the morasses they had passed through, that Hannibal found it absolutely necessary to repose them for some time in the territory of Adria, a most pleasant and fertile country. In his various engagements with the Romans he had taken a great number of their arms, with which he now armed his men after the Roman manner. Being now likewise master of that part of the country bordering on the sea, he found means to send an express to Carthage with the news of the glorious progress of his arms. The citizens received this news with the most joyful acclamations, at the same time coming to a resolution to reinforce their armies both in Italy and Spain, with a proper number of troops.

The Romans being now in the utmost consternation, named a dictator, as was their custom in times of great danger. The person they chose to this office was Fabius Maximus, surnamed *Verruscosus*; a man as cool and cautious as Sempronius and Flaminius were warm and impetuous. He set out with a design not to engage Hannibal, but only to watch his motions and cut off his provisions, which he knew was the most proper way to destroy him in a country so far from his own. Accordingly he followed him through Umbria and Picenum, into the territory of Adria, and then through the territories of the Marucini and Frentani into Apulia. When the enemy marched he followed them: when they encamped, he did the same; but for the most part on eminences, and at some distance from their camp, watching all their motions, cutting off their stragglers, and keeping them in a continual alarm. This cautious method of proceeding greatly distressed the Carthaginians, but at the same time raised discontents in his own army. But neither these discontents, nor the ravages committed by Hannibal, could prevail upon Fabius to alter his measures. The former, therefore, entered Campania, one of the finest countries of Italy. The ravages he committed there raised such complaints in the Roman army, that the dictator, for fear of irritating his soldiers, was obliged to pretend a desire of coming to an engagement. Accordingly he followed Hannibal with more expedition than usual; but at the same time avoided, under various pretences, an engagement, with more care than the enemy sought it. Hannibal, finding he could not by any means bring the dictator to a battle, resolved

115 Fabius Maximus named dictator.

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resolved to quit Campania, which he found abounding more with fruit and wine than corn, and to return to Samnium through the pass called Eribanus. Fabius concluding from his march that this was his design, got there before him, and encamped on Mount Callicula, which commanded the pass, after having placed several bodies in all the avenues leading to it.

116 He is outwitted by Hannibal.

Hannibal was for some time at a loss what to do; but at last contrived the following stratagem, which Fabius could not foresee nor guard against. Being encamped at the foot of Mount Callicula, he ordered Asdrubal to pick out of the cattle taken in the country 2000 of the strongest and nimblest oxen, to tie faggots to their horns, and to have them and the herdsmen ready without the camp. After supper, when all was quiet, the cattle were brought in good order to the hill, where Fabius had placed some Roman parties in ambush to stop up the pass. Upon a signal given, the faggots on the horns of the oxen were set on fire; and the herdsmen, supported by some battalions armed with small javelins, drove them on quietly. The Romans, seeing the light of the fires, imagined that the Carthaginians were marching by torch light. However, Fabius kept close in his camp, depending on the troops he had placed in ambuscade; but when the oxen, feeling the fire on their heads, began to run up and down the hills, the Romans in ambush thinking themselves surrounded on all sides, and climbing the ways where they saw least light, returned to their camp, leaving the pass open to Hannibal. Fabius, though rallied by his soldiers for being thus overreached by the Carthaginian, still continued to pursue the same plan, marched directly after Hannibal, and encamped on some eminences near him.

Soon after this, the dictator was recalled to Rome; and as Hannibal, notwithstanding the terrible ravages he had committed, had all along spared the lands of Fabius, the latter was suspected of holding a secret correspondence with the enemy. In his absence, Minucius, the general of the horse, gained some advantages, which greatly tended to increase the discontent with the dictator, insomuch that before his return Minucius was put upon an equal footing with himself. The general of the horse proposed that each should command his day; but the dictator chose rather to divide the army, hoping by that means to save at least a part of it. Hannibal soon found means to draw Minucius to an engagement, and by his masterly skill in laying ambushes, the Roman general was surrounded on every side, and would have been cut off with all his troops, had not Fabius hastened to his assistance, and relieved him. Then the two armies uniting, advanced in good order to renew the fight; but Hannibal, not caring to venture a second action, sounded a retreat, and retired to his camp; and Minucius, being ashamed of his rashness, resigned the command of the army to Fabius.

117 Minucius in great danger is relieved by Fabius.

118 The Romans utterly defeated at Cannæ.

The year following the Romans augmented their army to 87,000 men, horse and foot, under the command of Æmilius Paulus and Terentius Varro, the consuls for the year; and Hannibal being reduced to the greatest straits for want of provisions, resolved to leave Samnium, and penetrate into the heart of Apulia. Accordingly he decamped in the night; and by leaving fires burning, and tents standing in his camp, made the Romans believe for some time that his retreat was only feigned. When the truth was discovered, Æmilius was against pursuing him; but in this he was seconded by few besides Servilius, one of the consuls of the preceding year; Terentius and all the other officers being obstinately bent on pursuing the enemy. They accordingly overtook them at Cannæ, till this time an obscure village in Apulia.* A battle ensued at this place, as memorable as any mentioned in history; in which the Romans, though almost double in number to the Carthaginians, were put to flight with most terrible slaughter; at least 45,000 of them being left dead on the field of battle, and 10,000 taken prisoners in the action or pursuit. The night was spent in Hannibal's camp in feasting and rejoicings, and next day in stripping the dead bodies of the unhappy Romans; after which the victorious general invested their two camps, where he found 4000 men.

* See Cannæ.

119 Consequences of this victory.

The immediate consequences of this victory, as Hannibal had foreseen, was a disposition of that part of Italy called the Old Province, Magna Grecia, Tarentum, and part of the territory of Capua, to submit to him. The neighbouring provinces likewise discovered an inclination to shake off the Roman yoke, but wanted first to see whether Hannibal was able to protect them. His first march was into Samnium, being informed that the Hirpini and other neighbouring nations were disposed to enter into an alliance with the Carthaginians. He advanced to Compsa, which opened its gates to him. In this place he left his heavy baggage, as well as the immense plunder he had acquired. After which he ordered his brother Mago, with a body of troops destined for that purpose, to possess himself of all the fortresses in Campania, the most delicious province of Italy. The humanity Hannibal had all along shown the Italian prisoners, as well as the fame of the complete victory he had lately obtained, wrought so powerfully upon the Lucani, Bruttii, and Apulians, that they expressed an eager desire of being taken under his protection. Nay, even the Campanians themselves, a nation more obliged to the Romans than any in Italy, except the Latins, discovered an inclination to abandon their natural friends. Of this the Carthaginian general receiving intelligence, he bent his march towards Capua, not doubting but that, by means of the popular faction there, he should easily make himself master of it; which accordingly happened. Soon after this place had made its submission, many cities of the Bruttii opened their gates to Hannibal, who ordered his brother Mago to take possession of them. Mago was then dispatched to Carthage, with the important news of the victory at Cannæ, and the consequences attending it. Upon his arrival there, he acquainted the senate, that Hannibal had defeated six Roman generals, four of whom were consuls, one dictator, and the other general of horse to the dictator: that he had engaged six consular armies, killed two consuls, wounded one, and driven another out of the field, with scarce 50 men to attend him: that he had routed the general of the horse, who was of equal power with the consuls; and that the dictator was esteemed the only general fit to command an army, merely because he had not the courage to engage him; and as a demonstrative proof of what he advanced, he produced, according to some authors,

120 Capua submits to Hannibal.

121 Mago's account of Hannibal's success.

Carthage.

authors, three bushels and a half of gold rings, taken from knights and senators who had been killed in the various engagements.

122 Hannibal superior to every other general mentioned in history.

Hitherto we have seen Hannibal surprisingly victorious; and, indeed, if we consider what he had already done, we shall find his exploits superior to those of any other general, either ancient or modern. Other commanders have been celebrated for victories gained over barbarous and uncivilized nations. Alexander the Great invaded and overran the empire of Persia; but that kingdom was then sunk in sloth and effeminacy, so as to be an easy conquest: but had that great commander turned his arms against the western nations, who were of a more martial disposition, it is more than probable he had not conquered so easily. Hannibal, on the other hand, lived at a time when the Romans were not only the most powerful, but the most warlike nation in the whole world. That nation he attacked with an army of only 26,000 men, without resources either for recruits, money, or provisions, except what he could procure in the enemy's country. With these he had for three years resisted the Roman armies; which had been hitherto invincible by all other nations. Their armies had been commanded by generals of different tempers, dispositions, and abilities: the losses they sustained are by the Roman writers imputed to the faults of the generals themselves; but experience had abundantly shown, that these commanders, with all their faults, were able to conquer the most warlike nations, when commanded by another than Hannibal. In the battles fought with the Romans he had destroyed 200,000 of their men, and taken 50,000 prisoners; yet from the time of the battle of Cannæ, the affairs of this great man totally declined.

123 Cause of the decline of his affairs.

The reason of this is, by the Roman historians, said to be, that when he put his army into winter quarters in Capua, he so enervated himself and his army by debaucheries in that place, that he became no longer capable of coping with the Roman forces. But this seems by no means to have been the case; for the Roman historians themselves own, that, after the battle of Cannæ, he gave their armies many and terrible defeats, and took a great number of towns in their sight.

The true reason of that reverse of fortune which Hannibal now experienced, was his not having sufficient resources for recruiting his army. On the first news, indeed, of his success at Carthage, a body of 4000 Numidian cavalry, 40 elephants, and 1000 talents of silver, were granted by the senate. A large detachment of Spanish forces was also appointed to follow them; and that these last might be ready in due time, Mago set out immediately for Spain to raise 20,000 foot and 4000 horse there. Had this ample supply been sent with proper expedition, it is by no means probable that the Romans would have had any occasion to reflect upon Hannibal's conduct at Capua. That general would undoubtedly have obliged the haughty republic to submit to the superior force of his arms the next campaign. But, notwithstanding the influence of the Barcinian faction at Carthage, Hanno and his adherents found means not only to retard the march of the supplies intended, but even to diminish their number. Mago, through the artifices of that infatuated party, could obtain an order for only 12,000 foot and 2500 horse; and even with this inconsiderable body of troops he was sent into Spain. Hannibal being thus deserted by his country, found himself obliged to act on the defensive; his army amounting to no more now than 26,000 foot and 9000 horse. But though obliged to act in this manner, he was only hindered from conquering; the utmost efforts of the whole Roman power not being able to drive this small army out of Italy for more than 14 years.

124 Measures taken by the Romans.

The Romans, though greatly reduced, were not yet exhausted. They were able still to send two consular armies into the field, fully recruited and in good order; and as neither the Gauls nor Italians were natural allies of the Carthaginians, they did not fail to abandon them on the first reverse of fortune. After the Romans had recovered from the consternation into which they were thrown by the defeat at Cannæ, they chose a dictator, and recalled Marcellus, the conqueror of Syracuse, from Sicily. All the young Romans, above 17 years of age, of what rank soever, were obliged to enlist themselves; as were also those who had already served their legal time. By this means four legions and 10,000 horse were soon raised in the city. The allies of Rome, the colonies, and the municipia, furnished their contingents as usual. To these were added 8000 of the youngest and strongest slaves in the city. The republic purchased them of their masters, but did not oblige them to serve without their own consent, which they gave, by answering *Volo*, "I am willing;" whence they were called *volones*, to distinguish them from the other troops. As the Romans, after the loss of so many battles, had no swords, darts, or bucklers, left in their magazines, the *volones* were supplied with the arms which had been formerly taken from the enemy, and hung up in the public temples and porticoes. The finances of Rome were no less exhausted: but this defect was supplied by the liberality of her citizens. The senators shewing the example, were followed first by the knights, and afterwards by all the tribes; who stripping themselves of all the gold they had, brought it to the public treasury. The senators only reserved their rings, and the *bullæ* about their children's necks. As for the silver coin, it was now, for the first time, alloyed with copper, and increased in its value. Thus the finances were put into a good condition, and a competent army raised.

This was plainly the last effort the Romans could make; and could Hannibal have procured a sufficient supply of men and money to enable him to cope with this army, and to break it as he had done the others before, there could have been no more resistance made on their part. He began, however, to be in want of money; and, to procure it, gave the Roman prisoners leave to redeem themselves. These unhappy men agreed to send ten of their body to Rome to negotiate their redemption; and Hannibal required no other security for their return but their oath. Carthalo was sent at the head of them to make proposals of peace; but upon the first news of his arrival, the dictator sent a lictor to him, commanding him immediately to depart the Roman territory; and it was resolved not to redeem the captives. Upon this Hannibal sent the most considerable of them to Carthage; and of the rest he made gladiators, obliging them to fight with one another,

125 They refuse to treat of peace.

Carthage.

another, even relations with relations, for the entertainment of the troops.

126 Asdrubal defeated by the Romans in Spain.

All this time Cneius and Publius Scipio had carried on the war in Spain with great success against the Carthaginians. Asdrubal had been ordered to enter Italy with his army to assist Hannibal; but being defeated by the Romans, was prevented. The dictator and senate of Rome, encouraged by this news, carried on the preparations for the next campaign with the greatest vigour, whilst Hannibal remained inactive at Capua. This inaction, however, seems to have proceeded from his expectation of succours from Africa, which never came, and which delay occasioned his ruin. The Roman dictator now released from prison all criminals, and persons confined for debt, who were willing to enlist themselves. Of these he formed a body of 6000 foot, armed with the broadswords and bucklers formerly taken from the Gauls. Then the Roman army, to the number of about 25,000 men, marched out of the city under the command of the dictator; while Marcellus kept the remains of Varro's army, amounting to about 15,000 men, at Casilinum, in readiness to march whenever there should be occasion.

Thus the Roman forces were still superior to those of Hannibal; and as they now saw the necessity of following the example of Fabius Maximus, no engagement of any consequence happened the first year after the battle of Cannæ. Hannibal made a fruitless attempt upon Nola, expecting it would be delivered up to him; but this was prevented by Marcellus, who had entered that city, and sallying unexpectedly from three gates upon the Carthaginians, obliged them to retire in great confusion, with the loss of 5000 men. This was the first advantage that had been gained by the Romans where Hannibal had commanded in person, and raised the spirits of the former not a little. They were, however, greatly dejected, on hearing that the consul Posthumius Albinus, with his whole army, had been cut off by the Boii, as he was crossing a forest. Upon this it was resolved to draw all the Roman forces out of Gaul and other countries, and turn them against Hannibal; so that the Carthaginian stood daily more and more in need of those supplies, which yet never arrived from Carthage. He reduced, however, the cities of Nuceria, Casilinum, Petelia, Consentia, Crotona, Locri, and several others in Great Greece, before the Romans gained any advantage over him, except that before Nola, already mentioned. The Campanians, who had espoused the Carthaginian interest, raised an army of 14,000 of their own nation in favour of Hannibal, and put one Marius Alsius at the head of it; but he was surprised by the consul Sempronius, who defeated and killed him, with 2000 of his men. It was now found that Hannibal had concluded a treaty of alliance, offensive and defensive, with Philip king of Macedon: but, to prevent any disturbance from that quarter, a Roman army was sent to Macedon. Soon after this Marcellus defeated Hannibal in a pitched battle, having armed his men with long pikes used generally at sea, and chiefly in boarding of ships; by which means the Carthaginians were pierced through, while they were totally unable to hurt their adversaries with the short javelins they carried. Marcellus pursued them close; and before they got to their camp, killed 5000, and took 600 prisoners; losing himself about 1000 men, who were trod down by the Numidian horse, commanded by Hannibal in person. After this defeat the Carthaginian general found himself deserted by 1200 of his best horse, partly Spaniards, and partly Numidians, who had crossed the Alps with him. This touched him so sensibly, that he left Campania, and retired into Apulia.

127 Marcellus gains an advantage over Hannibal.

128 Hannibal takes several cities.

129 He is defeated by Marcellus.

130 He is deserted by a party of horse.

The Romans still continued to increase their forces; and Hannibal, not having the same resources, found it impossible to act against so many armies at once. Fabius Maximus advanced into Campania, whither Hannibal was obliged to return, in order to save Capua. He ordered Hanno, however, at the head of 17,000 foot and 1700 horse, to seize Beneventum; but he was utterly defeated, scarce 2000 of his men being left alive. Hannibal himself, in the mean time, advanced to Nola, where he was again defeated by Marcellus. He now began to lose ground: the Romans retook Casilinum, Accua in Apulia, Arpi, and Aternum; but the city of Tarentum was delivered up to him by its inhabitants. The Romans then entered Campania, and ravaged the whole country, threatening Capua with a siege. The inhabitants immediately acquainted Hannibal with their danger; but he was so intent upon reducing the citadel of Tarentum, that he could not be prevailed upon to come to their assistance. In the mean time Hanno was again utterly defeated by Fulvius, his camp taken, and he himself forced to fly into Bruttium, with a small body of horse. The consuls then advanced with a design to besiege Capua in form. But, in their way, Sempronius Gracchus, a man of great bravery, and an excellent general, was betrayed by a Lucanian and killed, which proved a very great detriment to the republic. Capua, however, was soon after invested on all sides; and the besieged once more sent to Hannibal, who now came to their assistance with his horse, his light-armed infantry, and 33 elephants. He found means to inform the besieged of the time he designed to attack the Romans, ordering them to make a vigorous sally at the same time. The Roman generals, Appius and Fulvius, upon the first news of the enemy's approach, divided their troops. Appius taking upon him to make head against the garrison, and Fulvius to defend the intrenchments against Hannibal. The former found no difficulty in repulsing the garrison, and would have entered the city with them, had he not been wounded at the very gate, which prevented him from pursuing his design. Fulvius found it more difficult to withstand Hannibal, whose troops behaved themselves with extraordinary resolution. A body of Spaniards and Numidians had even the boldness to pass the ditch, and, in spite of all opposition, climbing the ramparts, penetrated into the Roman camp: but, not being properly seconded by the rest, they were all to a man cut in pieces. The Carthaginian general was so disheartened at this, especially after the garrison was repulsed, that he sounded a retreat, which was made in good order. His next attempt for the relief of Capua was to march to Rome, where he hoped his approach would strike so much terror, that the armies would be called from before Capua; and that the Capuans might not be disheartened by his sudden departure, he found means

131 He is again defeated, and begins to lose ground.

132 Capua besieged by the Romans.

133 Hannibal in vain attempts to relieve it.

134 He marches to Rome.

Carthage.

means to acquaint them with his design. The news of his approach caused great consternation in the metropolis. Some of the senators were for calling all the armies in Italy into the neighbourhood of Rome, as thinking nothing less was able to resist the terrible Carthaginian. But Fabius told them that Hannibal's design was not to take Rome, but relieve Capua; upon which Fulvius was recalled to Rome with 15,000 foot and 1000 horse; and this obliged Hannibal again to retire. He then returned before Capua so suddenly that he surprised Appius in his camp, drove him out of it with the loss of a great number of men, and obliged him to intrench himself on some eminences, where he expected to be soon joined by his colleague Fulvius. As Hannibal, however, now expected to have all the Roman forces upon him, he could do nothing more for the relief of Capua; which was of consequence obliged to submit to the Romans.

135 He surprises and defeats Appius.

136 Capua submits to the Romans.

137 Centenius Penula defeated by Hannibal;

A little before the surrender of Capua, Hannibal came up with a Roman army commanded by one M. Centenius Penula, who had signalized himself on many occasions as a centurion. This rash man, being introduced to the senate, had the assurance to tell them, that if they would trust him with a body of only 5000 men, he would give a good account of Hannibal. They gave him 8000, and his army was soon increased to double that number. He engaged the Carthaginians on Hannibal's first offering him battle; but, after an engagement of two hours, was defeated, himself and all his men being slain except about 1000. Soon after, having found means to draw the prætor Cneius Fulvius into an ambuscade, Hannibal cut in pieces almost his whole army, consisting of 18,000 men. In the mean time Marcellus was making great progress in Samnium. The city of Salapia was betrayed to him; but he took other two by assault. In the last of these he found 3000 Carthaginians, whom he put to the sword; and carried off 240,000 bushels of wheat, and 110,000 of barley. This, however, was by no means a compensation for the defeat which Hannibal soon after gave the proconsul Fulvius Centumalus, whom he surprised and cut off, with 13,000 of his men.

138 as also the prætor Fulvius,

139 and the proconsul Fulvius Centumalus.

After this defeat the great Marcellus advanced with his army to oppose Hannibal. Various engagements happened without any thing decisive. In one of them the Romans are said to have been defeated, and in another Hannibal; but notwithstanding these, it was neither in the power of Marcellus, nor any other Roman general, totally to defeat or disperse the army commanded by Hannibal in person. Nay, in the eleventh year of the war, Hannibal found means to decoy into an ambuscade and cut off the great Marcellus himself; the consequence of which was, that the Romans were obliged to raise the siege of Locri, with the loss of all their military engines.

140 Marcellus drawn into an ambuscade and killed.

141 Carthaginian affairs totally ruined by the defeat of Asdrubal.

Hitherto the Carthaginians, though no longer the favourites of fortune, had lost but little ground; but now they met with a blow which totally ruined their affairs. This was the defeat of Asdrubal, Hannibal's brother, who had left Spain, and was marching to his assistance. He crossed the Pyrenees, without any difficulty; and, as the silver mines had supplied him with a very considerable quantity of treasure, he not only prevailed upon the Gauls to grant him a passage through their territories, but likewise to furnish him with a considerable number of recruits. Meeting with many favourable circumstances to expedite his march, he arrived at Placentia sooner than the Romans or even his brother Hannibal expected. Had he continued to use the same expedition with which he set out, and hastened to join his brother, it would have been utterly impossible to have saved Rome; but, sitting down before Placentia, he gave the Romans an opportunity of assembling all their forces to attack him. At last he was obliged to raise the siege, and began his march for Umbria. He sent a letter to acquaint his brother of his intended motion; but the messenger was intercepted: and the two consuls, joining their armies, with united forces fell upon the Carthaginians. As the latter were inferior both in numbers and resolution, they were utterly defeated, and Asdrubal was killed. About the same time, Hannibal himself is said to have suffered several defeats, and was retired to Canusium; but, on the fatal news of his brother's defeat and death, he was filled with despair, and retired to the extremity of Bruttium; where, assembling all his forces, he remained for a considerable time in a state of inaction, the Romans not daring to disturb him; so formidable did they esteem him alone, though every thing about him went to wreck, and the Carthaginian affairs seemed not far from the verge of destruction. Livy tells us, that it was difficult to determine whether his conduct was more wonderful in prosperity or in adversity. Notwithstanding which, Bruttium being but a small province, and many of its inhabitants being either forced into the service, or forming themselves into parties of banditti, so that a great part of it remained uncultivated, he found it a difficult matter to subsist there, especially as no manner of supplies were sent him from Carthage. The people there were as solicitous about preserving their possessions in Spain, and as little concerned about the situation of affairs in Italy, as if Hannibal had met with an uninterrupted course of success, and no disaster befallen him since he first entered that country.

All their solicitude, however, about the affairs of Spain, was to no purpose; their generals, one after another, were defeated by the Romans. They had indeed cut off the two Scipios; but found a much more formidable enemy in the young Scipio, afterwards surnamed *Africanus*. He overthrew them in conjunction with Masinissa king of Numidia; and the latter thereafter abandoned their interest. Soon after, Syphax king of the Masæsylii, was likewise persuaded to abandon their party. Scipio also gave the Spanish reguli a great overthrow, and reduced the cities of New Carthage, Gades, and many other important places. At last the Carthaginians began to open their eyes when it was too late. Mago was ordered to abandon Spain, and sail with all expedition to Italy. He landed on the coast of Liguria with an army of 12,000 foot and 2000 horse; where he surprised Genoa, and also seized upon the town and port of Savo. A reinforcement was sent him to this place, and new levies went on very briskly in Liguria; but the opportunity was past, and could not be recalled. Scipio having carried all before him in Spain, passed over into Africa, where he met with no enemy capable of

142 The great progress of Scipio Africanus.

143 Mago lands in Italy.

144 Scipio lands in Africa.

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Carthage. of opposing his progress. The Carthaginians, then, seeing themselves on the brink of destruction, were obliged to recal their armies from Italy, in order to save their city. Mago, who had entered Insubria, was defeated by the Roman forces there; and having retreated into the maritime parts of Liguria, met a courier who brought him orders to return directly to Carthage. At the same time, Hannibal was likewise recalled. When the messengers acquainted him with the senate's pleasure, he expressed the utmost indignation and concern, groaning, gnashing his teeth, and scarce refraining from tears. Never banished man, according to Livy, showed so much regret in quitting his native country as Hannibal did at going out of that of the enemy.

145 Mago and Hannibal recalled.

146 Hannibal's proceedings after his arrival in Africa.

The Carthaginian general was no sooner landed in Africa than he sent out parties to get provisions for the army, and buy horses to remount the cavalry. He entered into a league with the regulus of the Arcacidæ, one of the Numidian tribes. Four thousand of Syphax's horse came over in a body to him; but as he did not think proper to repose any confidence in them, he put them all to the sword, and distributed their horses among his troops. Vermina, one of Syphax's sons, and Macetulus, another Numidian prince, likewise joined him with a considerable body of horse. Most of the fortresses in Masinissa's kingdom either surrendered to him upon the first summons, or were taken by force. Narce, a city of considerable note there, he made himself master of by stratagem. Tychæus, a Numidian regulus, and faithful ally of Syphax, whose territories were famous for an excellent breed of horses, reinforcing him also with 2000 of his best cavalry, Hannibal advanced to Zama, a town about five days journey distant from Carthage, where he encamped. He thence sent out spies to observe the posture of the Romans. These being brought to Scipio, he was so far from inflicting any punishment upon them, which he might have done by the laws of war, that he commanded them to be led about the camp, in order to take an exact survey of it, and then dismissed them. Hannibal, admiring the noble assurance of his rival, sent a messenger to desire an interview with him; which, by means of Masinissa, he obtained. The two generals, therefore, escorted by equal detachments of horse, met at Nadagara, where, by the assistance of two interpreters, they held a private conference. Hannibal flattered Scipio in the most refined and artful manner, and expatiated upon all those topics which he thought could influence that general to grant his nation a peace upon tolerable terms; amongst other things, that the Carthaginians would willingly confine themselves to Africa, since such was the will of the gods, in order to procure a lasting peace, whilst the Romans would be at liberty to extend their conquests to the remotest nations. Scipio answered, that the Romans were not prompted by ambition, or any sinister views, to undertake either the former or present war against the Carthaginians, but by justice and a proper regard for their allies. He also observed, that the Carthaginians had, before his arrival in Africa, not only made him the same proposals, but likewise agreed to pay the Romans 5000 talents of silver, restore all the Roman prisoners without ransom, and deliver up all their galleys. He insisted on the perfidious conduct

147 He has an interview with Scipio.

of the Carthaginians, who had broke a truce concluded with them; and told him, that, so far from granting them more favourable terms, they ought to expect more rigorous ones; which if Hannibal would submit to, a peace would ensue; if not, the decision of the dispute must be left to the sword.

148 The battle of Zama.

This conference betwixt two of the greatest generals the world ever produced, ending without success, they both retired to their respective camps; where they informed their troops, that not only the fate of Rome and Carthage, but that of the whole world, was to be determined by them the next day. An engagement ensued *, in which, as Polybius informs us, the surprising military genius of Hannibal displayed itself in an extraordinary manner. Scipio likewise, according to Livy, passed a high encomium upon him, on account of his uncommon capacity in taking advantages, the excellent arrangement of his forces, and the manner in which he gave his orders during the engagement. The Roman general, indeed, not only approved his conduct, but openly declared that it was superior to his own. Nevertheless, being vastly inferior to the enemy in horse, and the state of Carthage obliging him to hazard a battle with the Romans at no small disadvantage, Hannibal was utterly routed, and his camp taken. He fled first to Thon, and afterwards to Adrumentum, from whence he was recalled to Carthage; where being arrived, he advised his countrymen to conclude a peace with Scipio on whatever terms he thought proper to prescribe.

* See Zama.

149 Hannibal totally routed.

150 Peace concluded.

Thus was the second war of the Carthaginians with the Romans concluded. The conditions of peace were very humiliating to the Carthaginians. They were obliged to deliver up all the Roman deserters, fugitive slaves, prisoners of war, and all the Italians whom Hannibal had obliged to follow him. They also delivered up all their ships of war, except ten triremes, all their tame elephants, and were to train up no more of these animals for the service. They were not to engage in any war without the consent of the Romans. They engaged to pay to the Romans, in 50 years, 10,000 Euboic talents, at equal payments. They were to restore to Masinissa all they had usurped from him or his ancestors, and to enter into an alliance with him. They were also to assist the Romans both by sea and land, whenever they were called upon so to do, and never to make any levies either in Gaul or Liguria. These terms appeared so intolerable to the populace, that they threatened to plunder and burn the houses of the nobility; but Hannibal having assembled a body of 6000 foot and 500 horse at Marthama, prevented an insurrection, and by his influence completed the accommodation.

151 Carthaginians oppressed by Masinissa.

The peace between Carthage and Rome was scarcely signed, when Masinissa unjustly made himself master of part of the Carthaginian dominions in Africa, under pretence that these formerly belonged to his family. The Carthaginians, through the villanous mediation of the Romans, found themselves under a necessity of ceding these countries to that ambitious prince, and of entering into an alliance with him. The good understanding between the two powers continued for many years afterwards; but at last Masinissa violated the treaties subsisting betwixt him and the Carthaginian

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thaginian republic, and not a little contributed to its subversion.

After the conclusion of the peace, Hannibal still kept up his credit among his countrymen. He was intrusted with the command of an army against some neighbouring nations in Africa: but this being disagreeable to the Romans, he was removed from it, and raised to the dignity of prætor in Carthage. Here he

152 Hannibal flies to Antiochus.

continued for some time, reforming abuses, and putting the affairs of the republic into a better condition: but this likewise being disagreeable to the Romans, he was obliged to fly to Antiochus king of Syria. After his flight, the Romans began to look upon the Carthaginians with a suspicious eye; though to prevent every thing of this kind, the latter had ordered two ships to pursue Hannibal, had confiscated his effects, razed his house, and by a public decree declared him an exile. Soon after, disputes arising

153 Iniquitous proceedings of Masinissa and the Romans.

between the Carthaginians and Masinissa, the latter, notwithstanding the manifest iniquity of his proceedings, was supported by the Romans. That prince, grasping at further conquest, endeavoured to embroil the Carthaginians with the Romans, by asserting that the former had received ambassadors from Perseus king of Macedon; that the senate assembled in the temple of Æsculapius in the night time, in order to confer with them; and that ambassadors had been dispatched from Carthage to Perseus, in order to conclude an alliance with him. Not long after this, Masinissa made an irruption into the province of Tysca, where he soon possessed himself of 70, or, as Appian will have it, 50 towns and castles. This obliged the Carthaginians to apply with great importunity to the Roman senate for redress, their hands being so tied up by an article in the last treaty, that they could not repel force by force, in case of an invasion, without their consent. Their ambassadors begged, that the Roman senate would settle once for all what dominions they were to have, that they might from thenceforth know what they had to depend upon; or, if their state had any way offended the Romans, they begged that they would punish them themselves, rather than leave them exposed to the insults and vexations of so merciless a tyrant. Then prostrating themselves on the earth, they burst out into tears. But, notwithstanding the impression their speech made, the matter was left undecided; so that Masinissa had liberty to pursue his rapines, as much as he pleased. But whatever villanous designs the Romans might have with regard to the republic of Carthage, they affected to show a great regard to the principles of justice and honour. They therefore sent Cato, a man famous for committing enormities under the specious pretence of public spirit, into Africa, to accommodate all differences betwixt Masinissa and the Carthaginians. The latter very well knew their fate, had they submitted to such a mediation; and therefore appealed to the treaty concluded with Scipio, as the only rule by which their conduct and that of their adversary ought to be examined. This *unreasonable* appeal so incensed the righteous Cato, that he pronounced them a devoted people, and from that time resolved upon their destruction. For some time he was opposed by Scipio Nasica; but the people of Carthage, knowing the Romans to be their inveterate enemies, and reflecting upon the iniquitous treatment they had met with from them ever since the commencement of their disputes with Masinissa, were under great apprehensions of a visit from them. To prevent a rupture as much as possible, by a decree of the senate, they impeached Asdrubal, general of the army, and Carthalo, commander of the auxiliary forces, together with their accomplices, as guilty of high treason, for being the authors of the war against the king of Numidia. They sent a deputation to Rome, to discover what sentiments were entertained there of their late conduct, and to know what satisfaction the Romans required. These messengers meeting with a cold reception, others were dispatched, who returned with the same success. This made the unhappy citizens of Carthage believe that their destruction was resolved upon; which threw them into the utmost despair. And indeed they had but too just grounds for such a melancholy apprehension, the Roman senate now discovering an inclination to fall in with Cato's measures. About the same time, the city of Utica, being the second in Africa, and famous for its immense riches, as well as its equally commodious and capacious port, submitted to the Romans. Upon the possession of so important a fortress, which, by reason of its vicinity to Carthage, might serve as a place of arms in

154 War declared by the Romans against Carthage.

the attack of that city, the Romans declared war against the Carthaginians without the least hesitation. In consequence of this declaration, the consuls M. Manlius, Nepos, and L. Marcius Censorinus, were dispatched with an army and fleet to begin hostilities with the utmost expedition. The land forces consisted of 80,000 foot and 4000 chosen horse; and the fleet of 50 quinqueremes, besides a vast number of transports. The consuls had secret orders from the senate not to conclude the operations but by the destruction of Carthage, without which, it was pretended, the republic could not but look upon all her possessions as insecure. Pursuant to the plan they had formed, the troops were first landed at Lilybæum in Sicily, from whence, after receiving a proper refreshment, it was proposed to transport them to Utica.

155 Ambassadors sent to Rome.

The answer brought by the last ambassadors to Carthage had not a little alarmed the inhabitants of that city. But they were not yet acquainted with the resolutions taken at Rome. They therefore sent fresh ambassadors thither, whom they invested with full powers to act as they thought proper for the good of the republic, and even to submit themselves without reserve to the pleasure of the Romans. But the most sensible persons among them did not expect any great success from this condescension, since the early submission of the Uticans had rendered it infinitely less meritorious than it would have been before. However the Romans seemed to be in some measure satisfied with it, since they promised them their liberty, the enjoyment of their laws, and, in short, every thing that was dear and valuable to them. This threw them into a transport of joy, and they wanted words to ex-

156 The Romans demand 300 hostages.

tol the moderation of the Romans. But the senate immediately dashed all their hopes, by acquainting them that this favour was granted upon condition that they would send 300 young Carthaginian noblemen of the first distinction to the prætor Fabius at Lilybæum, within the space of 30 days, and comply with all the orders of the consuls. These hard terms filled

Carthage. filled the whole city with inexpressible grief: but the hostages were delivered; and as they arrived at Lilybæum before the 30 days were expired, the ambassadors were not without hopes of softening their hard-hearted enemy. But the consuls only told them, that upon their arrival at Utica they should learn the further orders of the republic.

The ministers no sooner received intelligence of the Roman fleet appearing off Utica, than they repaired thither, in order to know the fate of their city. The consuls however did not judge it expedient to communicate all the commands of the republic at once, lest they should appear so harsh and severe, that the Carthaginians would have refused to comply with them. They first, therefore, demanded a sufficient supply of corn for the subsistence of their troops. Secondly, That they should deliver up into their hands all the triremes they were then masters of. Thirdly, That they should put them in possession of all their military machines. And, fourthly, That they should immediately convey all their arms into the Roman camp.

157 and all the Carthaginian arms, military machines, &c.

As care was taken that there should be a convenient interval of time betwixt every one of these demands, the Carthaginians found themselves ensnared, and could not reject any one of them, though they submitted to the last with the utmost reluctance and concern. Censorinus, now imagining them incapable of sustaining a siege, commanded them to abandon their city, or, as Zonaras will have it, to demolish it; permitting them to build another 80 stadia from the sea, but without walls or fortifications. This terrible decree threw the senate and every one else into despair; and the whole city became a scene of horror, madness, and confusion. The citizens cursed their ancestors for not dying gloriously in the defence of their country, rather than concluding such ignominious treaties of peace, that had been the cause of the deplorable condition to which their posterity was then reduced. At length, when the first commotion was a little abated, the senators assembled, and resolved to sustain a siege. They were stripped of their arms and destitute of provisions; but despair raised their courage, and made them find out expedients. They took care to shut the gates of the city; and gathered together on the ramparts great heaps of stones, to serve them instead of arms in case of a surprise. They took the malefactors out of prison, gave the slaves their liberty, and incorporated them in the militia. Asdrubal was recalled who had been sentenced to die only to please the Romans; and he was invited to employ 20,000 men he had raised against his country in defence of it. Another Asdrubal was appointed to command in Carthage; and all seemed resolute, either to save their city or perish in its ruins. They wanted arms; but, by order of the senate, the temples, porticoes, and all public buildings, were turned into workhouses, where men and women were continually employed in making arms. As they encouraged one another in their work, and lost no time in procuring to themselves the necessaries of life, which were brought to them at stated hours, they every day made 144 bucklers, 300 swords, 1000 darts, and 500 lances and javelins. As to balistæ and catapultæ, they wanted proper materials for them; but their industry supplied that defect. Where iron and brass were wanting, they made use of silver and gold, melting down the statues, vases, and even the utensils of private families; for, on this occasion, even the most covetous became liberal. As tow and flax were wanting to make cords for working the machines, the women, even those of the first rank, freely cut off their hair and dedicated it to that use. Without the walls, Asdrubal employed the troops in getting together provisions, and conveying them safe into Carthage; so that there was as great plenty there as in the Roman camp.

158 They command them to destroy their city.

159 The Carthaginians resolve to sustain a siege.

160 They make new arms.

In the mean time the consuls delayed drawing near to Carthage, not doubting but the inhabitants, whom they imagined destitute of necessaries to sustain a siege, would, upon cool reflection, submit; but at length, finding themselves deceived in their expectation, they came before the place and invested it. As they were still persuaded that the Carthaginians had no arms, they flattered themselves that they should easily carry the city by assault. Accordingly they approached the walls in order to plant their scaling ladders; but to their great surprise they discovered a prodigious multitude of men on the ramparts, shining in the armour they had newly made. The legionaries were so terrified at this unexpected sight, that they drew back, and would have retired, if the consuls had not led them on to the attack; which, however, proved unsuccessful; the Romans, in spite of their utmost efforts, being obliged to give over the enterprise, and lay aside all thoughts of taking Carthage by assault. In the mean time, Asdrubal, having collected from all places subject to Carthage a prodigious number of troops, came and encamped within reach of the Romans, and soon reduced them to great straits for want of provisions. As Marcius, one of the Roman consuls, was posted near a marsh, the exhalations of the stagnating waters, and the heat of the season, infected the air, and caused a general sickness among his men. Marcius, therefore, ordered his fleet to draw as near the shore as possible, in order to transport his troops to a healthier place. Asdrubal being informed of this motion, ordered all the old barks in the harbour to be filled with faggots, tow, sulphur, bitumen, and other combustible materials; and then, taking advantage of the wind, which blew towards the enemy, let them drive upon their ships, which were for the most part consumed. After this disaster, Marcius was called home to preside at the elections; and the Carthaginians looking upon the absence of one of the consuls to be a good omen, made a brisk sally in the night; and would have surprised the consul's camp, had not Æmilianus, with some squadrons, marched out of the gate opposite to the place where the attack was made, and, coming round, fell unexpectedly on their rear, and obliged them to return in disorder to the city.

161 The city attacked by the Romans, who are repulsed.

162 Part of the Roman fleet destroyed.

Asdrubal had posted himself under the walls of a city named Nepheris, 24 miles distant from Carthage, and situated on a high mountain, which seemed inaccessible on all sides. From thence he made incursions into the neighbouring country, intercepted the Roman convoys, fell upon their detachments sent out to forage, and even ordered parties to insult the consular army in their camp. Hereupon the consul resolved to drive the Carthaginian from this advantageous post, and set out for Nepheris. As he drew near the hills, Asdrubal

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Carthage. bal suddenly appeared at the head of his army in order of battle, and fell upon the Romans with incredible fury. The consular army sustained the attack with great resolution; and Asdrubal retired in good order to his post, hoping the Romans would attack him there. But the consul, being now convinced of his danger, resolved to retire. This Asdrubal no sooner perceived, than he rushed down the hill, and falling upon the enemy's rear, cut a great number of them in pieces. The whole Roman army was now saved by the bravery of Scipio Æmilianus. At the head of 300 horse, he sustained the attack of all the forces commanded by Asdrubal, and covered the legions, while they passed a river in their retreat before the enemy. Then he and his companions threw themselves into the stream, and swam across it. When the army had crossed the river, it was perceived that four manipuli were wanting; and soon after they were informed that they had retired to an eminence, where they resolved to sell their lives as dear as possible. Upon this news Æmilianus, taking with him a chosen body of horse, and provisions for two days, crossed the river, and flew to the assistance of his countrymen. He seized a hill over against that on which the four manipuli were posted; and, after some hours repose, marched against the Carthaginians who kept them invested; fell upon them at the head of his squadron with the boldness of a man determined to conquer or die; and, in spite of all opposition, opened a way for his fellow-soldiers to escape. On his return to the army, his companions, who had given him over for lost, carried him to his quarters in a kind of triumph; and the manipuli he had saved gave him a crown of *gramen*. By these and some other exploits, Æmilianus gained such reputation, that Cato, who is said never to have commended any body before, could not refuse him the praises he deserved; and is said to have foretold that Carthage would never be reduced till Scipio Æmilianus was employed in that expedition.

163 The Roman army in great danger, is saved by Scipio Æmilianus.

The next year, the war in Africa fell by lot to the consul L. Calpurnius Piso; and he continued to employ Æmilianus in several important enterprises, in which he was attended with uncommon success. He took several castles; and in one of his excursions, found means to have a private conference with Phameas, general, under Asdrubal, of the Carthaginian cavalry, and brought him over, together with 2200 of his horse, to the Roman interest. Under the consul Calpurnius Piso himself, however, the Roman arms were unsuccessful. He invested Clupea; but was obliged to abandon the enterprise, with the loss of a great number of men killed by the enemy in their sallies. From this place he went to vent his rage on a city newly built, and thence called *Neapolis*, which professed a strict neutrality, and had even a safeguard from the Romans. The consul, however, plundered the place, and stripped the inhabitants of all their effects. After this he laid siege to *Hippagretta*, which employed the Roman fleet and army the whole summer; and, on the approach of winter, the consul retired to Utica, without performing a single action worth notice during the whole campaign.

164 He gains over the Carthaginian general of horse.

The next year Scipio Æmilianus was chosen consul, and ordered to pass into Africa; and, upon his arrival, the face of affairs was greatly changed. At the time of his entering the port of Utica, 3500 Romans were in great danger of being cut in pieces before Carthage. These had seized Megalia, one of the suburbs of the city; but, as they had not furnished themselves with provisions to subsist there, and could not retire, being closely invested on all sides by the enemy's troops, the prætor Mancinus, who commanded this detachment, seeing the danger into which he had brought himself, dispatched a light boat to Utica, to acquaint the Romans there with his situation. Æmilianus received this letter a few hours after his landing; and immediately flew to the relief of the besieged Romans, obliged the Carthaginians to retire within their walls, and safely conveyed his countrymen to Utica. Having then drawn together all the troops, Æmilianus applied himself wholly to the siege of the capital.

165 He is chosen consul.

166 Cruelties of Asdrubal.

His first attack was upon Megalia; which he carried by assault, the Carthaginian garrison retiring into the citadel of Byrsa. Asdrubal, who had commanded the Carthaginian forces in the field, and was now governor of the city, was so enraged at the loss of Megalia, that he caused all the Roman captives taken in the two years the war lasted to be brought upon the ramparts, and thrown headlong, in the sight of the Roman army, from the top of the wall; after having, with an excess of cruelty, commanded their hands and feet to be cut off, and their eyes and tongues to be torn out. He was of a temper remarkably inhuman; and it is said that he even took pleasure in seeing some of these unhappy men flayed alive. Æmilianus, in the mean time, was busy in drawing lines of circumvallation and contravallation across the neck of land which joined the isthmus on which Carthage stood to the continent. By this means, all the avenues on the land side of Carthage being shut up, the city could receive no provisions that way. His next care was to raise a mole in the sea, in order to block up the old port, the new one being already shut up by the Roman fleet; and this great work he effected with immense labour. The mole reached from the western neck of land, of which the Romans were masters, to the entrance of the port, and was 90 feet broad at the bottom, and 80 at the top. The besieged, when the Romans first began this surprising work, laughed at the attempt; but were no less alarmed than surprised, when they beheld a vast mole appearing above water, and by that means the port rendered inaccessible to ships, and quite useless. Prompted by despair, however, the Carthaginians, with incredible and almost miraculous industry, dug a new bason, and cut a passage into the sea, by which they could receive the provisions that were sent them by the troops in the field. With the same diligence and expedition they fitted out a fleet of 50 triremes; which, to the great surprise of the Romans, appeared suddenly advancing into the sea through this new canal, and even ventured to give the enemy battle. The action lasted the whole day, with little advantage on either side. The day after, the consul endeavoured to make himself master of a terrace which covered the city on the side next the sea; and on this occasion the besieged signalized themselves in a most remarkable manner. Great numbers of them, naked and unarmed, went into the water in the dead of the night, with unlighted torches in their hands; and having, partly by swimming, partly by wading, got within reach of the Roman

167 Carthage blocked up by sea and land.

168 The besieged dig a wide bason.

169 They set fire to the Roman machines.

Carthage. Roman engines, they struck fire, lighted their torches, and threw them with fury against the machines. The sudden appearance of these naked men, who looked like so many monsters started up out of the sea, so terrified the Romans who guarded the machines, that they began to retire with the utmost confusion. The consul, who commanded the detachment in person, and had continued all night at the foot of the terrace, endeavoured to stop his men, and even ordered those who fled to be killed. But the Carthaginians, perceiving the confusion the Romans were in, threw themselves upon them like so many wild beasts; and having put them to flight only with their torches, they set fire to the machines, and entirely consumed them.—This, however, did not discourage the consul; he renewed the attack a few days after, carried the terrace by assault, and lodged 4000 men upon it. As this was an important post, because it pent in Carthage on the sea side, Æmilianus took care to fortify and secure it against the sallies of the enemy; and then, winter approaching, he suspended all further attacks upon the place till the return of good weather. During the winter season, however, the consul was not inactive. The Carthaginians had a very numerous army under the command of one Diogenes, strongly encamped near Nepheris, whence convoys of provisions were sent by sea to the besieged, and brought into

170 Vast slaughter of the Carthaginians. the new bason. To take Nepheris, therefore, was to deprive Carthage of her chief magazine. This Æmilianus undertook, and succeeded in the attempt. He first forced the enemy's intrenchments, put 70,000 of them to the sword, and made 10,000 prisoners; all the inhabitants of the country, who could not retire to Carthage, having taken refuge in this camp. After this he laid siege to Nepheris, which was reduced in 22 days. Asdrubal being disheartened by the defeat of the army, and touched with the misery of the besieged, now reduced to the utmost extremity for want of provisions, offered to submit to what conditions the Romans pleased, provided the city was spared; but this was absolutely refused.

171 Cotho taken. Early in the spring, Æmilianus renewed the siege of Carthage; and in order to open himself a way into the city, he ordered Lælius to attempt the reduction of Cotho, a small island which divided the two ports. Æmilianus himself made a false attack on the citadel, in order to draw the enemy thither. This stratagem had the desired effect: for the citadel being a place of the greatest importance, most of the Carthaginians hastened thither, and made the utmost efforts to repulse the aggressors; but in the mean time Lælius having, with incredible expedition, built a wooden bridge over the channel which divided Cotho from the isthmus, entered the island, scaled the walls of the fortress which the Carthaginians had built there, and made himself master of that important post. The proconsul, who was engaged before Byrsa, no sooner understood, by the loud shouts of the troops of Lælius, that he had made himself master of Cotho, than he

172 Romans enter the city. abandoned the false attack, and unexpectedly fell on the neighbouring gate of the city, which he broke down, notwithstanding the showers of darts that were incessantly discharged upon his men from the ramparts. As night coming on prevented him from proceeding farther, he made a lodgment within the gate, and waited there for the return of day, with a design to advance through the city to the citadel, and attack it on that side, which was but indifferently fortified. Pursuant to this design, at daybreak, he ordered 4000 fresh troops to be sent from his camp; and having solemnly devoted to the infernal gods the unhappy Carthaginians, he began to advance at the head of his men through the streets of the city, in order to attack the citadel. Having advanced to the market place, he found that the way to the citadel lay through three exceeding steep streets. The houses on both sides were very high, and filled with the Carthaginians, who overwhelmed the Romans as they advanced with darts and stones; so that they could not proceed till they had cleared them. To this end Æmilianus in person, at the head of a detachment, attacked the first house and made himself master of it, sword in hand. His example was followed by the officers and soldiers, who went on from house to house, putting all they met with to the sword. As fast as the houses were cleared on both sides, the Romans advanced in order of battle towards the citadel; but met with a vigorous resistance from the Carthaginians, who on this occasion behaved with uncommon resolution. From the market place to the citadel, two bodies of men fought their way every step, one above on the roofs of the houses, the other below in the streets. The slaughter was inexpressibly great and dreadful. The air rung with shrieks and lamentations. Some were cut in pieces, others threw themselves down from the tops of the houses; so that the streets were filled with dead and 173
mangled bodies. But the destruction was yet greater when the proconsul commanded fire to be set to that quarter of the town which lay next to the citadel. Incredible multitudes, who had escaped the swords of the enemy, perished in the flames, or by the fall of the houses. After the fire, which lasted six days, had demolished a sufficient number of houses, Æmilianus ordered the rubbish to be removed, and a large area to be made, where all the troops might have room to act. Then he appeared with his whole army before Byrsa; which so terrified the Carthaginians, who had fled thither for refuge, that first of all 25,000 women, and then 30,000 men, came out of the gates in such a condition as moved pity. They threw themselves prostrate before the Roman general, asking no favour but life. This was readily granted, not only to them but to all that were in Byrsa except the Roman de- 174
serters, whose number amounted to 900. Asdrubal's wife earnestly entreated her husband to suffer her to join the suppliants, and carry with her to the proconsul her two sons who were as yet very young; but the barbarian denied her request, and rejected her remonstrances with menaces. The Roman deserters, seeing themselves excluded from mercy, resolved to die sword in hand, rather than deliver themselves up to the vengeance of their countrymen. Then Asdrubal, finding them all resolved to defend themselves to the last breath, committed to their care his wife and children; after which, he in a most cowardly and mean-spirited manner, came and privately threw himself at the conqueror's feet. The Carthaginians in the citadel no sooner understood that their commander had abandoned the place, than they threw open the gates, and put the Romans in possession of Byrsa. They had now no

Which is set on fire.

Cruelty and cowardice of Asdrubal.

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Carthage. no enemy to contend with but the 900 deserters, who, being reduced to despair, retreated into the temple of Æsculapius, which was as a second citadel within the first. There the proconsul attacked them; and these unhappy wretches, finding there was no way to escape, set fire to the temple. As the flames spread, they retreated from one part of the building to another, till

175 Asdrubal's wife destroys herself and two children. they got to the roof. There Asdrubal's wife appeared in her best apparel, and having uttered the most bitter imprecations against her husband, whom she saw standing below with Æmilianus, "Base coward! (said she) the mean things thou hast done to save thy life shall not avail thee: thou shalt die this instant, at least in thy two children." Having thus spoken, she stabbed both the infants with a dagger; and while they were yet struggling for life, threw them both from the top of the temple, and then leaped down after them into the flames.

176 Carthage plundered, Æmilianus delivered up the city to be plundered, but in the manner prescribed by the Roman military law. The soldiers were allowed to appropriate to themselves all the furniture, utensils, and brass money, they should find in private houses; but all the gold and silver, the statues, pictures, &c. were reserved to be put into the hands of the quæstors. On this occasion the cities of Sicily, which had been often plundered by the Carthaginian armies, recovered a number of statues, pictures, and other valuable monuments; among the rest the famous brazen bull, which Phalaris had ordered to be cast, and used as the chief instrument of his cruelty, was restored to the inhabitants of Agrigentum. As Æmilianus was greatly inclined to spare what remained of this stately metropolis, he wrote to the senate on the subject, from whom he received the following orders: 1. The city of Carthage, with Byrsa and Megalia, shall be entirely destroyed, and no traces of them left. 2. All the cities that have lent Carthage any assistance shall be dismantled. 3. The territories of those cities which have declared for the Romans shall be enlarged with lands taken from the enemy. 4. All the lands between Hippo and Carthage shall be divided among the inhabitants of Utica. 5. All the Africans of the Carthaginian state, both men and women, shall pay an annual tribute to the Romans at so much per head. 6. The whole country, which was subject to the Carthaginian state, shall be turned into a Roman province, and be governed by a prætor, in the same manner as Sicily. Lastly, Rome shall send commissioners into Africa, there to settle jointly with the proconsul the state of the new province. Before Æmilianus destroyed the city, he performed those religious ceremonies which were required on such occasions: he first sacrificed to the gods, and then caused a plough to be drawn round the

177 and utterly destroyed. walls of the city. After this the towers, ramparts, walls, and all the works which the Carthaginians had raised in the course of many ages, and at a vast expence, were levelled with the ground; and lastly, fire was set to the edifices of the proud metropolis, which consumed them all, not a single house escaping the flames. Though the fire began in all quarters at the same time, and burnt with incredible fury, it continued for 17 days before all the buildings were consumed.

Thus fell Carthage, about 146 years before the birth of Christ; a city whose destruction ought to be attributed more to the intrigues of an abandoned faction, composed of the most profligate part of its citizens, than to the power of its rival. The treasure which Æmilianus carried off, even after the city had been delivered up to be plundered by the soldiers, was immense, Pliny making it to amount to 4,470,000 pounds weight of silver. The Romans ordered Carthage never to be inhabited again, denouncing dreadful imprecations against those who, contrary to this prohibition, should attempt to rebuild any part of it, especially Byrsa and Megalia. Notwithstanding this, however, about 24 years after, C. Gracchus, tribune 178 Rebuilt. of the people, in order to ingratiate himself with them, undertook to rebuild it; and to that end conducted thither a colony of 6000 Roman citizens. The workmen, according to Plutarch, were terrified by many unlucky omens at the time they were tracing the limits and laying the foundations of the new city; which the senate being informed of, would have suspended the attempt. But the tribune, little affected with such presages, continued to carry on the work, and finished it in a few days. From hence it is probable that only a slight kind of huts were erected; but whether Gracchus executed his design, or the work was entirely discontinued, it is certain that Carthage was the first Roman colony ever sent out of Italy. According to some authors, Carthage was rebuilt by Julius Cæsar; and Strabo, who flourished in the reign of Tiberius, affirms it in his time to have been equal, if not superior, to any other city in Africa. It was looked upon as the capital of Africa for several centuries after the commencement of the Christian era. Maxentius laid it in ashes about the sixth or seventh year of Constantine's reign. Genseric, king of the Vandals, took it A. D. 439; but about a century afterwards it was reannexed to the Roman empire by the renowned Belisarius. At last the Saracens, under Mohammed's successors, towards the close of the seventh century, so 179 Utterly destroyed by the Saracens. completely destroyed it, that there are now scarce any traces remaining.

At the commencement of the third Punic war, Carthage appears to have been one of the first cities in 180 Its ancient grandeur. the world. It was seated on a peninsula 360 stadia or 45 miles in circumference, joined to the continent by an isthmus 25 stadia or three miles and a furlong in breadth. On the west side there projected from it a long tract of land half a stadium broad; which shooting out into the sea, separated it from a lake or morass, and was strongly fortified on all sides by rocks and a single wall. In the middle of the city stood the citadel of Byrsa, having on the top of it a temple sacred to Æsculapius, seated upon rocks on a very high hill, to which the ascent was by 60 steps. On the south side the city was surrounded by a triple wall, 30 cubits high, flanked all round by parapets and towers, placed at equal distances of 480 feet. Every tower had its foundation sunk 32 feet deep, and was four stories high, though the walls were but two: they were arched; and, in the lower part, corresponding in depth with the foundation above mentioned, were stalls large enough to hold 300 elephants, with their fodder, &c. Over these were stalls and other conveniences for 4000 horses; and there was likewise room for lodging 20,000 foot and 4000 cavalry, without in

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Carthage. in the least incommoding the inhabitants. There were two harbours, so disposed as to have a communication with one another. They had one common entrance 70 feet broad, and shut up with chains. The first was appropriated to the merchants; and included in it a vast number of places of refreshment, and all kinds of accommodation for seamen. The second, as well as the island of Cothon, in the midst of it, was lined with large quays, in which were distinct receptacles for securing and sheltering from the weather 220 ships of war. Over these were magazines of all sorts of naval stores. The entrance into each of these receptacles was adorned with two marble pillars of the Ionic order; so that both the harbour and island represented on each side two magnificent galleries. Near this island was a temple of Apollo, in which was a statue of the god all of massy gold; and the inside of the temple all lined with plates of the same metal, weighing 1000 talents. The city was 23 miles in circumference, and at the time we speak of contained 700,000 inhabitants. Of their power we may have some idea, by the quantity of arms they delivered up to the Roman consuls. The whole army was astonished at the long train of carts loaded with them, which were thought sufficient to have armed all Africa. At least it is certain, that on this occasion were put into the hands of the Romans 2000 catapultæ, 200,000 complete suits of armour, with an innumerable quantity of swords, darts, javelins, arrows, and beams armed with iron, which were thrown from the ramparts by the balistæ.

The character transmitted of the Carthaginians is extremely bad; but we have it only on the authority of the Romans, who, being their implacable enemies, cannot be much relied upon. As to their religion, manners, &c. being much the same with the Phœnicians, of which they were a colony, the reader is referred for an account of these things to the article PHŒNICIA.

On the ruins of Carthage there now stands only a small village called *Melcha*. The few remains of Carthage consist only of some fragments of walls, and 17 cisterns for the reception of rain water.

There are three eminences, which are so many masses of fine marbles pounded together, and were in all probability the sites of temples and other distinguished buildings. The present ruins are by no means the remains of the ancient city destroyed by the Romans; who, after taking it, entirely erased it, and ploughed up the very foundations; so truly they adhered to the well-known advice perpetually inculcated by Cato the Elder, *Delenda est Carthago*. It was again rebuilt by the Gracchi family, who conducted a colony to re-people it: and continually increasing in splendour, it became at length the capital of Africa under the Roman emperors. It subsisted near 700 years after its first demolition, until it was entirely destroyed by the Saracens in the beginning of the 7th century.

It is a singular circumstance that the two cities of Carthage and Rome should have been built just opposite one to the other; the bay of Tunis and the mouth of the Tiber being in a direct line.

> *Littora littoribus contraria, fluctibus undas,*
> *Arma armis.* VIRG. Æn. iv. 627.

New CARTHAGE, a considerable town of Mexico, in the province of Costa Rica. It is a very rich trading place. W. Long. 86. 7. N. Lat. 9. 5.

Carthage, Carthagena

CARTHAGENA, a province of South America, in the new kingdom of Grenada, bounded on the north by the Carribbean sea, on the south by the province of Antioquia, on the east by Santa Martha, and on the west by Darien. The capital city, called likewise *Carthagena*, is situated in W. Long. 77. N. Lat. 11. on a sandy island, by most writers called a peninsula; which, forming a narrow passage on the south-west, opens a communication with that called *Tierra Bomba*, as far as *Bocca Chica*. The little island which now joins them was formerly the entrance of the bay; but it having been filled up by orders of the court, Bocca Chica became the only entrance: this, however, has been filled up since the attempt of Vernon and Wentworth, and the old passage again opened. On the north side the land is so narrow, that before the wall was begun, the distance from sea to sea was only 35 toises; but afterwards enlarging, it forms another island on this side; so that, excepting these two places, the whole city is entirely surrounded by salt water. To the eastward it has a communication, by means of a wooden bridge, with a large suburb called *Xemani*, built on another island, which is also joined to the continent by a bridge of the same materials. The fortifications both of the city and suburbs are built after the modern manner, and lined with freestone; and, in time of peace, the garrison consists of ten companies of 77 men each, besides militia. The city and suburbs are well laid out, the streets straight, broad, uniform, and well paved. All the houses are built of stone or brick, only one story high, well contrived, neat, and furnished with balconies and lattices of wood, which is more durable in that climate than iron, the latter being soon corroded by the acrimonious quality of the atmosphere. The climate is exceedingly unhealthy. The Europeans are particularly subject to the terrible disease called the *black vomit*, which sweeps off multitudes annually on the arrival of the galleons. It seldom continues above three or four days, in which time the patient is either dead or out of danger, and if he recovers, is never subject to a return of the same distemper. —This disease has hitherto foiled all the art of the Spanish physicians; as has also the leprosy, which is very common here. At Carthagena, likewise, that painful tumour in the legs, occasioned by the entrance of the *dracunculus* or Guinea-worm, is very common and troublesome. Another disorder peculiar to this country, and to Peru, is occasioned by a little insect called *nigua*, so extremely minute as scarce to be visible to the naked eye. This insect breeds in the dust, insinuates itself into the soles of the feet and the legs, piercing the skin with such subtility, that there is no being aware of it, before it has made its way to the flesh. If it is perceived in the beginning, it is extracted with little pain; but having once lodged its head, and pierced the skin, the patient must undergo the pain of an incision, without which a nidus would be formed, and a multitude of insects ingendered, which would soon overspread the foot and leg. The province contains about 60,000 whites, 13,000 Indians, and 7000 negro slaves. It has not been much concerned in the revolutionary movements which began in 1810, and still continue.

CARTHAGENA,

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CARTHAGENA, a seaport town of Spain, in the kingdom of Murcia, and capital of a territory of the same name, built by Asdrubal, a Carthaginian general, and named after Carthage. It has the best harbour in all Spain, but nothing else very considerable; the bishop's see being transferred to Toledo. In 1706 it was taken by Sir John Leake: but the duke of Berwick retook it afterwards. Population 25,000. W. Long. 0. 58. N. Lat. 37. 36.

CARTHAMUS. See BOTANY *Index*. The carthamus tinctorius is at present cultivated in many parts of Europe, and also in the Levant, from whence great quantities of it are annually imported into Britain for the purposes of dyeing and painting. The good quality of this commodity is in the colour, which is of a bright saffron hue: and in this the British carthamus very often fails; for if there happens much rain during the time the plants are in flower, the flowers change to a dark or dirty yellow, as they likewise do if the flowers are gathered with any moisture remaining upon them.—The seeds of carthamus have been celebrated as a cathartic; but they operate very slowly, and for the most part disorder the stomach and bowels, especially when given in substance: triturated with distilled aromatic waters, they form an emulsion less offensive, yet inferior in efficacy to the more common purgatives. They are eaten by a species of Egyptian parrot, which is very fond of them; to other birds or beasts they would prove a mortal poison.

CARTHUSIANS, a religious order, founded in the year 1080, by one Brudo. The Carthusians, so called from the desert of *Chartreux*, the place of their institution, are remarkable for the austerity of their rule. They are not to go out of their cells, except to church, without leave of their superior, nor speak to any person without leave. They must not keep any portion of their meat or drink till next day; their beds are of straw, covered with a felt; their clothing two haircloths, two cowls, two pair of hose, and a cloak, all coarse. In the refectory, they are to keep their eyes on the dish, their hands on the table, their attention on the reader, and their hearts fixed on God. Women are not allowed to come into their churches. It is computed that there are 172 houses of Carthusians; whereof five are of *nuns*, who practise the same austerities as the monks. They are divided into 16 provinces, each of which has two visitors. There have been several canonized saints of this order, 4 cardinals, 70 archbishops and bishops, and a great many very learned writers.

CARTHUSIAN Powder, the same with kermes mineral. See KERMES.

CARTILAGE, in *Anatomy*, a body approaching to the nature of bones; but lubricous, flexible, and elastic. See ANATOMY *Index*.

Brit. Zool. iii. 75.

CARTILAGINOUS, in *Ichthyology*, a title given to all fishes whose muscles are supported by cartilages instead of bones: and comprehends the same genera of fish to which Linnæus has given the name of *amphibia nantes*: but the word *amphibia* ought properly to be confined to such animals as inhabit both elements; and can live, without any inconvenience, for a considerable time, either on land or in water; such as tortoises, frogs, and several species of lizards; and among the quadrupeds, hippopotami, &c. &c.

Many of the cartilaginous fish are viviparous, being excluded from an egg, which is hatched within them. The egg consists of a white and yolk; and is lodged in a case formed of a thick tough substance, not unlike softened horn; such are the eggs of the *ray* and *shark* kinds. Some again differ in this respect, and are oviparous; such is the *sturgeon*, and others.

They breathe either through certain apertures beneath, as in the *rays*; on their sides, as in the *sharks*, &c.; or on the top of the head, as in the *pipe-fish*: for they have not covers to their gills like bony fish.

CARTMEL, a town of Lancashire in England. It is seated among the hills called Cartmell-fells, not far from the sea, and near the river Kent; adorned with a very handsome church, built in the form of a cross like a cathedral. The market is well supplied with corn, sheep, and fish. Population 280 in 1811. W. Long. 2. 43. N. Lat. 54. 15.

CARTON, or CARTOON, in *Painting*, a design drawn on strong paper, to be afterwards chalked through, and transferred on the fresh plaster of a wall, to be painted in fresco. It is also used for a design coloured, for working in mosaic, tapestry, &c. The word is from the Italian *cartoni* (*carta*, "paper," and *oni*, "large,") denoting many sheets of paper pasted on canvas on which large designs are made, whether coloured or with chalks only. Of these many are to be seen at Rome, particularly by Domenichino. Those by Andrea Mantegna, which are at Hampton Court, were made for paintings in the old ducal palace at Mantua. But the most famous performances of this sort are,

The *Cartoons of Raphael*, so deservedly applauded throughout Europe by all authors of refined taste, and all true admirers of the art of design, for their various and matchless merit, particularly with regard to the invention, and to the great and noble expression of such a variety of characters, countenances, and most expressive attitudes, as they are differently affected and properly engaged, in every composition. These cartoons are seven in number, and form only a small part of the sacred historical designs executed by this great artist, while engaged in the chambers of the Vatican under the auspices of Popes Julius II. and Leo X. When finished, they were sent to Flanders, to be copied in tapestry, for adorning the pontifical apartments; which tapestries were not sent to Rome till several years after the decease of Raphael, and even in all probability were not finished and sent there before the terrible sack of that city in the time of Clement VII. when Raphael's scholars had fled from thence, and none left to inquire after the original cartoons, which lay neglected in the store-rooms of the manufactory. The great revolution also which followed in the Low Countries prevented their being noticed amidst the entire neglect of the works of art. It was therefore a most fortunate circumstance that these seven escaped the wreck of the others, which were torn in pieces and remained dispersed as fragments in different collections. These seven were purchased by Rubens for Charles I. and they have been so roughly handled from the first, that holes were pricked for the weavers to pounce the outlines, and other parts almost cut through in tracing also. In this state perhaps they as fortunately escaped the sale amongst the royal collection,

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sion, by the disproportioned appraisement of these seven at 300l. and the nine pieces, being the Triumph of Julius Cæsar, by Andræa Mantegna, appraised at 1000l. They seem to have been taken small notice of till King William built a gallery, purposely to receive them at Hampton Court; whence they were moved, on their suffering from damps, to the Queen's Palace. They are now at Windsor Castle, and open to public inspection.

CARTOUCHE, in *Architecture* and *Sculpture*, an ornament representing a scroll of paper. It is usually a flat member, with wavings to represent some inscription, device, cipher, or ornament of armoury. They are, in architecture, much the same as modillions; only these are set under the cornice in wainscotting, and those under the cornice at the eaves of a house.

CARTOUCHE, in the military art, a case of wood, about three inches thick at the bottom, girt with marline, holding about four hundred musket balls, besides six or eight balls of iron, of a pound weight, to be fired out of a hobit, for the defence of a pass, &c.

A cartouche is sometimes made of a globular form, and filled with a ball of a pound weight; and sometimes it is made for the guns, being of a ball of half or quarter a pound weight, according to the nature of the gun, tied in form of a bunch of grapes, on a tompion of wood, and coated over. These were made in the room of partridge-shot.

CARTRIDGE, in the military art, a case of pasteboard or parchment, holding the exact charge of a firearm. Those for muskets, carabines, and pistols, hold both the powder and ball for the charge: and those of cannon and mortars are usually in cases of pasteboard or tin, sometimes of wood, half a foot long, adapted to the caliber of the piece.

Cartridge-Box, a case of wood or turned iron, covered with leather, holding a dozen musket cartridges. It is worn upon a belt, and hangs a little lower than the right pocket-hole.

CARTWRIGHT, WILLIAM, an eminent divine and poet, born at Northway, near Tewkesbury, in Gloucestershire, in September 1611. He finished his education at Oxford; afterwards went into holy orders, and became a most florid preacher in the university. In 1642, he had the place of succentor in the church of Salisbury: and, in 1642, was chosen junior proctor in the university. He was also metaphysical reader there. Wit, judgment, elocution, a graceful person and behaviour, occasioned that encomium of him from Dean Fell, "That he was the utmost that man could come to." He was an expert linguist; an excellent orator; and at the same time was esteemed an admirable poet. There are extant of his, four plays, and some poems. He died in 1643, aged 33.

CARVAGE (*carvagium*), the same with CARRUCAGE.

Henry III. is said to have taken carvage, that is, two marks of silver of every knight's fee, towards the marriage of his sister Isabella to the emperor. Carvage could only be imposed on tenants *in capite*.

CARVAGE also denotes a privilege whereby a man is exempted from the service of carrucage.

CARUCATURIUS, in ancient law books, he that held land in soccage, or by plough tenure.

CARUCATE. See CARRUCATE.

CARVER, a cutter of figures or other devices in wood. See CARVING.

Carvers answer to what the Romans called *sculptores*, who were different from *cælatores*, or engravers, as these last wrought in metal.

CARVER is also an officer of the table, whose business is to cut up the meat, and distribute it to the guests. The word is formed from the Latin *carptor*, which signifies the same. The Romans also called him *carpus*, sometimes *scissor*, *scindendi magister*, and *structor*.

In the great families at Rome, the carver was an officer of some figure. There were masters to teach them the art regularly, by means of figures of animals cut in wood. The Greeks also had their carvers, called δαιτροι, q. d. *diribitores*, or *distributors*. In the primitive times, the master of the feast carved for all his guests. Thus in Homer, when Agamemnon's ambassadors were entertained at Achilles's table, the hero himself carved the meat. Of latter times, the same office on solemn occasions was executed by some of the chief men of Sparta. Some derive the custom of distributing to every guest his portion, from those early ages when the Greeks first left off feeding on acorns, and learned the use of corn: The new diet was so great a delicacy, that to prevent the guests from quarrelling about it, it was found necessary to make a fair distribution.

In Scotland, the king has a hereditary carver in the family of Anstruther.

CARUI, or CARVI, in *Botany*. See CARUM, BOTANY *Index*.

CARVING, in a general sense, the art or act of cutting or fashioning a hard body, by means of some sharp instrument, especially a chissel. In this sense carving includes statuary and engraving, as well as cutting in wood.

CARVING, in a more particular sense, is the art of engraving or cutting figures in wood. In this sense *carving*, according to Pliny, is prior both to statuary and painting.

To carve a figure or design, it must be first drawn or pasted on the wood; which done, the rest of the block not covered by the lines of the design, is to be cut away with little narrow-pointed knives. The wood fittest for the use is that which is hard, tough, and close, as beech, but especially box: to prepare it for drawing the design on, they wash it over with white lead tempered in water; which better enables it either to bear ink or the crayon, or even to take the impression by chalking. When the design is to be pasted on the wood, this whitening is omitted, and they content themselves with seeing the wood well planed. Then wiping over the painted side of the figure with gum tragacanth dissolved in water, they clap it smooth on the wood, and let it dry: which done, they wet it slightly over, and fret off the surface of the paper gently, till all the strokes of the figure appear distinctly. This done, they fall to cutting or carving, as above.

CARUM. See BOTANY *Index*.

CARUNCULA, or CARUNCLE, in *Anatomy*, a term denoting a little piece of flesh, and applied to several parts of the human body. Thus,

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CARUNCULÆ *Myrtiformes*, in *Anatomy*, fleshy knobs about the size of a myrtle berry, supposed to owe their origin to the breaking of the hymen. See ANATOMY *Index*.

CARUNCLES, in the urethra, proceeding from a gonorrhoea, or an ulceration of the urethra, may be reduced by introducing the BOUGIE.

CARUS, a sudden deprivation of sense and motion, affecting the whole body. See MEDICINE *Index*.

CARUS, *Marcus Aurelius*, was raised from a low station, by his great merit, to be emperor of Rome in 282. He shewed himself worthy of the empire; subdued his enemies; and gave the Romans a prospect of happy days, when he was unfortunately killed by lightning in 284.

CARWAR, a town of Asia, on the coast of Malabar in the East Indies, and where the East India Company have a factory, fortified with two bastions. The valleys about it abound in corn and pepper, which last is the best in the East Indies. The woods on the mountains abound with quadrupeds, such as tigers, wolves, monkeys, wild hogs, deers, elks, and a sort of beeves of a prodigious size. The religion of the natives is Paganism; and they have a great many strange and superstitious customs. E. Long. 73. 7. N. Lat. 15. 0.

CARY, LUCIUS, Lord Viscount Falkland, was born in Oxfordshire, about the year 1610; a young nobleman of great abilities and accomplishments. About the time of his father's death in 1633, he was made gentleman of the privy chamber to King Charles I. and afterwards secretary of state. Before the assembling of the long parliament, he had devoted himself to literature, and every pleasure which a fine genius, a generous disposition, and an opulent fortune, could afford: when called into public life, he stood foremost in all attacks on the high prerogatives of the crown; but when civil convulsions came to an extremity, and it was necessary to choose a side, he tempered his zeal, and defended the limited powers that remained to monarchy. Still anxious, however, for his country, he seems to have dreaded equally the prosperity of the royal party, and that of the parliament; and among his intimate friends, often sadly reiterated the word *peace*. This excellent nobleman freely exposed his person for the king in all hazardous enterprises, and was killed in the 34th year of his age at the battle of Newberry. In Wellwood's Memoirs we are told, that whilst he was with the king at Oxford, his majesty went one day to see the public library, where he was shown among other books a Virgil, nobly printed, and exquisitely bound. The Lord Falkland, to divert the king, would have his majesty make a trial of his fortune by the Sortes Virgilianæ, an usual kind of divination in ages past, made by opening a Virgil. The king opening the book, the passage which happened to come up, was that part of Dido's imprecation against Æneas, iv. 615, &c. which is thus translated by Dryden:

"Oppress'd with numbers in th' unequal field,
"His men discourag'd, and himself expell'd;
"Let him for succour sue from place to place,
"Torn from his subjects and his son's embrace." &c.

King Charles seeming concerned at this accident, the Lord Falkland, who observed it, would likewise try his own fortune in the same manner, hoping he might fall upon some passage that could have no relation to his case, and thereby divert the king's thoughts from any impression the other might make upon him: but the place Lord Falkland stumbled upon was yet more suited to his destiny than the other had been to the king's; being the following expressions of Evander, upon the untimely death of his son Pallas, Æn. xi. 152.

"O Pallas! thou hast fail'd thy plighted word;
"To fight with caution, not to tempt the sword;
"I warn'd thee, but in vain; for well I knew
"What perils youthful ardour would pursue;
"That boiling blood would carry thee too far;
"Young as thou wert in dangers, raw to war.
"O curst essay of arms, disastrous doom,
"Prelude of bloody fields and fights to come!"

He wrote several things both poetical and political; and in some of the king's declarations, supposed to be penned by Lord Falkland, we find the first regular definition of the English constitution that occurs in any composition published by authority. His predecessor, the first Viscount Cary, was ennobled for being the first who gave King James an account of Queen Elizabeth's death.

CARY, *Robert*, a learned English chronologer, born in Devonshire about the year 1615. On the Restoration, he was preferred to the archdeaconry of Exeter, but on some pretext was ejected in 1664, and spent the rest of his days at his rectory of Portlemoth, where he died in 1688. He published *Palælogia Chronica*, a chronology of ancient times, in three parts, didactical, apodeictical, and canonical; and translated the hymns of the church into Latin verse.

CARYA, -Æ, (Stephanus); *Caryæ*, *-arum*, (Pausanius); a town of Laconia, between Sparta and the borders of Messenia; where stood a temple of Diana, thence called *Caryatis*, *-idis*; whose annual festival, called *Carya*, *-orum*, was celebrated by Spartan virgins with dances. An inhabitant, *Caryates*, and *Caryatis*, *Caryatis apis*, a Laconian bee, (Stephanus).

CARYÆ, *-arum*, in *Ancient Geography*, a place in Arcadia, towards the borders of Laconia. Whether from this of Arcadia, or that of Laconia, the *columnæ caryatides* of Vitruvius and Pliny (which were statues of matrons in stoles or long robes) took the appellation, is disputed.

CARYTES, in antiquity, a festival in honour of Diana, surnamed *Caryatis*, held at Caryum, a city of Laconia. The chief ceremony was a certain dance said to have been invented by Castor and Pollux, and performed by the virgins of the place. During Xerxes's invasion, the Laconians not daring to appear and celebrate the customary solemnity, to prevent incurring the anger of the goddess by such an intermission, the neighbouring swains are said to have assembled and sung pastorals or *bucolismi*, which is said to have been the origin of *bucolic* poetry.

CARYATIDES, or CARIATES. See ARCHITECTURE.

CARYL, JOSEPH, a divine of the last century, bred at Oxford, and some time preacher to the society of Lincoln's-inn, an employment he filled with much applause. He became a frequent preacher before the long parliament, a licenser of their books, one of the assembly

assembly of divines, and one of the triers for the approbation of ministers; in all which capacities he showed himself a man of considerable parts and learning, but with great zeal against the king's person and cause. On the restoration of Charles II. he was silenced by the act of uniformity, and lived privately in London, where, besides other works, he distinguished himself by a laborious *Exposition of the Book of Job;* and died in 1672.

CARYLL, John, a late English poet, was of the Roman Catholic persuasion, being secretary to Queen Mary the wife of James II. and one who followed the fortunes of his abdicating master; who rewarded him, first with knighthood, and then with the honorary titles of Earl Caryll and Baron Dartford. How long he continued in that service is not known; but he was in England in the reign of Queen Anne, and recommended the subject of the "Rape of the Lock" to Mr Pope, who at its publication addressed it to him. He was also the intimate friend of Pope's "Unfortunate Lady." He was the author of two plays: 1. "The English Princess, or the Death of Richard III. 1667," 4to; 2. "Sir Salomon, or the Cautious Coxcomb, 1671," 4to; and in 1700, he published "The Psalms of David, translated from the Vulgate," 12mo. In Tonson's edition of Ovid's Epistles, that of "Briseis to Achilles" is said to be by Sir John Caryll; and in Nichols's Select Collection of Miscellany Poems, vol. ii. p. 1. the first eclogue of Virgil is translated by the same ingenious poet. He was living in 1717, and at that time must have been a very old man. See three of his letters in the "Additions to Pope," vol. ii. p. 114.

CARYOCAR, in *Botany*, a genus of the tetragynia order, belonging to the polyandria class of plants. The calyx is quinquepartite, the petals five, the styles more frequently four. The fruit is a plum, with nucleusses, and four furrows netted.

CARYOPHYLLÆI, in *Botany*, the name of a very numerous family or order in Linnæus's Fragments of a Natural Method; containing, besides the class of the same name in Tournefort, many other plants, which from their general appearance seem pretty nearly allied to it. The following are the genera, viz. Agrostema, Cacubalus, Dianthus, Drypis, Gypsophilia, Lychnis, Saponaria, Silene, Velazia, Alsine, Arenaria, Bufonia, Cerastium, Cherleria, Glinus, Holosteum, Loeflingia, Mochringia, Polycarpen, Sagina, Spergula, Stellaria, Minuartia, Mollugo, Ortegia, Pharnaceum, Queria. All the plants of this order are herbaceous, and mostly annual. Some of the creeping kinds do not rise an inch, and the tallest exceed not seven or eight feet. See Botany, *Natural Orders.*

CARYOPHYLLUS, the Pink, in *Botany*. See Dianthus.

Caryophyllus, the Clove tree. See Botany *Index.*

The caryophyllus aromaticus is a native of the Molucca islands, particularly of Amboyna, where it is principally cultivated. The clove tree resembles in its bark the olive, and is about the height of the laurel, which it also resembles in its leaves. No verdure is ever seen under it. It has a great number of branches, at the extremities of which are produced vast quantities of flowers, that are first white, then green, and at last pretty red and hard. When they arrive at this degree of maturity, they are, properly speaking, *cloves.* As they dry, they assume a dark yellowish cast; and when gathered, become of a deep brown. The season for gathering the cloves is from October to February. The boughs of the trees are then strongly shaken, or the cloves beat down with long reeds. Large cloths are spread to receive them, and they are afterwards either dried in the sun or in the smoke of the bamboo cane. The cloves which escape the notice of those who gather them, or are purposely left upon the tree, continue to grow till they are about an inch in thickness; and these falling off, produce new plants, which do not bear in less than eight or nine years. Those which are called *mother cloves* are inferior to the common sort; but are preserved in sugar by the Dutch; and in long voyages, eaten after their meals, to promote digestion.

The clove, to be in perfection, must be full sized, heavy, oily, and easily broken; of a fine smell, and of a hot aromatic taste, so as almost to burn the throat. It should make the fingers smart when handled, and leave an oily moisture upon them when pressed. In the East Indies, and in some parts of Europe, it is so much admired as to be thought an indispensable ingredient in almost every dish. It is put into their food, liquors, wines, and enters likewise the composition of their perfumes. Considered as medicines, cloves are very hot stimulating aromatics, and possess in an eminent degree the general virtues of substances of this class. Their pungency resides in their resin; or rather in a combination of resin with essential oil: for the spirituous extract is very pungent; but if the oil and the resin contained in this extract are separated from each other by distillation, the oil will be very mild; and any pungency which it does retain, proceeds from some small portion of adhering resin, and the remaining resin will be insipid. No plant, or part of any plant, contains such a quantity of oil as cloves do. From 16 ounces Newman obtained by distillation two ounces and two drachms, and Hoffman obtained an ounce and a half of oil from two ounces of the spice. The oil is specifically heavier than water. Cloves acquire weight by imbibing water; and this they will do at some considerable distance. The Dutch, who trade in cloves, make a considerable advantage by knowing this secret. They sell them always by weight; and when a bag of cloves is ordered, they hang it, for several hours before it is sent in, over a vessel of water, at about two feet distance from the surface. This will add many pounds to the weight, which the unwary purchaser pays for on the spot. This is sometimes practised in Europe, as well as in the Spice islands; but the degree of moisture must be more carefully watched in the latter; for there a bag of cloves will, in one night's time, attract so much water, that it may be pressed out of them by squeezing them with the hand.

The clove tree is never cultivated in Europe. At Amboyna the Company have allotted the inhabitants 4000 parcels of land, on each of which they were at first allowed, and about the year 1720 compelled, to plant about 125 trees, amounting in all to 500,000. Each of these trees produces annually, on an average, more than two pounds of cloves; and consequently the collective produce must weigh more than a million.

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lion. The cultivator is paid with the specie that is constantly returned to the Company, and receives some unbleached cottons which are brought from Coromandel.

CARYOTA. See BOTANY *Index*.

CASA, in ancient and middle-age writers, is used to denote a cottage or house.

CASA, Santa, denotes the chapel of the holy virgin at Loretto. The *Santa Casa* is properly the house, or rather chamber, in which the blessed virgin is said to have been born, where she was betrothed to her spouse Joseph, where the angel saluted her, the Holy Ghost overshadowed her, and by consequence where the Son of God was conceived or incarnated. Of this building the Catholics tell many wonderful stories too childish to transcribe. The *Santa Casa*, or holy chamber, consists of one room, forty-four spans long, eighteen broad, and twenty-three high. Over the chimney, in a niche, stands the image called the great *Madona* or Lady, four feet high, made of cedar, and, as they say, wrought by St Luke, who was a carver as well as a physician. The mantle or robe she has on, is covered with innumerable jewels of inestimable value. She has a crown, given her by Louis XIII. of France, and a little crown for her son.

CASAL, a strong town of Italy in Montserrat, with a citadel and a bishop's see. It was taken by the French from the Spaniards in 1640; and the duke of Mantua sold it to the French in 1681. In 1695 it was taken by the allies, who demolished the fortifications; but the French retook it, and fortified it again. The king of Sardinia became master of it in 1706, from whom the French took it in 1745; however the king of Sardinia got possession again in 1746. It is seated on the river Po, and contains 15,000 inhabitants. E. Long. 8. 37. N. Lat. 45. 12.

CASAL-Maggiore, a small strong town of Italy, in the duchy of Milan, seated on the river Po. E. Long. 11. 5. N. Lat. 45. 6.

CASA NOVA, MARC ANTONY, a Latin poet, born at Rome, succeeded particularly in epigrams. The poems he composed in honour of the illustrious men of Rome are also much esteemed. He died in 1527.

CASAN, a considerable town of Asia, and capital of a province of the same name in the Russian empire, with a strong castle, a citadel, and an archbishop's see. The country about it is very fertile in all sorts of fruits, corn, and pulse. It carries on a great trade in furs, and furnishes wood for the building of ships. The fortress is built of stone; but the town is of wood. The inhabitants amount to 17,500. Besides several schools, it has a university, founded in 1803. E. Long. 49. 25. N. Lat. 55. 38.

CASAS, BARTHOLOMEW DE LAS, bishop of Chiapa, distinguished for his humanity and zeal for the conversion of the Indians, was born at Seville in 1474: and went with his father who sailed to America with Christopher Columbus in 1493. At his return to Spain, he embraced the state of an ecclesiastic, and obtained a curacy in the island of Cuba: but some time after quitted his cure in order to procure liberty for the Indians, whom he saw treated by the Spaniards in the most cruel and barbarous manner; which naturally gave them an unconquerable aversion to Christianity. Bartholomew exerted himself with extraordinary zeal, for 50 years together, in his endeavours to persuade the Spaniards that they ought to treat the Indians with equity and mildness; for which he suffered a number of persecutions from his countrymen. At last the court, moved by his continual remonstrances, made laws in favour of the Indians, and gave orders to the governors to observe them, and see them executed.* He died at Madrid in 1566, aged 92. He wrote several works, which breathe nothing but humanity and virtue. The principal of them are, 1. An account of the destruction of the Indies. 2. Several treatises in favour of the Indies, against Dr Sepulveda, who wrote a book to justify the inhuman barbarities committed by the Spaniards. 3. A very curious and now scarce work in Latin, on this question, "Whether kings or princes can, consistently with conscience, or in virtue of any right or title, alienate their subjects, and place them under the dominion of another sovereign?

* See the article *Mexico*.

CASATI, PAUL, a learned Jesuit, born at Placentia in 1617, entered early among the Jesuits; and after having taught mathematics and divinity at Rome, was sent into Sweden to Queen Christina, whom he prevailed on to embrace the Popish religion. He wrote, 1. *Vacuum proscriptum*. 2. *Terra machinis mota*. 3. *Mechanicorum, libri octo*. 4. *De Igne Dissertationes*, which is much esteemed. 5. *De Angelis Disputatio Theolog*. 6. *Hydrostaticæ Dissertationes*. 7. *Opticæ Disputationes*. It is remarkable that he wrote this treatise on optics at 88 years of age, and after he was blind. He also wrote several books in Italian.

CASAUBON, ISAAC, was born at Geneva in 1559; and Henry IV. appointed him his library keeper in 1603. After this prince's death, he went to England with Sir Henry Wotton, ambassador from King James I. where he was kindly received, and engaged in writing against Baronius's annals. He died not long after this, in 1614; and was interred in Westminster-abbey, where a monument was erected to him. He was greatly skilled in the Greek, and in criticism; published several valuable commentaries; and received the highest eulogiums from all his cotemporaries.

CASAUBON, *Meric*, a son of the preceding, was born at Geneva in 1599. He was bred at Oxford, and took the degree of master of arts in 1621. The same year he published a book in defence of his father against the calumnies of certain Roman Catholics, which gained him the favour of King James I. and a considerable reputation abroad. He was made prebendary of Canterbury by Archbishop Laud. In the beginning of the civil war he lost all his spiritual promotions, but still continued to publish excellent works. Oliver Cromwell, then lieutenant-general of the parliament's forces, would have employed his pen in writing the history of the late war; but he declined it, owning that this subject would oblige him to make such reflections as would be ungrateful, if not injurious, to his lordship. Notwithstanding this answer, Cromwell, sensible of his worth, ordered three or four hundred pounds to be paid him by a bookseller in London, whose name was Cromwell, on demand, without requiring from him any aknowledgment of his benefactor. But this offer he rejected, though his circumstances were then mean. At the same time it was proposed by his friend Mr Greaves,

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Greaves, who belonged to the library at St James's, that, if Casaubon would gratify Cromwell in the request above mentioned, all his father's books, which were then in the royal library, having been purchased by King James, should be restored to him, and a pension of 300l. a year paid to the family as long as the youngest son of Dr Casaubon should live; but this also was refused. He likewise refused handsome offers from Christina queen of Sweden, being determined to spend the remainder of his life in England. At the Restoration he recovered all his preferments, and continued writing till his death in 1671. He was the author of an English translation of Marcus Aurelius Antoninus's Meditations, and of Lucius Florus; editions of several of the classics, with notes; a treatise of use and custom; a treatise of enthusiasm; with many other works; and he left a number of MSS. to the university of Oxford.

CASAURINA. See BOTANY *Index*.

CASCADE, a steep fall of water from a higher into a lower place. The word is French, formed of the Italian *cascata*, which signified the same; of *cascaro*, "to fall," and that from the Latin *cadere*.

Cascades are neither natural, as that at Tivoli, &c.; or artificial, as those of Versailles, &c.; and either falling with a gentle descent, as those of Sceaux; or in form of a buffet, as at Trianon; or down steps, in form of a perron, as at St Cloud; or from bason to bason, &c.

CASCAIS, a town of Estremadura in Portugal, situated at the mouth of the river Tagus, 17 miles east of Lisbon. W. Long. 10. 15. N. Lat, 38. 40.

CASCARILLA. See CLUTIA and CROTON.

CASE, among grammarians, implies the different inflections or terminations of nouns, serving to express the different relations they bear to each other; and to the things they represent. See GRAMMAR.

CASE also denotes a receptacle for various articles; as a case of knives, of lancets, of pistols, &c.

CASE, in printing, a large flat oblong frame, placed aslope, divided into several compartments or little square cells; in each of which are lodged a number of types or letters of the same kind, whence the compositor takes them out, each as he needs it, to compose his matter. See PRINTING.

CASE is also used for a certain numerous quantity of divers things. Thus a case of crown glass contains usually 24 tables, each table being nearly circular, and about three feet six inches diameter; of Newcastle glass, 35 tables; of Normandy glass, 25.

Case-Hardening of Iron, is a superficial conversion of that metal into steel, by the ordinary method of conversion, namely, by cementation with vegetable or mineral coals. This operation is generally practised upon small pieces of iron, wrought into tools and instruments to which a superficial conversion is sufficient; and it may be performed conveniently by putting the pieces of iron to be case-hardened, together with the cement, into an iron box, which is to be closely shut and exposed to a red heat during some hours. By this cementation a certain thickness from the surface of the iron will be converted into steel, and a proper hardness may be afterwards given by sudden extinction of the heated pieces of converted iron in a cold fluid. See STEEL.

Case-Shot, in the military art, musket balls, stones, old iron, &c. put into cases, and shot out of great guns.

CASEMENT, or CASEMATE, in *Architecture*, a hollow moulding, which some architects make one-sixth of a circle, and others one fourth.

CASEMENT is also used in building, for a little moveable window, usually within a larger, being made to open or turn on hinges.

CASERN, in fortification, lodgings built in garrison towns, generally near the rampart, or in the waste places of the town for lodging soldiers of the garrison. There are usually two beds in each casern for six soldiers to lie, who mount the guard alternately; the third part being always on duty.

CASERTA, an episcopal town of Italy, in the kingdom of Naples, and in the Terra de Lavoro, with the title of a duchy, seated at the foot of a mountain of the same name, in E. Long. 15. 5. N. Lat. 41. 5.

CASES, PETER-JAMES, of Paris, the most eminent painter of the French school. The churches of Paris and of Versailles abound with his works. He died in 1754, aged 79.

CASH, in a commercial style, signifies the stock or ready money which a merchant or other person has in his present disposal to negotiate; so called from the French term *caisse*, i. e. "chest or coffer," for the keeping of money.

M. Savary shows that the management of the cash of a company is the most considerable article, and that whereon its good or ill success depends.

Cash-Book. See BOOK-KEEPING.

CASHEL, or CASHIL, a town of Ireland in the county of Tipperary, and province of Munster, with an archbishop's see. The ruins of the old cathedral testify its having been an extensive as well as handsome Gothic structure, boldly towering on the celebrated rock of Cashel, which taken together form a magnificent object, and bear honourable testimony to the labour and ingenuity, as well as the piety and zeal, of its former inhabitants. It is seen at a great distance and in many directions. Adjoining it are the ruins of the chapel of Cormac M'Culinan, at once king and archbishop of Cashel, supposed to have been the first stone building in Ireland; and seems, by its rude imitation of pillars and capitals, to have been copied after the Grecian architecture, and long to have preceded that which is usually called *Gothic*. Cormac M'Culinan was a prince greatly celebrated by the Irish historians for his learning, piety, and valour. He wrote, in his native language, a history of Ireland, commonly called the *Psalter of Cashel*, which is still extant, and contains the most authentic account we have of the annals of the country to that period, about the year 900. On the top of the rock of Cashel, and adjoining the cathedral, is a lofty round tower, which proudly defied the two successful attempts of Archbishop Price, who in this century unroofed and thereby demolished the ancient cathedral founded by St Patrick. In the choir are the monuments of Myler Magrath, archbishop of this see, in the reign of Queen Elizabeth, and some other curious remains of antiquity. Cashel was formerly the royal seat and metropolis of the kings of Munster; and on the ascent to the cathedral is a large stone on

which

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which every new king of Munster was, as the inhabitants report from tradition, formerly proclaimed. Cashel is smaller than it once was, containing only about 600 houses. The archbishop's palace is a fine building. Here is a very handsome market house, a sessions house, the county infirmary, a charter school for twenty boys and the same number of girls, and a very good barrack for two companies of foot. Dr Agar finished a very elegant church which was begun by his predecessor. W. Long. 7. 36. N. Lat. 52. 16.

CASHEW NUT. See ANACARDIUM, BOTANY *Index*.

CASHIER, the cash-keeper; he who is charged with the receiving and paying the debts of a society. In the generality of foundations, the cashier is called *treasurer*.

CASHIERS of the Bank, are officers who sign the notes that are issued out, and examine and mark them when returned for payment.

CASHMIRE, a province of India, for a long time belonging to Hindostan, but now an appendage of Afghanistan. It is about 90 miles in length, and nearly of an oval form, situated chiefly between 34 and 35 degrees of north latitude, and between 73 and 76 degrees of east longitude. Being girt in by a zone of hills, and elevated very considerably above an arid plain, which stretches many miles around it, the scenes which it exhibits are wild and picturesque. Rivers, hills, and valleys, charmingly diversify the landscape. Here, Mr Sullivan * informs us, a cascade rushes from a foaming precipice; there a tranquil stream glides placidly along; the tinkling rill, too, sounds amidst the groves; and the feathered choristers sing the song of love, close sheltered in the shade.

* *Philosophical Rhapsodies.*

At what time Cashmire came under the dominion of the Mogul government, and how long and in what manner it was independent, before it was annexed to the territories of the house of Timur, are points that are beyond our present purpose. Though inconsiderable as to its revenues, it was uniformly held in the highest estimation by the emperors of Hindostan. Thither they repaired in the plenitude of their greatness, when the affairs of the state would admit of their absence; and there they divested themselves of form, and all the oppressive ceremony of state. The royal manner of travelling to Cashmire was grand, though tedious and unwieldy, and showed, in an eminent degree, the splendour and magnificence of an eastern potentate. Aurengzebe, we are told, seldom began his march to that country, for a march certainly it was to be called, without an escort of 80,000 or 100,000 fighting men, besides the gentlemen of his household, the attendants of his seraglio, and most of his officers of state. These all continued with him during the time he was on the road, which generally was a month; but no sooner was he arrived at the entrance of those aerial regions, than, with a select party of friends, he separated from the rest of his retinue, and with them ascended the defiles which led him to his Eden.

The temperature of the air of Cashmire, elevated as it is so much above the adjoining country, together with the streams which continually pour from its mountains, enables the husbandman to cultivate with success the soil he appropriates to agriculture; whilst the gardener's labour is amply repaid in the abundant produce of his fruit. In short, nature wears her gayest clothing in this enchanting spot. The rivers supply the inhabitants with almost every species of fish; the hills yield sweet herbage for the cattle; the plains are covered with grain of different denominations; and the woods are stored with variety of game. The Cashmireans, according to our author, seem a race distinct from all the others in the east: Their persons are more elegant, and their complexions more delicate and more tinged with red.

On the decadence of the Mogul power in Hindostan, Cashmire felt some of the ravages of war. The inhabitants are sprightly and ingenious, and manufacture a beautiful species of shawls much valued in India. They are all Mahometans or idolaters. Cashmire is the capital town.

CASIMIR, the name of several kings of Poland. See (*History of*) POLAND.

CASIMIR, *Matthias Sorbiewski*, a Polish Jesuit, born in 1597. He was a most excellent poet; and is, says M. Baillet, an exception to the general rule of Aristotle and the other ancients, which teaches us to expect nothing ingenious and delicate from northern climates. His odes, epodes, and epigrams, have been thought not inferior to those of the finest wits of Greece and Rome. Dr Watts has translated one or two of his small pieces, which are added to his Lyric Poems. He died at Warsaw in 1640, aged 43. There have been many editions of his poems, the best of which is that of Paris, 1759.

CASING *of* TIMBER WORK, among builders, is the plastering the house all over the outside with mortar, and then striking it while wet, by a ruler, with the corner of a trowel, to make it resemble the joints of freestone. Some direct it to be done upon heart-laths, because the mortar would, in a little time, decay the sap-laths; and to lay on the mortar in two thicknesses, viz. a second before the first is dry.

CASIRI, MICHAEL, a learned orientalist, a native of Syria. See SUPPLEMENT.

CASK, or CASQUE, a piece of defensive armour wherewith to cover the head and neck; otherwise called the *head-piece* and *helmet* *. The word is French, *casque*, from *cassicum* or *cassicus*, a diminutive of *cassis* "a helmet." Le Gendre observes, that anciently, in France, the gens d'armes all wore *casks*. The king wore a *cask* gilt; the dukes and counts silvered; gentlemen of extraction polished steel; and the rest plain iron.

* See *Helmet*.

The cask is frequently seen on ancient medals, where we may observe great varieties in the form and fashion thereof; as the Greek fashion, the Roman fashion, &c. F. Joubert makes it the most ancient of all the coverings of the head, as well as the most universal. Kings, emperors, and even gods themselves, are seen therewith. That which covers the head of Rome has usually two wings like those of Mercury; and that of some kings is furnished with horns like those of Jupiter Ammon; and sometimes barely bulls or rams horns, to express uncommon force.

CASK, in *Heraldry*, the same with helmet. See HERALDRY, No. 45.

CASK, a vessel of capacity, for preserving liquors of divers kinds; and sometimes also dry goods, as sugar, almonds,

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Cask ‖ Caslon.

almonds, &c.—A cask of sugar is a barrel of that commodity, containing from eight to eleven hundred weight. A cask of almonds is about three hundred weight.

CASKET, in a general sense, a little coffer or cabinet. See CABINET.

CASKETS, in the sea language, are small ropes made of sinnet, and fastened to gromets, or little rings upon the yards; their use is to make fast the sail to the yard when it is to be furled.

Biog. Brit. and *Anecdotes of Bowyer*, by Nicholas.

CASLON, WILLIAM, eminent in an art of the greatest consequence to literature, the art of letter-founding, was born in 1692, in that part of the town of Hales Owen which is situated in Shropshire. Though he justly attained the character of being the Coryphæus in that employment, he was not brought up to the business; and it is observed by Mr Mores, that this handywork is so concealed among the artificers of it, that he could not discover that any one had taught it to another, but every person who had used it had learned it of his own genuine inclination. Mr Caslon served a regular apprenticeship to an engraver of ornaments on gun barrels; and after the expiration of his term, carried on this trade in Vine-street, near the Minories. He did not, however, solely confine his ingenuity to that instrument, but employed himself likewise in making tools for the bookbinders, and for the chasing of silver plate. Whilst he was engaged in this business, the elder Mr Bowyer accidentally saw, in a bookseller's shop, the lettering of a book uncommonly neat; and inquiring who the artist was by whom the letters were made, was hence induced to seek an acquaintance with Mr Caslon. Not long after, Mr Bowyer took Mr Caslon to Mr James's foundery, in Bartholomew-close. Caslon had never before that time seen any part of the business; and being asked by his friend, if he thought he could undertake to cut types, he requested a single day to consider the matter; and then replied that he had no doubt but he could. Upon this answer, Mr Bowyer, Mr Bettenham, and Mr Watts, had such a confidence in his abilities, that they lent him 500l. to begin the undertaking, and he applied himself to it with equal assiduity and success. In 1720, the society for promoting Christian knowledge, in consequence of a representation from Mr Solomon Negri, a native of Damascus in Syria, who was well skilled in the oriental tongues, and had been professor of Arabic in places of note, deemed it expedient to print, for the use of the Eastern churches, the New Testament and Psalter, in the Arabic language. These were intended for the benefit of the poor Christians in Palestine, Syria, Mesopotamia, Arabia, and Egypt, the constitution of which countries did not permit the exercise of the art of printing. Upon this occasion Mr Caslon was pitched upon to cut the fount; in his specimens of which he distinguished it by the name of English Arabic. Under the farther encouragement of Mr Bowyer, Mr Bettenham, and Mr Watts, he proceeded with vigour in his employment; and he arrived at length to such perfection, that he not only freed us from the necessity of importing types from Holland, but in the beauty and elegance of those made by him he so far exceeded the productions of the best artificers, that his workmanship was frequently exported to the continent. In short, his foundery became, in process of time, the most capital one that exists in this or in foreign countries. Having acquired opulence in the course of his employment, he was put into the commission of the peace for the county of Middlesex. Towards the latter end of his life, his eldest son being in partnership with him, he retired in a great measure from the active execution of business. His death happened in January 1766.

Caslon, Caspian sea.

CASPIAN SEA, a large lake of salt water in Asia, bounded by the province of Astracan on the north, and by part of Persia on the south, east, and west. It is 646 miles in length, 265 in breadth, and 2350 in circumference, including gulfs and bogs. This sea embraces between Astracan and Astrabad an incredible number of small islands. Its bottom is mud, but sometimes mixed with shells. At the distance of some German miles from land it is 500 fathoms deep; but on approaching the shore it is everywhere so shallow, that the smallest vessels, if loaded, are obliged to remain at a distance.

When we consider that the Caspian is enclosed on all sides by land, and that its banks are in the neighbourhood of very high mountains, we easily see why the navigation in it should be perfectly different from that in every other sea. There are certain winds that domineer over it with such absolute sway, that vessels are often deprived of every resource; and in the whole extent of it there is not a port that can truly be called safe. The north, north-east, and east winds, blow most frequently, and occasion the most violent tempests. Along the eastern shore the east winds prevail; for which reason vessels bound from Persia to Astracan always direct their course along this shore.

The surface of the Caspian sea is found to be 324 feet lower than the ocean. Although its extent is immense, the variety of its productions is exceedingly small. This undoubtedly proceeds from its want of communication with the ocean, which cannot impart to it any portion of its inexhaustible stores. But the animals which this lake nourishes multiply to such a degree, that the Russians, who alone are in condition to make them turn to account, justly consider them as a never-failing source of profit and wealth. It will be understood that we speak of the fish of the Caspian, and of its fisheries, which make the sole occupation and principal trade of the people inhabiting the banks of the Wolga and of the Jaik. This business is distinguished into the great and lesser fisheries. The fish comprehended under the first division, such as the sturgeon and others, abound in all parts of the Caspian, as well as in the rivers that communicate with it, and which they ascend at spawning time. The small fishes, such as the salmon and many others, observe the general law of quitting the salt waters for the fresh; nor is there an instance of one of them remaining constantly in the sea.

Seals are the only quadrupeds that inhabit the Caspian; but they are there in such numbers as to afford the means of subsistence to many people in that country as well as in Greenland. The varieties of the species are numerous, diversified however only by the colour. Some are quite black, others quite white; there are some whitish, some yellowish, some of a mouse colour, and some streaked like a tiger. They crawl by means of their fore feet upon the islands, where they become the prey of the fishermen, who kill them

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Caspian sea.

them with long clubs. As soon as one is dispatched, he is succeeded by several who come to the assistance of their unhappy companion, but come only to share his fate. They are exceedingly tenacious of life, and endure more than thirty hard blows before they die. They will even live for several days after having received many mortal wounds. They are most terrified by fire and smoke; and as soon as they perceive them, retreat with the utmost expedition to the sea. These animals grow so very fat, that they look rather like oil bags than animals. At Astracan is made a sort of gray soap with their fat mixed with pot-ashes, which is much valued for its property of cleansing and taking grease from woollen stuffs. The greatest numbers of them are killed in spring and autumn. Many small vessels go from Astracan merely to catch seals.

If the Caspian has few quadrupeds, it has in proportion still fewer of those natural productions which are looked upon as proper only to the sea. There have never been found in it any zoophytes, nor any animal of the order of mollusca. The same may almost be said of shells; the only ones found being three or four species of cockle, the common muscle, some species of snails, and one or two others.

But to compensate this sterility, it abounds in birds of different kinds. Of those that frequent the shores, there are many species of the goose and duck kind, of the stork and heron, and many others of the water tribe. Of birds properly aquatic, it contains the grebe, the crested diver, the pelican, the cormorant, and almost every species of gull. Crows are so fond of fish, that they haunt the shores of the Caspian in prodigious multitudes.

The waters of this lake are very impure, the great number of rivers that run into it, and the nature of its bottom, affecting it greatly. It is true, that in general the waters are salt: but though the whole western shore extends from the 46th to the 35th degree of north latitude; and though one might conclude from analogy that these waters would contain a great deal of salt, yet experiments prove the contrary; and it is certain, that the saltness of this sea is diminished by the north, north-east, and north-west winds; although we may with equal reason conclude, that it owes its saltness to the mines of salt which lie along its two banks, and which are either already known, or will be known to posterity. The depth of these waters also diminishes gradually as you approach the shores, and their saltness in the same way grows less in proportion to their proximity to the land, the north winds not unfrequently causing the rivers to discharge into it vast quantities of troubled water impregnated with clay. These variations which the sea is exposed to are more or less considerable, according to the nature of the winds; they affect the colour of the river waters to a certain distance from the shore, till these mixing with those of the sea, which then resume the ascendancy, the fine green colour appears, which is natural to the ocean, and to all those bodies of water that communicate with it.

It is well known, that, besides its salt taste, all sea water has a sensible bitterness, which must be attributed not only to the salt itself, but to the mixture of different substances that unite with it, particularly to different sorts of alum, the ordinary effect of different combinations of acids. Besides this, the waters of the Caspian have another taste, bitter too, but quite distinct, which affects the tongue with an impression similar to that made by the bile of animals; a property which is peculiar to this sea, though not equally sensible at all seasons. When the north and north-west winds have raged for a considerable time, this bitter taste is sensibly felt; but when the wind has been south, very imperfectly. We shall endeavour to account for this phenomenon.

The Caspian is surrounded on its western side by the mountains of Caucasus, which extend from Derbent to the Black sea. These mountains make a curve near Astracan, and directing their course towards the eastern shore of the Caspian, lose themselves near the mouth of the Jaik, where they become secondary mountains, being disposed in strata. As Caucasus is an inexhaustible magazine of combustible substances, it consequently lodges an astonishing quantity of metals in its bowels. Accordingly, along the foot of this immense chain of mountains, we sometimes meet with warm springs, sometimes springs of naphtha of different quality; sometimes we find native sulphur, mines of vitriol, or lakes heated by internal fires. Now the foot of Mount Caucasus forming the immediate western shore of the Caspian sea, it is very easy to imagine that a great quantity of the constituent parts of the former must be communicated to the latter: but it is chiefly to the naphtha, which abounds so much in the countries which surround this sea, that we must attribute the true cause of the bitterness peculiar to its waters; for it is certain that this bitumen flows from the mountains, sometimes in all its purity, and sometimes mixed with other substances which it acquires in its passage through subterranean channels, from the most interior parts of these mountains to the sea, where it falls to the bottom by its specific gravity. It is certain, too, that the north and north-west winds detach the greatest quantities of this naphtha; whence it is evident that the bitter taste must be most sensible when these winds prevail. We may also comprehend why this taste is not so strong at the surface or in the neighbourhood of the shore, the waters there being less impregnated with salt, and the naphtha, which is united with the water by the salt, being then either carried to a distance by the winds, or precipitated to the bottom.

But it is not a bitter taste alone that the naphtha communicates to the waters of the Caspian: these waters were analysed by M. Gmelin, and found to contain, besides the common sea salt, a considerable proportion of Glauber salt, intimately united with the former, and which is evidently a production of the naphtha.

As the waters of the Caspian have no outlet, it has been supposed that they are discharged by subterranean canals; but this is shewn to be incredible, by the lower level of this sea. The two great deserts which extend from it to the east and west are chiefly composed of a saline earth, in which the salt is formed by efflorescence into regular crystals; for which reason salt showers and dews are exceedingly common in that neighbourhood. The salt of the marshes at Astracan, and that found in efflorescence in the deserts, is by no means pure sea salt, but much debased

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based by the bitter Glauber salt we mentioned above. In many places indeed it is found with crystals of a lozenge shape, which is peculiar to it, without any cubical appearance, the form peculiar to crystals of sea salt.

A great deal has been written on the successive augmentation and decrease of the Caspian sea, but with little truth. There is indeed to be perceived in it a certain rise and fall of its waters; in which, however, no observation has ever discovered any regularity.

Many suppose (and there are strong presumptions in favour of the supposition), that the shores of the Caspian were much more extensive in ancient times than they are at present, and that it once communicated with the Black sea. It is probable, too, that the level of this last sea was once much higher than it is at present. If then it be allowed, that the waters of the Black sea, before it procured an exit by the straits of Constantinople, rose several fathoms above their present level, which from many concurring circumstances may easily be admitted, it will follow, that all the plains of the Crimea, of the Kuman, of the Wolga, and of the Jaik, and those of Great Tartary beyond the lake of Aral, in ancient times formed but one sea, which embraced the northern extremity of Caucasus by a narrow strait of little depth; the vestiges of which are still obvious in the river Mantysch.

CASQUE, or Cask. See Cask.

CASSADA. See Jatropha; Botany *Index*.

CASSANA, Nicolo, called Nicoletto, an eminent Italian painter, was born at Venice in 1659, and became a disciple of his father Giovanni Francesco Cassana, a Genoese, who had been taught the art of painting by Bernardino Strozzi. He soon distinguished himself, not only by the beauty of his colouring, but by the gracefulness of his figures in historical compositions, as well as in portrait. The most eminent personages solicited him to enrich their cabinets with some of his performances; and were more particularly desirous to obtain their portraits, because in that branch he excelled beyond competition. The grand duke of Tuscany, who was an excellent judge of merit in all professons, and as liberal an encourager of it, invited Nicoletto to his court; and he there painted the portraits of that prince and the Princess Violante his consort. These performances procured him uncommon applause, as well as a noble gratuity, and he was employed and caressed by the principal nobility of Florence. Beside several historical subjects painted by this master while he resided in that city, one was a very capital design. The subject of it was the *Conspiracy of Catiline;* it consisted of nine figures as large as life, down to the knees; and the two principal figures were represented as with one hand joined in the presence of their companions, and in their other hand holding a cup of blood. Some of the English nobility on their travels sat to him for their portraits; which being sent to London, and highly admired, Nicoletto was invited to England, with strong assurances of a generous reception; and on his arrival he experienced the kindness, the respect, and the liberality, so peculiar to the natives of that kingdom. He had the honour of being introduced to the presence of Queen Anne, and to paint her portrait: in which he succeeded so happily, that the Queen distinguished him by many marks of favour and honour; but he had not the happiness to enjoy his good fortune for any length of time, dying in London, universally regretted, in the year 1713.

Cassana, *Giovanni Agostino*, called *L'Abate Cassana*, was brother to the preceding, and born in 1664. He was educated along with him by their father Francesco Cassana, and he finished his studies at Venice, where his brother Nicoli resided for some time. Although he composed and designed historical subjects with expertness, and with a correctness of outline equal to his brother; yet, from prudence and fraternal affection, he declined to interfere with him, and chose therefore to design and paint all sorts of animals and fruits. In that style he arrived at a high degree of excellence, imitating nature with exactness, beauty, and truth; expressing the various plumage of his birds, and the hairs of the different animals, with such tenderness and delicacy as rendered them estimable to all judges and lovers of the art. His works were admitted into the collections of those of the first rank, and accounted ornaments of those repositories of what is curious or valuable. He also painted fruits of those kinds which were the most uncommon, or naturally of odd and singular colours; and such fishes as seemed worthy to excite admiration by their unusual form, colour, or appearance. But, besides those subjects, he sometimes painted the portraits of particular persons of distinction, which he designed, coloured, and touched, with the same degree of merit that was visible in all his other performances. At last he determined to visit Genoa, where his family had lived in esteem; and took with him several pictures which he had already finished. His intention was to display his generosity, and to appear as a person of more wealth, and of greater consequence than he really was; and, to support that character, he bestowed his pictures on several of the principal nobility of that city. But, unhappily, he experienced no grateful return for all that prodigal munificence; he reduced himself by that vain liberality to the most necessitous circumstances; was deprived of the means to procure for himself even the common necessaries of life; and wasted away the remainder of his days in the bitterness of poverty, misery, and neglect.

CASSANDER, king of Macedon after Alexander the Great, was the son of Antipater. He made several conquests in Greece, abolished democracy at Athens, and gave the government of that state to the orator Demetrius. Olympias, the mother of Alexander, having caused Aridæus and his wife Eurydice, with others of Cassander's party, to be put to death, he besieged Pydne, whither the queen had retired, took it by a stratagem, and caused her to be put to death. He married Thessalonica, the sister of Alexander the Great; and killed Roxana and Alexander, the wife and son of that conqueror. At length he entered into an alliance with Seleucus and Lysimachus, against Antigonus and Demetrius; over whom he obtained a great victory near Ipsus in Phrygia, 301 years before the Christian era, and died three years after, in the 19th year of his reign.

CASSANDRA, in fabulous history, the daughter of Priam and Hecuba, was beloved of Apollo, who promised to bestow on her the spirit of prophecy, provided

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vided she would consent to his love. Cassandra seemed to accept the proposal; but had no sooner obtained that gift, than she laughed at the tempter, and broke her word. Apollo, being enraged, revenged himself, by causing no credit to be given to her predictions, hence she in vain prophesied the ruin of Troy. Ajax, the son of Oileus, having ravished her in the temple of Minerva, he was struck with thunder. She fell into the hands of Agamemnon, who loved her to distraction; but in vain did she predict that he would be assassinated in his own country. He was killed, with her, by the intrigues of Clytemnestra; but their death was avenged by Orestes.

CASSANO, a town of Italy in the duchy of Milan, rendered remarkable by an obstinate battle fought there between the Germans and French in 1705. It is subject to the house of Austria, and is seated on the river Adda, in E. Long. 10. 0. N. Lat. 45. 20.

CASSANO, a town of Italy in Calabria Citerior, in the kingdom of Naples, with a bishop's see. E. Long. 16. 30. N. Lat. 39. 55.

CASSAVI, or CASSADA. See JATROPHA, BOTANY *Index*.

CASSEL, a town of French Flanders, in the department of the North. It contains 3600 inhabitants, and is seated on a mountain; and from whence there is one of the finest prospects in the world; for one may see no less than 32 towns, with a great extent of the sea, from whence it is distant 15 miles. E. Long. 2. 27. N. Lat. 50. 48.

CASSEL, the capital city of the landgravate of Hesse Cassel, in the circle of the Upper Rhine in Germany; (see HESSE CASSEL). It is divided into the Old, New, and High Towns. The New Town is best built, the houses being of stone, and the streets broad. The houses of the Old Town, which is within the walls, are mostly of timber; but the streets are broad, and the market places spacious. The place is strongly fortified, but the fortifications are not regular. It contained 20,300 inhabitants in 1810, and was the capital of the kingdom of Westphalia till 1814. There are several manufactories in the place, particularly in the woollen branch. It is seated on the declivity of a hill near the river Fulva, in E. Long. 9. 28. N. Lat. 51. 20.

CASSIA. See BOTANY *Index*.

CASSIA Lignea. See LAURUS.

CASSIDA. See SCUTELLARIA, BOTANY *Index*.

CASSIDA, in *Zoology*, a genus of insects belonging to the order of coleoptera. See ENTOMOLOGY *Index*.

CASSIMER, or CASIMER, the name of a thin tweeled woollen cloth, much in fashion for summer use.

CASSIMIRE, or CASHMIRE. See CASHMIRE.

CASSINE. See BOTANY *Index*. The Spaniards who live near the gold mines of Peru, are frequently obliged to drink an infusion of this herb in order to moisten their breasts; without which they are liable to a sort of suffocation, from the strong metallic exhalations that are continually proceeding from the mines. In Paraguay, the Jesuits make a great revenue by importing the leaves of this plant into many countries, under the name of Paraguay or South sea tea, which is there drank in the same manner as that of China or Japan is with us. It is with difficulty preserved in England.

CASSINI, JOHANNES DOMINICUS, a most excellent astronomer, was born at Piedmont in 1635. His early proficiency in astronomy procured him an invitation to be mathematical professor at Bologna when he was no more than 15 years of age: and a comet appearing in 1652, he discovered that comets were not accidental meteors, but of the same nature, and probably governed by the same laws, as the planets. In the same year he solved a problem given up by Kepler and Bullialdus as insolvable, which was, to determine geometrically the apogee and eccentricity of a planet from its true and mean place. In 1663, he was appointed inspector general of the fortifications of the castle of Urbino, and had afterwards the care of all the rivers in the ecclesiastical state: he still, however, prosecuted his astronomical studies, by discovering the revolution of Mars round his own axis; and, in 1666, published his theory of Jupiter's satellites. Cassini was invited into France by Louis XIV. in 1669, where he settled as the first professor in the royal observatory. In 1677 he demonstrated the line of Jupiter's diurnal rotation; and in 1684 discovered four more satellites belonging to Saturn, Huygens having found one before. He inhabited the royal observatory at Paris more than forty years; and when he died in 1712, was succeeded by his only son James Cassini.

CASSINI, *James*, another celebrated astronomer, was the only son of the former. He was born at Paris, 18th February 1677. It would appear that his early studies were conducted in his father's house, where, from the pursuits and studies of his father, mathematics, and their application to astronomy, it is probable, were not neglected. He became a student afterwards at the Mazarine college, at the time that the celebrated Varignon was professor of mathematics. With the assistance of this eminent man young Cassini made such progress, that at 15 years of age he supported a mathematical thesis with great honour. At the age of 17 he was admitted a member of the Academy of Sciences; and the same year he accompanied his father in a journey to Italy, where he assisted him in the verification of the meridian at Bologna and other measurements. After his return he performed similar operations in a journey into Holland, and he discovered some errors in the measure of the earth by Snell, the result of which was communicated to the Academy in 1702. In 1696 he made also a visit to England, where he was made a member of the Royal Society. In 1712 he succeeded his father as astronomer royal at the observatory of Paris. In 1717 he gave to the Academy his researches on the distance of the fixed stars; in which he shewed that the whole annual orbit, of near 200 millions of miles diameter, is but as a point in comparison of that distance. The same year he communicated also his discoveries concerning the inclination of the orbits of the satellites in general, and especially of those of Saturn's satellites and ring. In 1725 he undertook to determine the cause of the moon's libration, by which she shews sometimes a little towards one side, and sometimes a little on the other, of that half which is commonly behind or hid from our view.

In 1732 an important question in astronomy enga-

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Cassini.

ged the ingenuity of our author. His father had determined, by his observations, that the planet Venus revolved about her axis in the space of 23 hours; and M. Bianchini had published a work in 1729, in which he settled the period of the same revolution at 24 days 8 hours. From an examination of Bianchini's observations which were upon the spots in Venus, he discovered that he had intermitted his observations for the space of three hours, from which cause he had probably mistaken new spots for the old ones, and so had been led into the mistake. He also determined the nature and quantity of the acceleration of the motion of Jupiter at half a second per year, and of that of the retardation of Saturn at two minutes per year; that these quantities would go on increasing for 2000 years, and then would decrease again. In 1740 he published his Astronomical Tables, and his Elements of Astronomy; very extensive and accurate works.

Astronomy was the principal object of our author's consideration, but he did not confine himself absolutely to that pursuit, but made occasional excursions into other fields. We owe to him Experiments on Electricity, Experiments on the Recoil of Fire-arms; Researches on the Rise of the Mercury in the Barometer at different Heights; Reflections on the perfecting of Burning-glasses; and some other memoirs.

One of the most important objects of the French academy was the measurement of the earth. In 1669 Picard measured a little more than a degree of latitude to the north of Paris; but as that extent appeared too small from which to conclude the whole circumference with sufficient accuracy, it was resolved to continue that measurement on the meridian of Paris to the north and the south, through the whole extent of the country. Accordingly, in 1683, the late M. de la Hire continued that on the north side of Paris, and the older Cassini that on the south side. The latter was assisted in 1700 in the continuation of this operation by his son our author. The same work was farther continued by the same academicians; and finally, the part left unfinished by De la Hire in the north was finished in 1718 by our author, with the late Maraldi, and De la Hire the younger.

These operations produced a considerable degree of precision. From this measured extent of six degrees, it appeared also, that the degrees were of different lengths in different parts of the meridian; and our author concluded, in the volume published for 1718, that they decreased more and more towards the pole, and that therefore the figure of the earth was that of an oblong spheroid, or having its axis longer than the equatorial diameter. He also measured the perpendicular to the same meridian, and compared the measured distance with the differences of longitude as before determined by the eclipses of Jupiter's satellites; from which he concluded that the length of the degrees of longitude was smaller than it would be on a sphere, and that therefore again the figure of the earth was an oblong spheroid, contrary to the determination of Newton by the theory of gravity. Newton was indeed of all men the most averse from controversy; but the other mathematicians in Britain did not tamely submit to conclusions in direct opposition to the fundamental doctrine of this philosopher. The consequence was, that the French government sent two different sets of measurers, the one to measure a degree at the equator, the other at the polar circle; and the comparison of the whole determined the figure to be an oblate spheroid, contrary to Cassini's determination.

Cassini, Cassini de Thury.

After a long and laborious life, James Cassini died in April 1756, and was succeeded in the Academy and Observatory by his second son. He published, A Treatise on the Magnitude and Figure of the Earth; as also, the Elements or Theory of the Planets, with Tables; beside a great number of papers in the Memoirs of the Academy, from the year 1699 to 1755.

Cassini de Thury, Cæsar Francois, a celebrated French astronomer, director of the observatory, and member of most of the learned societies of Europe, was born at Paris June 17. 1714. He was the second son of James Cassini, whose occupations and talents he inherited and supported with great honour. He received his first lessons in astronomy and mathematics from MM. Maraldi and Camus; and made such a rapid progress, that when he was not more than ten years of age he calculated the phases of a total eclipse of the sun. At the age of eighteen he accompanied his father in his two journeys undertaken for drawing the perpendicular to the observatory meridian from Strasbourg to Brest. A general chart of France was from that time devised; for which purpose it was necessary to traverse the country by several lines parallel and perpendicular to the meridian of Paris. Our author was charged with the conduct of this business; in which he was so scrupulous as to measure again what had been measured by his father. This great work was published in 1740, with a chart shewing the new meridian of Paris, by two different series of triangles, passing along the sea coasts to Bayonne, traversing the frontiers of Spain to the Mediterranean and Antibes, and thence along the eastern limits of France to Dunkirk, with parallel and perpendicular lines described at the distance of 6000 toises from one another, from side to side of the country.

Our author made a tour in 1741, in Flanders, in the train of the king. This gave rise, at his majesty's instance, to the chart of France; relative to which Cassini published different works, as well as a great number of the sheets of the chart itself. He undertook, in 1761, an expedition into Germany, for the purpose of continuing to Vienna the perpendicular of the Paris meridian; to unite the triangles of the chart of France with the points taken in Germany; to prepare the means of extending into that country the same plan as in France; and thus to establish successively for all Europe a most useful uniformity. Our author was at Vienna the 6th of June 1761, the day of the transit of the planet Venus over the sun, of which he observed as much as the state of the weather would permit him to do, and published the account of it in his *Voyage en Allemagne*.

Cassini, always meditating the perfection of his grand design, profited of the peace of 1783 to propose the joining of certain points taken upon the English coast with those which had been determined on the coast of France, and thus to connect the general chart of the latter with that of the British isles, as he had before united it with those of Flanders and Germany. The proposal was favourably received by the English government,

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government, and presently carried into effect under the direction of the Royal Society, by the late General Roy.

Between the years 1735 and 1770, M. Cassini published, in the volumes of Memoirs of the French Academy, a great number of pieces, consisting chiefly of astronomical observations and questions; among which are researches concerning the parallax of the sun, the moon, Mars and Venus; on astronomical refractions, and the effect caused in their quantity and laws by the weather; numerous observations on the obliquity of the ecliptic, and on the law of its variations. He cultivated astronomy for 50 years, the most important for that science that ever elapsed for the magnitude and variety of objects; and in which he commonly sustained a principal share.

M. Cassini was of a very strong and vigorous constitution, which carried him through the many laborious operations in geography and astronomy which he conducted. An habitual retention of urine, however, rendered the last twelve years of his life very painful and distressing, till it was at length terminated by the small-pox the 4th of September 1784, in the 71st year of his age. He was succeeded in the academy, and as director of the observatory, by his only son John-Dominic Cassini, the fourth in order of direct descent who has filled that honourable station. *Hutton's Math. Dic.*

CASSIODORUS, Marcus Aurelius, secretary of state to Theodoric king of the Goths, was born at Squillace, in the kingdom of Naples, about the year 470. He was consul in 514, and was in great credit under the reigns of Athalaric and Vitiges; but at 70 years of age retired into a monastery in Calabria, where he amused himself in making sun-dials, water hour-glasses, and perpetual lamps. He also formed a library; and composed several works, the best edition of which is that of Father Garet, printed at Rouen in 1679. Those most esteemed are his Divine Institutions, and his Treatise on the Soul. He died about the year 562.

CASSIOPEIA, in fabulous history, wife to Cepheus king of Ethiopia, and mother of Andromeda. She thought herself more beautiful than the Nereides, who desired Neptune to revenge the affront; so that he sent a sea monster into the country, which did much harm. To appease the god, her daughter Andromeda was exposed to the monster, but was rescued by Perseus; who obtained of Jupiter, that Cassiopeia might be placed after her death among the stars; hence the constellation of that name.

Cassiopeia, in *Astronomy*, one of the constellations of the northern hemisphere, situated next to Cepheus. In 1572, there appeared a new star in this constellation, which at first surpassed in magnitude and brightness Jupiter himself: but it diminished by degrees, and at last disappeared, at the end of eighteen months. It alarmed all the astronomers of that age, many of whom wrote dissertations on it; among the rest Tycho Brahe, Kepler, Maurolycus, Lycetus, Gramineus, &c. Beza, the landgrave of Hesse, Rosa, &c. wrote to prove it a comet, and the same which appeared to the Magi at the birth of Jesus Christ, and that it came to declare his second coming; they were answered on this subject by Tycho. The stars in the constellation Cassiopeia, in Ptolemy's catalogue, are 13; in Hevelius's, 33; in Tycho's, 46: But in the Britannic catalogue Mr Flamstead makes them 55.

CASSIS, in antiquity, a plated or metalline helmet; different from the *galea*, which was of leather.

CASSITERIA, in the history of fossils, a genus of crystals, the figures of which are influenced by an admixture of some particles of tin.

The cassiteria are of two kinds; the whitish pellucid cassiterion, and the brown cassiterion. The first is a tolerably bright and pellucid crystal, and seldom subject to the common blemishes of crystal: it is of a perfect and regular form, in the figure of a quadrilateral pyramid: and is found in Devonshire and Cornwall principally. The brown cassiterion is like the former in figure: it is of a very smooth and glossy surface, and is also found in great plenty in Devonshire and Cornwall.

CASSITERIDES, in *Ancient Geography*, a cluster of islands to the west of the Land's End; opposite to Celtiberia, (Pliny); famous for their tin, which he calls *candidum plumbum*, formerly open to none but the Phœnicians, who alone carried on this commerce from Gades, concealing the navigation from the rest of the world, (Strabo). The appellation is from *Cassiteros*, the name for tin in Greek. Now thought to be the Scilly islands, or Sorlings, (Camden).

CASSIUS, Spurius, a renowned Roman general and consul, whose enemies accusing him of aspiring to royalty, he was thrown down from the Tarpeian rock 485 years before Christ; after having thrice enjoyed the consular dignity, been once general of the horse under the first dictator that was created at Rome, and twice received the honour of a triumph.

Cassius *Longinus*, a celebrated Roman lawyer, flourished 113 years before Christ. He was so inflexible a judge, that his tribunal was called the *Rock of the impeached*. It is from the judicial severity of this Cassius, that very severe judges have been called *Cassiani*.

Cassius, *Caius*, one of the murderers of Julius Cæsar; after his defeat by Mark Antony at the battle of Philippi, he ordered one of his freedmen to put him to death with his own sword, 41 years before Christ. See Rome.

CASSOCK, or Cassula, a kind of robe or gown, worn over the rest of the habit, particularly by the clergy. The word cassock comes from the French *cassaque*, a horseman's coat.

CASSONADE, in commerce, cask-sugar, or sugar put into casks or chests, after the first purification, but which has not been refined. It is sold either in powder or in lumps; the whitest, and that of which the lumps are largest, is the best. Many imagine it to sweeten more than loaf sugar; but it is certain that it yields a great deal more scum.

CASSOWARY. See Struthio, Ornithology Index.

CASSUMAR, in the *Materia Medica*, a root resembling that of zedoary.

It is cardiac and sudorific, and famous in nervous cases; it is also an ingredient in many compositions, and is prescribed in powders, boluses, and infusions. Its dose is from five to fifteen grains.

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CASSUMBAZAR, a town of India in Asia, situated on the river Ganges, in the province of Bengal. E. Long. 37. 0. and N. Lat. 24. 0.

CAST is peculiarly used to denote a figure or small statue of bronze. See BRONZE.

CAST, among founders, is applied to tubes of wax fitted in divers parts of a mould of the same matter; by means of which, when the wax of the mould is removed, the melted metal is conveyed into all the parts which the wax before possessed.

CAST, also denotes a cylindrical piece of brass or copper, slit in two, lengthwise, used by the founders in sand, to form a canal or conduit in their moulds, whereby the metal may be conveyed to the different pieces intended to be cast.

CAST, among plumbers, denotes a little brazen funnel at one end of a mould, for casting pipes without soldering, by means of which the melted metal is poured into the mould.

CAST, or *Caste*, in speaking of the eastern affairs, denotes a tribe, or number of families, of the same rank or profession. The division of a nation into casts chiefly obtains in the dominions of the Great Mogul, kingdom of Bengal, island of Ceylon, and the great peninsula opposite thereto. In each of these there are, according to Father Martin, four principal casts, viz. the cast of the *bramins*, which is the first and most noble; the cast of the *rajas*, or princes, who pretend to be descended from divers royal families; the cast of the *choutres*, which comprehends all the artificers; and that of the *parias*, the lowest and most contemptible of all; though Henry Lord, it must be observed, divides the Indians about Surat into four *casts*, somewhat differently from Martin, viz. into *bramins*, or priests; *cuttery*, or soldiers; *shuddery*, which we call *banians*, or merchants; and *wyse*, the mechanics or artificers. Every art and trade is confined to its proper *cast*, nor is allowed to be exercised by any but those whose fathers professed the same. So that a tailor's son can never rise to be a painter, nor a painter's son fall to be a tailor; though there are some employments that are proper to all the casts, *e. g.* every body may be a soldier or a merchant. There are also divers casts which are allowed to till the ground, but not all. The cast of *parias* is held infamous, insomuch that it is a disgrace to have any dealings or conversation with them; and there are some trades in the cast of *choutres*, which debase their professors almost to the same rank. Thus shoemakers, and all artificers in leather, as also fishermen, and even shepherds, are reputed no better than *parias*. See CASTE, SUPPLEMENT.

CASTAGNO, ANDREA DAL, historical painter, was born at a small village called *Castagno*, belonging to the territory of Tuscany, in 1409; and being deprived of his parents, was employed by his uncle to attend the herds of cattle in the fields; but having accidentally seen an ordinary painter at work in the country, he observed him for some time with surprise and attention, and afterwards made such efforts to imitate him, as astonished all who saw his productions. The extraordinary genius of Andrea became at last a common topic of discourse in Florence; and so far excited the curiosity of Bernardetto de Medici, that he sent for Andrea; and perceiving that he had promising talents, he placed him under the care of the best masters who were at that time in Florence. Andrea diligently pursued his studies, devoted himself entirely to practice under the direction of his instructors, became particularly eminent in design, and in a few years made so great a progress, that he found as much employment as he could possibly execute. He painted only in distemper, and fresco, with a manner of colouring that was not very agreeable, being rather dry and hard, till he learned the secret of painting in oil from Domenico Venetiano, who had derived his knowledge of that new discovery from Antonello da Messina. Andrea was the first of the Florentine artists who painted in oil; but although he was in the highest degree indebted to Domenico for disclosing the secret, yet he secretly envied the merit of the man who taught him the art; and because his own works seemed to be much less admired than those of Domenico, he determined to assassinate his friend and benefactor. He executed his design with the utmost ingratitude and treachery (for Domenico at that time lived with him, and painted in partnership with him), and he stabbed him at a corner of a street so secretly, that he escaped, unobserved and unsuspected, to his own house, where he composedly sat down to work; and thither Domenico was soon after conveyed, to die in the arms of his murderer. The real author of so inhuman a transaction was never discovered, till Andrea, through remorse of conscience, disclosed it on his death-bed, in 1480. He finished several considerable works at Florence, by which he gained great riches, and as great a reputation; but when his villanous misconduct became public, his memory was ever after held in the utmost detestation. The most noted work of this master is in the hall of justice at Florence, representing the execution of the conspirators against the house of Medicis.

CASTALIAN SPRING. See CASTALIUS.

CASTALIO, SEBASTIAN, was born at Chatillon, on the Rhone, in the year 1515. Calvin conceived such an esteem and friendship for him, during the stay he made at Strasburg in 1540 and 1541, that he lodged him some days at his house, and procured him a regent's place in the college of Geneva. Castalio after continuing in this office near three years, was forced to quit it in the year 1544, on account of some particular opinions which he held concerning Solomon's Song, and Christ's descent into hell. He retired to Basil, where he was made Greek professor, and died in that place in 1564, aged 48. He incurred the high displeasure of Calvin and Theodore Beza, for differing with them concerning predestination and the punishment of heretics. His works are very considerable both on account of their quality and number. In 1545, he printed at Basil four books of dialogues, containing the principal histories of the Bible in elegant Latin; so that youth might thereby make a proficiency in piety and in the Latin tongue at the same time. But his principal work is a Latin and French translation of the Scripture. He began the Latin translation at Geneva in 1542, and finished it at Basil in 1550. It was printed at Basil in 1551, and dedicated by the author to Edward VI. king of England. The French version was dedicated to Henry II. of France,

France, and printed at Basil in 1555. The fault which has been most generally condemned in his Latin translation, is the affectation of using only classical terms.

CASTALIUS FONS (Strabo, Pausanias); *Castalia*, (Pindar, Virgil); a fountain at the foot of Mount Parnassus, in Phocis, near the temple of Apollo, or near Delphi; sacred to the Muses, thence called *Castalides*. Its murmurs were thought prophetic. (Nonnius, Lucian). See the articles DELPHI and PARNASSUS.

CASTANEA. See FAGUS, BOTANY *Index*.

CASTANETS, CASTAGNETTES, or CASTANETTAS, a kind of musical instrument, wherewith the Moors, Spaniards, and Bohemians, accompany their dances, sarabands, and guitars. It consists of two little round pieces of wood dried, and hollowed in the manner of a spoon, the concavities whereof are placed on one another, fastened to the thumb, and beat from time to time with the middle finger, to direct their motion and cadences. The *castanets* may be beat eight or nine times in the space of one measure, or second of a minute.

CASTANOVITZ, a town of Croatia, situated on the river Unna, which divides Christendom from Turkey. E. Long. 17. 20. N. Lat. 45. 40. It is subject to the house of Austria.

CASTEL, LEWIS BERTRAND, a learned Jesuit, was born at Montpelier in 1688, and entered among the Jesuits in 1703. He studied polite literature in his youth; and at length applied himself entirely to the study of mathematics and natural philosophy. He distinguished himself by writing on gravity; the mathematics; and on the music of colours, a very whimsical idea, which he took great pains to reduce to practice. His piece on gravity, entitled *Traité de la Pensateur Universelle*, was printed at Paris in 1724. He afterwards published his *Mathematique Universelle*; which occasioned his being unanimously chosen a fellow of the Royal Society of London, without the least solicitation. He was also member of the academies of Bourdeaux and Rouen: but his *Clavecin oculaire* made the most noise; and he spent much time and expence in making an harpsichord for the eye, but without success. He also wrote for and against Sir Isaac Newton, and published several other works; the principal of which are, *Le plan du Mathematique abregée*, and a treatise entitled *Optique des Couleurs*. He led a very exemplary life, and died in 1757.

CASTELAMARA, a town of Italy, in the kingdom of Naples, and the Hither Principato, with a bishop's see, and a good harbour. E. Long. 14. 15. N. Lat. 41. 40.

CASTEL-ARAGONESE, a strong town of Italy, in the island of Sardinia, with a bishop's see, and a good harbour. It is seated on the N. W. coast of the island, in E. Long. 8. 57. N. Lat. 40. 56.

CASTEL-Branco, a town of Portugal, and capital of the province of Beira; seated on the river Lyra, 35 miles N. W. of Alcantara. W. Long. 8. 0. N. Lat. 39. 35.

CASTEL-Franco, a very small, but well fortified frontier town of the Bolognese, in Italy, belonging to the pope.

CASTEL-de-Vide, a small strong town of Alentejo. It was taken by Philip V. W. Long. 6. 25. N. Lat. 39. 15.

CASTEL Folit, a town of Spain, in Catalonia, seated on an inaccessible eminence, between Gironne and Campredon, about 15 miles from each, and near the river Fulva.

CASTEL Gandolpho, a town of Italy, in the territory of the church, with a castle, to which the pope retires in the summer season; 10 miles S. by E. of Rome. E. Long. 12. 46. N. Lat. 41. 44.

CASTEL-Novo, a strong town of Dalmatia, subject to the Venetians; seated on the gulf of Cataro, in E. Long. 18. 45. N. Lat. 42. 25.

CASTEL-Rodrigo, a town of Portugal, in the province of Tra-los-Montes, in W. Long. 7. 1. N. Lat. 41. 0.

CASTEL-Novo-de-Carfagnana, a town of Italy, in the Modenese, with a strong fortress. It is the capital of the valley of Carfagnana, and seated on the river Serchio, 17 miles above Lucca.

CASTEL-del-Ovo, a small island in the Tuscan sea, in the gulf of Naples, near a town of that name, to which it is joined by a stone bridge. The fortress is called Castel-del-Ovo, in which there is always a good garrison.

CASTLEBAR, a town of Ireland, in the county of Mayo, and province of Connaught, 35 miles N. of Galway. W. Long. 9. 25. N. Lat. 53. 45.

CASTELL, EDMUND, D. D. a learned English divine of the 17th century, distinguished by his skill in the eastern languages. He was educated at Cambridge; where he was master of Catharine hall, and Arabic professor; and was at length canon of Canterbury. He had the greatest share in the Polyglott Bible of London; and wrote the *Heptaglotton pro septem Orientalibus*, &c. On this excellent work, which occupied a great part of his life, he bestowed incredible pains and expence, even to the breaking of his constitution, and exhausting of his fortune, having expended no less than 12,000l. upon that work. At length, when it was printed, the copies remained unsold upon his hands. He died in 1685; and lies buried in the churchyard of Higham Gobyon in Bedfordshire, of which he was rector. It appears from the inscription on his monument, which he erected in his lifetime, that he was chaplain to Charles II. He bequeathed all his oriental manuscripts to the university of Cambridge, on condition that his name should be written on every copy in the collection.

CASTELLA, a town of the Mantuan, in Italy, about five miles north-east of the city of Mantua. E. Long. 11. 15. N. Lat. 45. 30.

CASTELLAN, the name of a dignity or charge in Poland: The castellans are senators of the kingdom, but senators only of the lower class, who, in diets, sit on low seats, behind the palatines, or great senators. They are a kind of lieutenants of provinces, and command a part of the palatinate under the palatine.

CASTELLANY, the territory belonging to any city or town, chiefly used in France and Flanders: Thus we say, the castellany of Lisle, Ypres, &c.

CASTELLARIUS, the keeper, or curator, of a castellum. Gruter gives an ancient sepulchral inscription in memory of a *castellarius*.

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CASTELLATIO, in middle-age writers, the act of building a castle, or of fortifying a house, and rendering it a castle.—By the ancient English laws, castellation was prohibited without the king's special license.

CASTELLI, Bernard, an Italian painter, was born at Genoa in 1557; and excelled in colouring and in portraits. He was the intimate friend of Tasso, and took upon himself the task of designing and etching the figures of his Jerusalem Delivered. He died at Genoa in 1629.

Valerio Castelli, one of his sons, was born at Genoa in 1625, and surpassed his father. He particularly excelled in painting battles; which he composed with spirit, and executed them with so pleasing a variety, and so great freedom of hand, as gained him universal applause. His horses are admirably drawn, thrown into attitudes that are natural and becoming, full of motion, action, and life. In that style of painting he showed all the fire of Tintoretto, united with the fine taste of composition of Paolo Veronese. He died in 1659. The works of this master are not very frequent; but they are deservedly held in very high esteem. A greater number of his easel pictures are in the collections of the nobility and gentry of England.

CASTELLORUM operatio, castle work, or service and labour done by inferior tenants for the building and upholding of castles of defence; towards which some gave personal assistance, and others paid their contributions. This was one of the three necessary charges to which all lands among the Anglo-Saxons were expressively subject.

CASTELVETRO, Lewis, a native of Modena, of the 16th century, famous for his *Comment on Aristotle's Poetics*. He was prosecuted by the inquisition for a certain book of Melancthon, which he had translated into Italian. He retired to Basil, where he died.

CASTI, Giambatista, a modern Italian poet. See Supplement.

CASTIGATION, among the Romans, the punishment of an offender by blows, or beating with a wand or switch. Castigation was chiefly a military punishment; the power of inflicting of which on the soldiery was given to the tribunes. Some make it of two kinds; one with a stick or cane, called *fustigatio:* the other with rods, called *flagellatio:* the latter was the most dishonourable.

CASTIGATORY, *for* Scolds. A woman indicted for being a common scold, if convicted, shall be placed in a certain engine of correction, called the *trebucket castigatory*, or *cucking stool;* which, in the Saxon language, signifies the *scolding stool;* though now it is frequently corrupted into the *ducking stool;* because the residue of the judgment is, that when she is placed therein, she shall be plunged in water for her punishment.

CASTIGLIONE, Giovanni Benedetto, a celebrated painter, was born at Genoa in 1616. His first master was Gio-Battista Paggi. Afterwards he studied under Andrea Ferrari; and lastly perfected himself from the instructions of Anthony Vandyck, who at that time resided at Genoa. He painted portraits, historical pieces, landscapes, and castles; in the latter of which he is said chiefly to have excelled; as also in fairs, markets, and all kinds of rural scenes. By this master we have also a great number of etchings, which are all spirited, free, and full of taste. The effect is, in general, powerful and pleasing; and many of them have a more harmonized and finished appearance than is usual from the point, so little assisted by the graver. His drawing of the naked figure, though by no means correct, is notwithstanding managed in a style that indicates the hand of the master.

His son, *Francesco*, was bred under himself, and excelled in the same subjects; and it is thought that many good paintings which are ascribed to Benedetto, and are frequently seen at sales, or in modern collections, are copies after him by his son Francesco, or perhaps originals of the younger Castiglione.

Castiglione, a small but strong town of Italy, in Mantua, with a castle. It was taken by the Germans in 1701, and the French defeated the Imperialists near it in 1706. E. Long. 10. 29. N. Lat. 43. 23.

CASTIGLIONI, Balthazar, an eminent Italian nobleman, descended from an illustrious and ancient family, and born at his own villa at Casalico in the duchy of Milan in 1478. He studied painting, sculpture, and architecture, as appears from a book he wrote in favour of these arts; and excelled so much in them, that Raphael Urbino, and Buonaroti, though incomparable artists, never thought their works complete, without the approbation of Count Castiglioni. When he was 26 years of age, Guido Ubaldo, duke of Urbino, sent him ambassador to Pope Julius II. He was sent upon a second embassy to Louis XII. of France, and upon a third to Henry VII. of England. After he had dispatched his business here, he returned, and began his celebrated work, entitled *the Courtier;* which he completed at Rome in 1516. This work is full of moral and political instruction: and if we seek for the Italian tongue in perfection, it is said to be nowhere better found than in this performance. A version of this work, together with the original Italian, was published at London in 1727, by A. P. Castiglioni, a gentleman of the same family, who resided there under the patronage of Dr Gibson, bishop of London. Count Castiglioni was sent by Clement VII. to the court of the emperor Charles V. in quality of legate, and died at Toledo in 1529.

CASTILE, New, or The Kingdom of Toledo, a province of Spain, bounded on the north by Old Castile, on the east by the kingdoms of Arragon and Valencia, on the south by those of Murcia and Andalusia, and on the west by the kingdom of Leon. It is divided into three parts; Argaria to the north, Mancha to the east, and Sierra to the south. Madrid is the capital. Both these provinces are very well watered with rivers, and the air is generally pure and healthy; but the land is mountainous, dry, and uncultivated, through the laziness of the inhabitants. The north part produces fruits and wine, and the south good pastures and fine wool. The population of New Castile in 1787 amounted to 949,649 persons, including 14,000 priests, monks, and nuns.

Castile, *Old*, a province of Spain, with the title of a kingdom. It is about 192 miles in length, and 115 in breadth; bounded on the south by New Castile, on the east by Arragon and Navarre, on the north by Biscay

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Biscay and Asturias, and on the west by the kingdom of Leon. Burgos is the capital town.

Castile-del-Oro, a fertile and large country in South America, lying to the west of the Oroonoko. It comprehends eight governments; viz. Terra Firma, Proper Carthagena, St Martha, Rio de la Hacha, Venezuela, New Andalusia, Popayan, and the kingdom of New Granada.

CASTILLAN, or Castillane, a gold coin current in Spain, and worth fourteen rials and sixteen deniers.

Castillan, is also a weight used in Spain for weighing gold. It is a hundredth part of a pound Spanish weight. What they commonly call a weight of gold in Spain is always understood of the castillan.

CASTILLARA, a town of the Mantuan in Italy, situated six miles north-east of the city of Mantua. E. Long. 11. 25. N. Lat. 45. 20.

CASTILLON, a town of France, in the department of Gironde, situated on the river Dordogne, 16 miles east of Bourdeaux. W. Long. 2. 40. N. Lat. 44. 50.

CASTING, in foundry, the running of metal into a mould, prepared for that purpose.

Casting of Metals, of Letters, Bells, &c. See the article Foundry.

Casting in Sand or Earth, is the running of metals between two frames, or moulds, filled with sand or earth, wherein the figure that the metal is to take has been impressed *en creux*, by means of the pattern.

Casting, among sculptors, implies the taking of casts and impressions of figures, busts, medals, leaves, &c.

The method of taking of casts of figures and busts, is most generally by the use of plaster of Paris, *i. e.* alabaster calcined by a gentle heat. The advantage of using this substance preferably to others is, that notwithstanding a slight calcination reduces it to a pulverine state, it becomes again a tenacious and cohering body, by being moistened with water, and afterwards suffered to dry; by which means either a concave or a convex figure may be given by a proper mould or model to it when wet, and retained by the hardness it acquires when dry: and from these qualities, it is fitted for the double purpose of making both casts, and moulds for forming those casts. The particular manner of making casts depends on the form of the subject to be taken. Where there are no projecting parts, it is very simple and easy; as likewise where there are such as form only a right or any greater angle with the principal surface of the body: but where parts project in lesser angles, or form a curve inclined towards the principal surface of the body, the work is more difficult.

The first step to be taken is the forming the mould. In order to this, if the original or model be a bass relief, or any other piece of a flat form, having its surface first well greased, it must be placed on a proper table, and surrounded by a frame, the sides of which must be at such a distance from it as will allow a proper thickness for the sides of the mould. As much plaster as will be sufficient to cover and rise to such a thickness as may give sufficient strength to the mould, as also to fill the hollow betwixt the frame and the model, must be moistened with water, till it be just of such consistence as will allow it to be poured upon the model. This must be done as soon as possible; or the plaster would concrete or set, so as to become more troublesome in the working, or unfit to be used. The whole must then be suffered to remain in this condition, till the plaster has attained its hardness; and then the frame being taken away, the preparatory cast or mould thus formed may be taken off from the subject entire.

Where the model or original subject is of a round or erect form, a different method must be pursued; and the mould must be divided into several pieces: or if the subject consists of detached and projecting parts, it is frequently most expedient to cast such parts separately, and afterwards join them together.

Where the original subject or mould forms a round, or spheroid, or any part of such round or spheroid, more than one half the plaster must be used without any frame to keep it round the model; and must be tempered with water to such a consistence, that it may be wrought with the hand like very soft paste; but though it must not be so fluid as when prepared for flat-figured models, it must yet be as moist as is compatible with its cohering sufficiently to hold together; and being thus prepared, it must be put upon the model, and compressed with the hand, or any flat instrument, that the parts of it may adapt themselves, in the most perfect manner, to those of the subject, as well as to be compact with respect to themselves. When the model is so covered to a convenient thickness, the whole must be left at rest till the plaster be set and firm, so as to bear dividing without falling to pieces, or being liable to be put out of its form by slight violence; and it must then be divided into pieces, in order to its being taken off from the model, by cutting it with a knife with a very thin blade: and being divided, must be cautiously taken off, and kept till dry: but it must be always carefully observed, before the separation of the parts be made, to notch them across the joints or lines of the division, at proper distances, that they may with ease and certainty be properly conjoined again; which would be much more precarious and troublesome without such directive marks. The art of properly dividing the moulds, in order to make them separate from the model, requires more dexterity and skill than any other thing in the art of casting; and does not admit of rules for the most advantageous conduct of it in every case. Where the subject is of a round or spheroidal form, it is best to divide the mould into three parts, which will then easily come off from the model: and the same will hold good of a cylinder or any regular curved figure.

The mould being thus formed, and dry, and the parts put together, it must be first greased, and placed in such a position that the hollow may lie upwards, and then filled with plaster mixed with water, in the same proportion and manner as was directed for the casting the mould: and when the cast is perfectly set and dry, it must be taken out of the mould, and repaired where it is necessary; which finishes the operation.

This is all that is required with respect to subjects where the surfaces have the regularity above mentioned: but where they form curves which intersect each other, the conduct of the operation must be varied with respect to the manner of taking the cast of the mould from off the subject or model; and where there are long projecting parts, such as legs or arms, they should be wrought in separate casts. The operator may easily judge, from the original subjects, what parts will come off together, and what require to be separated: the principle of the whole consists only in this, that where under-workings, as they are called, occur, that is, wherever a straight line drawn from the basis or insertion of any projection, would be cut or crossed by any part of such projection, such part cannot be taken off without a division; which must be made either in the place where the projection would cross the straight line; or, as that is frequently difficult, the whole projection must be separated from the main body, and divided also lengthwise into two parts; and where there are no projections from the principal surfaces, but the body is so formed as to render the surface a composition of such curves, that a straight line being drawn parallel to the surface of one part would be cut by the outline, in one or more places, of another part, a division of the whole should be made, so as to reduce the parts of it into regular curves, which must then be treated as such.

In larger masses, where there would otherwise be a great thickness of the plaster, a core or body may be put within the mould, in order to produce a hollow in the cast; which both saves the expence of the plaster, and renders the cast lighter.

This core may be of wood, where the forming a hollow of a straight figure, or a conical one with the basis outward, will answer the end; but if the cavity require to be round, or of any curve figure, the core cannot be then drawn while entire; and consequently should be of such matter as may be taken out piecemeal. In this case, the core is best formed of clay; which must be worked upon wires to give it a tenacity, and suspended in the hollow of the mould by cross wires lying over the mouth; and when the plaster is sufficiently set to bear handling, the clay must be picked out by a proper instrument.

Where it is desired to render the plaster harder, the water with which it is tempered should be mixed with parchment size properly prepared, which will make it very firm and tenacious.

In the same manner, figures, busts, &c. may be cast of lead, or any other metal, in the moulds of plaster; only the expence of plaster, and the tediousness of its becoming sufficiently dry, when in a very large mass, to bear the heat of melted metal, render the use of clay, compounded with some other proper materials, preferable where large subjects are in question. The clay, in this case, should be washed over till it be perfectly free from gravel or stones; and then mixed with a third or more of fine sand to prevent it cracking; or, instead of sand, coal ashes sifted fine may be used. Whether plaster or clay be employed for the casting in metal, it is extremely necessary to have the mould perfectly dry: otherwise the moisture, being rarefied, will make an explosion that will blow the metal out of the mould, and endanger the operator, or at least crack the mould in such a manner as to frustrate the operation. Where the parts of a mould are larger, or project much, and consequently require a greater tenacity of the matter they are formed of to keep them together, flocks of cloth, prepared like those designed for paper hangings, or fine cotton plucked or cut till it is very short, should be mixed with the ashes or sand before they are added to the clay to make the composition for the mould. The proportion should be according to the degree of cohesion required; but a small quantity will answer the end, if the other ingredient of the composition be good, and the parts of the mould properly linked together by means of the wires above directed.

There is a method of taking casts in metals from small animals, and the parts of vegetables, which may be practised for some purposes with advantage: particularly for the decorating grottoes or rock works, where nature is imitated. The proper kinds of animals are lizards, snakes, frogs, birds, or insects; the casts of which, if properly coloured, will be exact representations of the originals.

This is to be performed by the following method: A coffin or proper chest for forming the mould being prepared of clay, or four pieces of boards fixed together, the animal or parts of vegetables must be suspended in it by a string: and the leaves, tendrils, or other detached parts of the vegetables, or the legs, wings, &c. of the animals, properly separated, and adjusted in their right position by a small pair of pincers: a due quantity of plaster of Paris and calcined talk, in equal quantities, with some alumen plumosum, must then be tempered with water to the proper consistence for casting; and the subject from whence the cast is to be taken, also the sides of the coffin, moistened with spirit of wine. The coffin or chest must then be filled with the tempered composition of the plaster and talk, putting at the same time a piece of straight stick or wood to the principal part of the body of the subject, and pieces of thick wire to the extremities of the other parts, in order that they may form, when drawn out after the matter of the mould is properly set and firm, a channel for pouring in the melted metal, and vents for the air; which otherwise by the rarefaction it would undergo from the heat of the metal, would blow it out or burst the mould. In a short time the plaster and talk will set and become hard, when the stick and wires may be drawn out, and the frame or coffin in which the mould was cast taken away: and the mould must then be put first into a moderate heat, and afterwards, when it is as dry as it can be rendered by that degree, removed into a greater; which may be gradually increased till the whole be red hot. The animal or part of any vegetable, which was included in the mould, will then be burnt to a coal; and may be totally calcined to ashes, by blowing for some time gently into the channel and passages made for pouring in the metal, and giving vent to the air, which will, at the same time that it destroys the remainder of the animal or vegetable matter, blow out the ashes. The mould must then be suffered to cool gently; and will be perfect; the destruction of the substance of the animal or vegetable having produced a hollow of a figure correspondent to it; but it may be nevertheless proper to shake the mould, and turn it upside down, as also to blow with the bellows into each of the air-vents, in order to free it wholly from any remainder of the ashes; or where there may be an opportunity of filling the hollow with quicksilver without expence, it will be found a very effectual method of clearing the cavity, as all dust, ashes, or small detached bodies, will necessarily

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Casting.

necessarily rise to the surface of the quicksilver, and be poured out with it. The mould being thus prepared, it must be heated very hot when used, if the cast be made with copper or brass; but a less degree will serve for lead or tin; and the matter being poured in, the mould must be gently struck; and then suffered to rest till it be cold; at which time it must be carefully taken from the cast, but without the least force; for such parts of the matter as appear to adhere more strongly must be softened by soaking in water till they be entirely loosened, that none of the more delicate parts of the cast may be broken off or bent.

Where the alumen plumosum, or talk, cannot easily be procured, the plaster may be used alone; but it is apt to be calcined by the heat used in burning the animal or vegetable from whence the cast is taken, and to become of too incohering and crumbly texture; or, for cheapness, Sturbridge or any other good clay, washed over, till it be perfectly fine, and mixed with an equal part of sand, and some flocks cut small, may be employed. Pounded pumice stone and plaster of Paris, taken in equal quantities, and mixed with washed clay in the same proportion, is said to make excellent moulds for this and parallel uses.

Casts of medals, or such small pieces as are of a similar form, may be made in plaster by the method directed for bass relievos.

Indeed there is nothing more required than to form a mould by laying them on a proper board, and having surrounded them by a rim made by the piece of a card or any other pasteboard, to fill the rim with soft tempered plaster of Paris; which mould, when dry, will serve for several casts. It is nevertheless a better method to form the mould of melted sulphur; which will produce a sharper impression in the cast, and be more durable than those made of plaster.

The casts are likewise frequently made of sulphur, which being melted must be treated exactly in the same manner as the plaster.

Phil. Com. of Arts. For taking casts from medals, Dr Lewis recommends a mixture of flowers of brimstone and red lead: equal parts of these are to be put over the fire in a ladle, till they soften to the consistence of pap; then they are kindled with a piece of paper, and stirred for some time. The vessel being afterwards covered close, and continued on the fire, the mixture grows fluid in a few minutes. It is then to be poured on the metal, previously oiled and wiped clean. The casts are very neat; their colours sometimes a pretty deep black, sometimes a dark grey: they are very durable; and when soiled, may be washed clean in spirit of wine.

Naturalists Companion. Dr Lettsom recommends tin foil for taking off casts from medals. The thinnest kind is to be used. It should be laid over the subject from which the impression is to be taken, and then rubbed with a brush, the point of a skewer, or a pin, till it has perfectly received the impression. The tin foil should now be pared close to the edge of the medal, till it is brought to the same circumference: the medal must then be reversed, and the tin foil will drop off into a chip box or mould placed ready to receive it. Thus the concave side of the foil will be uppermost, and upon this plaster of Paris, prepared in the usual manner, may be poured. When dry, the whole is to be taken out, and the tin foil sticking on the plaster will give a perfect representation of the medal, almost equal in beauty to silver. If the box or mould is a little larger than the medal, the plaster running round the tin foil will give the appearance of a white frame or circular border; whence the new made medal will appear more neat and beautiful.

Casts may be made likewise with iron, prepared in the following manner: "Take any iron bar, or piece of a similar form; and having heated it red hot, hold it over a vessel containing water, and touch it very slightly with a roll of sulphur, which will immediately dissolve it, and make it fall in drops into the water. As much iron as may be wanted being thus dissolved, pour the water out of the vessel; and pick out the drops formed by the melted iron from those of the sulphur, which contain little or no iron, and will be distinguishable from the other by their colour and weight." The iron will, by this means, be rendered so fusible, that it will run with less heat than is required to melt lead; and may be employed for making casts of medals, and many other such purposes, with great convenience and advantage.

Impressions of medals having the same effect as casts, may be made also of isinglass-glue, by the following means. Melt the isinglass, beaten, as when commonly used, in an earthen pipkin, with the addition of as much water as will cover it, stirring it gently till the whole is dissolved; then with a brush of camels hair, cover the medal, which should be previously well cleansed and warmed, and then laid horizontally on a board or table, greased in the part around the medal. Let them rest afterwards till the glue be properly hardened; and then, with a pin, raise the edge of it; and separate it carefully from the medal: the cast will be thus formed by the glue as hard as horn; and so light, that a thousand will scarcely weigh an ounce. In order to render the relief of the medal more apparent, a small quantity of carmine may be mixed with the melted isinglass; or the medal may be previously coated with leaf gold by breathing on it, and then laying it on the leaf, which will by that means adhere to it; but the use of leaf gold is apt to impair a little the sharpness of the impression.

Impressions of medals may be likewise taken in putty; but it should be the true kind made of calx of tin, and drying oil. These may be formed in the moulds, previously taken in plaster or sulphur; or moulds may be made in its own substance, in the manner directed for those of the plaster. These impressions will be very sharp and hard; but the greatest disadvantage that attends them, is their drying very slowly, and being liable in the mean time to be damaged.

Impressions of prints, or other engravings, may be taken from copperplates, by cleansing them thoroughly, and pouring plaster upon them; but the effect in this way is not strong enough for the eye; and therefore the following method is preferable, where such impressions on plaster are desired.

Take vermilion, or any other coloured pigment, finely powdered, and rub it over the plate: then pass a folded piece of paper, or the flat part of the hand, over the

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Casting.

the plate to take off the colour from the lights or parts where there is no engraving; the proceeding must then be the same as where no colour is used. This last method is also applicable to the making of impressions of copperplates on paper with dry colours; for the plate being prepared as here directed, and laid on the paper properly moistened, and either passed under the rolling press, or any other way strongly forced down on the paper, an impression of the engraving will be obtained.

Impressions may be likewise taken from copperplates, either on plaster or paper, by means of the smoke of a candle or lamp; if, instead of rubbing them with any colour, the plate be held over the candle or lamp till the whole surface become black, and then wiped off by the flat of the hand, or paper.

These methods are not, however, of great use in the case of copperplates, except where impressions may be desired on occasions where printing ink cannot be procured: but as they may be applied likewise to the taking impressions from snuff-boxes, or other engraved subjects, by which means designs may be instantly borrowed by artists or curious persons, they may in such instances be very useful.

The expedient of taking impressions by the smoke of a candle or lamp may be employed also for botanical purposes in the case of leaves, as a perfect and durable representation of not only the general figure, but the contexture and disposition of the larger fibres, may be extemporaneously obtained at any time. The same may be nevertheless done in a more perfect manner, by the use of linseed oil, either alone or mixed with a small proportion of colour, where the oil can be conveniently procured: but the other method is valuable on account of its being practicable at almost all seasons, and in all places, within the time that the leaves will keep fresh and plump. In taking these impressions it is proper to bruise the leaves, so as to take off the projections of the large ribs, which might prevent the other parts from plying to the paper.

Leaves, as also the petals, or flower leaves, of plants, may themselves be preserved on paper, with their original appearance, for a considerable length of time, by the following means.—Take a piece of paper, and rub it over with isinglass-glue treated as above directed for taking impressions from medals; and then lay the leaves in a proper position on the paper. The glue laid on the paper being set, brush over the leaves with more of the same; and that being dry likewise, the operation will be finished, and the leaves so secured from the air and moisture, that they will retain their figure and colour much longer than by any other treatment.

Butterflies, or other small animals of a flat figure, may also be preserved in the same manner.

CASTING is also sometimes used for the quitting, laying, or throwing aside any thing; thus deer cast their horns, snakes their skins, lobsters their shells, hawks their feathers, &c. annually.

Casting of feathers is more properly called *moulting* or *mewing*.

A horse *casts* his hair or coat, at least once a-year, viz. in the spring, when he casts his winter coat; and sometimes, at the close of autumn, he casts his summer coat, in case he has been ill kept. Horses also sometimes *cast* their hoofs, which happens frequently to coach horses brought from Holland; these being bred in a moist marshy country, have their hoofs too flabby; so that coming into a drier soil, and less juicy provender, their hoofs fall off, and others that are firmer succeed.

Casting, Castle.

CASTING a Colt, denotes a mare's proving abortive.

CASTING Net, a sort of fishing net, so called, because it is to be *cast* or thrown out; which when exactly done, nothing escapes it, but weeds and every thing within its extent are brought away.

CASTLE, a fortress or place rendered defensible either by nature or art. It frequently signifies with us the principal mansion of noblemen. In the time of Henry II. there were no less than 1115 castles in England, each of which contained a manor.

CASTLES, walled with stone, and designed for residence as well as defence, are for the most part, according to Mr Grose, of no higher antiquity than the Conquest; for although the Saxons, Romans, and even, according to some writers on antiquity, the ancient Britons, had castles built with stone; yet these were both few in number, and at that period, through neglect or invasions, either destroyed or so much decayed, that little more than their ruins were remaining. This is asserted by many of our historians and antiquaries, and assigned as a reason for the facility with which William made himself master of this country.

This circumstance was not overlooked by so good a general as the Conqueror; who, effectually to guard against invasions from without, as well as to awe his newly acquired subjects, immediately began to erect castles all over the kingdom, and likewise to repair and augment the old ones. Besides, as he had parcelled out the lands of the English amongst his followers, they, to protect themselves from the resentment of those so despoiled, built strong holds and castles on their estates. This likewise caused a considerable increase of these fortresses; and the turbulent and unsettled state of the kingdom in the succeeding reigns, served to multiply them prodigiously, every baron or leader of a party, building castles; insomuch that towards the latter end of the reign of King Stephen, they amounted to the almost incredible number of 1115.

As the feudal system gathered strength, these castles became the heads of baronies. Each castle was a manor; and its castelain, owner, or governor, the lord of that manor. Markets and fairs were directed to be held there; not only to prevent frauds in the king's duties or customs, but also as they were esteemed places where the laws of the land were observed, and as such had a very particular privilege. But this good order did not long last; for the lords of castles began to arrogate to themselves a royal power, not only within their castles, but likewise its environs; exercising judicature both civil and criminal, coining of money, and arbitrarily seizing forage and provision for the subsistence of their garrisons, which they afterwards demanded as a right; at length their insolence and oppression grew to such a pitch, that, according to William of Newbury, " there were in England as many kings, or rather tyrants, as lords of castles;" and Matthew Paris styles

Grose's Antiquities of England and Wales, vol. i. Preface.

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styles them very nests of devils, and dens of thieves. Castles were not solely in the possession of the crown and the lay barons, but even bishops had these fortresses; though it seems to have been contrary to the canons, from a plea made use of in a general council, in favour of King Stephen, who had seized upon the strong castles of the bishops of Lincoln and Salisbury. This prohibition (if such existed) was, however, very little regarded; as in the following reigns many strong places were held, and even defended, by the ecclesiastics: neither was more obedience afterwards paid to a decree made by the pope at Viterbo, the fifth of the kalends of June 1220, wherein it was ordained, that no person in England should keep in his hands more than two of the king's castles.

The licentious behaviour of the garrisons of these places becoming intolerable, in the treaty between King Stephen and Henry II. when only duke of Normandy, it was agreed, that all the castles built within a certain period should be demolished; in consequence of which many were actually rased, but not the number stipulated.

The few castles in being under the Saxon government, were probably, on occasion of war or invasions, garrisoned by the national militia, and at other times slightly guarded by the domestics of the princes or great personages who resided therein; but after the Conquest, when all the estates were converted into baronies held by knight's service, castle guard coming under that denomination, was among the duties to which particular tenants were liable. From these services the bishops and abbots, who till the time of the Normans had held their lands in frank almoign, or free alms, were, by this new regulation, not exempted; they were not, indeed, like the laity, obliged to personal service, it being sufficient that they provided fit and able persons to officiate in their stead. This was, however, at first stoutly opposed by Anselm, archbishop of Canterbury; who being obliged to find some knights to attend King William Rufus in his wars in Wales, complained of it as an innovation and infringement of the rights and immunities of the church.

It was no uncommon thing for the Conqueror and the kings of those days to grant estates to men of approved fidelity and valour, on condition that they should perform castle guard in the royal castles, with a certain number of men, for some specified time: and sometimes they were likewise bound by their tenures to keep in repair and guard some particular tower or bulwark, as was the case at Dover castle.

In process of time these services were commuted for annual rents, sometimes styled *wardpenny*, and waytfee, but commonly *castleguard* rents, payable on fixed days, under prodigious penalties called *sursizes*. At Rochester, if a man failed in the payment of his rent of castle guard on the feast of St Andrew, his debt was doubled every tide during the time for which the payment was delayed. These were afterwards restrained by an act of parliament made in the reign of King Henry VIII. and finally annihilated, with the tenures by knight's service in the time of Charles II. Such castles as were private property were guarded either by mercenary soldiers, or the tenants of the lord or owner.

Castles which belonged to the crown, or fell to it either by forfeiture or escheat, (circumstances that frequently happened in the distracted reigns of the feudal times), were generally committed to the custody of some trusty person, who seems to have been indifferently styled governor and constable. Sometimes also they were put into the possession of the sheriff of the county, who often converted them into prisons. That officer was then accountable at the exchequer, for the farm or produce of the lands belonging to the places intrusted to his care, as well as all other profits; he was likewise, in case of war or invasion, obliged to victual and furnish them with munition out of the issues of his county; to which he was directed by writ of privy seal.

The materials of which castles were built, varied according to the places of their erection: but the manner of their construction seems to have been pretty uniform. The outsides of the walls were generally built with the stones nearest at hand laid as regularly as their shapes would admit; the insides were filled up with the like materials, mixed with a great quantity of fluid mortar, which was called by the workmen groutwork.

The general shape or plan of these castles depended entirely on the caprice of the architects, or the form of the ground intended to be occupied; neither do they seem to have confined themselves to any particular figure in their towers; square, round, and polygonal, oftentimes occurring in the original parts of the same building.

The situation of the castles of the Anglo-Norman kings and barons was most commonly on an eminence, and near a river; a situation on several accounts eligible. The whole site of the castle (which was frequently of great extent and irregular figure) was surrounded by a deep and broad ditch, sometimes filled with water, and sometimes dry, called the *fosse*. Before the great gate was an outwork, called a *barbacan*, or *antemural*, which was a strong and high wall, with turrets upon it, designed for the defence of the gate and drawbridge. On the inside of the ditch stood the wall of the castle, about eight or ten feet thick, and between 20 and 30 feet high, with a parapet, and a kind of embrasures called *crennels* on the top. On this wall, at proper distances, square towers of two or three stories high were built, which served for lodging some of the principal officers of the proprietor of the castle, and for other purposes: and on the inside were erected lodgings for the common servants or retainers, granaries, storehouses, and other necessary offices. On the top of this wall, and on the flat roofs of these buildings, stood the defenders of the castle, when it was besieged, and from thence discharged arrows, darts, and stones on the besiegers. The great gate of the castle stood in the course of this wall, and was strongly fortified with a tower on each side, and rooms over the passage, which was closed with thick folding doors of oak, often plated with iron, and with an iron portcullis or grate let down from above. Within this outward wall was a large open space or court, called, in the largest and most perfect castles, the *outer bayle*, or *ballium*, in which stood commonly a church or chapel. On the inside of this outer bayle was another ditch, wall, gate, and towers, inclosing the inner bayle or court, within which the chief tower or *keep* was built. This was a very large square fabric, four or five stories high,

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high, having small windows in prodigious thick walls, which rendered the apartments within it dark and gloomy. This great tower was the palace of the prince, prelate, or baron, to whom the castle belonged, and the residence of the constable or governor. Under ground were dismal dark vaults, for the confinement of prisoners, which made it sometimes be called the *dungeon*. In this building also was the great hall, in which the owner displayed his hospitality, by entertaining his numerous friends and followers. At one end of the great halls of castles, palaces, and monasteries, there was a place raised a little above the rest of the floor, called the *deis*, where the chief table stood, at which persons of the highest rank dined. Though there were unquestionably great variations in the structure of castles, yet the most perfect and magnificent of them seem to have been constructed nearly on the above plan. Such, to give one example, was the famous castle of Bedford, as appears from the following account of the manner in which it was taken by Henry III. A. D. 1224. The castle was taken by four assaults. "In the first was taken the barbacan; in the second the outer ballia; at the third attack, the wall by the old tower was thrown down by the miners, where, with great danger, they possessed themselves of the inner ballia, through a chink; at the fourth assault the miners set fire to the tower, so that the smoke burst out, and the tower itself was cloven to that degree, as to show visibly some broad chinks: whereupon the enemy surrendered." See a representation of a castle in Plate CXXXV. where 1 is the barbacan, 2 the ditch or moat, 3 the wall of the outer ballium, 4 the outer ballium, 5 the artificial mount, 6 the wall of the inner ballium, 7 the inner ballium, 8 the keep or dungeon.

Before the accession of James VI. to the throne of England, the situation of Scotland was such, that every baron's house was more or less fortified, according to the power or consequence of its lord, or according to the situation of the castle. Near Edinburgh or Stirling, where the inhabitants were more polished in their manners, and overawed by the seat of government, no more was necessary than towers capable of resisting the cursory attack of robbers and thieves, who never durst stop to make a regular investment, but plundered by surprise, and, if repulsed, instantly fled away. Such was Melville Castle. It anciently consisted of a strong built tower of three stories, embattled at the top, and was sufficiently strong to resist a sudden attack, unaided by artillery, or other engines of war. But, when further removed, as in Perthshire, Inverness-shire, or Aberdeenshire, then it was necessary to be better defended, and the aids of a peel or dungeon, with outer walls, moat, and wet ditch, barnakin, &c. added to enable the powerful lord to resist the formidable attack of his powerful adversary. The history of Scotland, so late as the reign of the Stuart family, affords a number of melancholy instances of inveterate feuds among the greater and lesser barons of that period: by which every mode of fortification then in use was seldom adequate to the defence of the castle against the storm or blockade of the enraged chieftain. The castle of Doune seems to answer this description of fortification, and has made several gallant defences, in the annals of Scotland. The third kind of fortresses we meet with in Scotland are those situated on the borders of England, or on the sea coasts of the kingdom, and in the Western isles, and very remote places. Many of the old castles in Scotland were situated on an island, in a deep lake, or on a peninsula, which by a broad deep cut was made an island. Of this kind was Lochmaben, in the stewartry of Annandale, the castle of Closeburn in the shire of Nithsdale, the castle of the Rive, situated on the river Dee in the shire of Galloway, Lochleven castle, and many others.

This kind of fortress was only accessible in a hard frost, or by boats, which were not easily transported by a people destitute of good roads and wheel carriages. In fact, they could only be taken by surprise or blockade; the first very difficult, the second very tedious; so that, before the use of artillery, they might be deemed almost impregnable. On that account, their situation was very desirable in the inland parts of Scotland.

On the sea coasts of Scotland we generally find the strongest and most ancient, as well as the most impregnable castles. These had to defend themselves from the invasion of the foreign enemy, as well as the attacks of the domestic foe. Thus we find the barons, whose lands extended to the sea coast, perched, like the eagle, on the most inaccessible rocks that lay within their possessions. Of this kind were Slains castle, Tantallon and Dunottar, on the east coast, and Dunvegan in the isle of Sky, with Dunolly on the west coast. These must have been most uncomfortable retreats, except to a barbarous people, or when a pressing danger forced the baron to seek his safety in the only possible retreat left him.

Castle, in ancient writers, denotes a town or village surrounded with a ditch and wall, furnished with towers at intervals, and guarded by a body of troops. The word is originally Latin, *castellum*, a diminutive from *castrum*. *Castellum* originally seems to have signified a smaller fort for a little garrison: though Suetonius uses the word where the fortification was large enough to contain a cohort. The *castella*, according to Vegetius, were often like towns, built on the borders of the empire, and where there were constant guards and fences against the enemy. Horsley takes them for much the same with what were otherwise denominated *stations*.

Castle, or *Castle-steed*, is also an appellation given by the country people in the north to the Roman *castella*, as distinguished from the *castra stativa*, which they usually call *chesters*. Horsley represents this as an useful criterion, whereby to discover or distinguish a Roman camp or station. There are several of these castella on Severus's wall: they are generally 60 feet square; their north side is formed by the wall itself, which falls in with them; the intervals between them are from six furlongs and a half to seven; they seem to have stood closest where the stations are widest. The neighbouring people call them *castles*, or *castle-steeds*, by which it seems probable that their ancient Latin name had been *castellum*. Some modern writers call them *mile castles*, or military *castellæ*; Horsley sometimes *exploratory castles*. In these *castella* the *areans* had their station, who were an order of men whose business was to make incursions into the enemy's country, and give intelligence of their motions.

Castle, in the sea language, is a part of the ship, of

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Castle Castor. of which there are two; the forecastle, being the elevation at the prow, or the uppermost deck towards the mizen, the place where the kitchens are. Hindcastle is the elevation which reigns on the stern, over the last deck, where the officers cabins and places of assembly are.

CASTLE, *Edmund.* See CASTEL.

CASTLE-Bar, a borough and market town, capital of the county of Mayo in Ireland, is a well-inhabited place, and carries on a brisk trade: it has a barrack for a troop of horse; and there is here a charter school capable of receiving 50 children, and endowed with two acres of land, rent free, by the right honourable Lord Lucan, who has also granted a lease of 20 acres more at a pepper corn yearly.

CASTLE-Carty, a remarkable Roman station about four miles west from Falkirk, on the borders of Stirlingshire in Scotland. It comprehends several acres of ground, is of a square form, and is surrounded with a wall of stone and mortar; all the space within the walls has been occupied by buildings, the ruins of which have raised the earth eight or ten feet above its natural surface; so that the fort now seems like a hill top surrounded with a sunk fence. In 1770, some workmen employed in searching for stones for the great canal, which passes very near it, discovered several apartments of stone; and in one of them a great number of stones about two feet in length, and standing erect, with marks of fire upon them, as if they had been employed in supporting some vessel under which fire was put. In a hollow of the rock near this place, in 1771, a considerable quantity of wheat quite black with age was found, with some wedges and hammers supposed to be Roman.

CASTLE-Rising, a borough town of Norfolk in England, which sends two members to parliament. E. Long. 0. 40. N. Lat. 52. 46.

CASTLE-Work, service or labour done by inferior tenants, for the building and upholding castles of defence, toward which some gave their personal assistance, and others paid their contributions. This was one of the three necessary charges to which the Anglo-Saxons were expressly subject.

CASTLETOWN, the capital of the Isle of Man, seated on the south-west part of the island. It has a strong castle; but of no great importance, on account of its distance from the harbour. The number of houses is about 500. W. Long. 4. 39. N. Lat. 53. 30.

CASTOR, the BEAVER, in *Zoology*, a genus of quadrupeds belonging to the order of glires. See MAMMALIA *Index*.

CASTOR, in *Astronomy*, a moiety of the constellation GEMINI, called also APOLLO. Its latitude northwards, for the year 1700, according to Hevelius, was 10° 4′ 23″; and its longitude, of Cancer, 17° 4′ 14″. It is also called Razalgenze, Apollo, Aphellan, Avellar, and Anelan.

CASTOR and Pollux, in Pagan mythology. Jupiter having an amour with Leda, the wife of Tyndarus king of Sparta, in the form of a swan, she brought forth two eggs, each containing twins. From that impregnated by Jupiter proceeded Pollux and Helena, who were both immortal; from the other Castor and Clytemnestra, who being begot by Tyndarus were both mortal. They were all, however, called by the common name of *Tyndaridæ*. These two brothers entered into an inviolable friendship; they went with the other noble youths of Greece in the expedition to Colchis, and on several occasions signalized themselves by their courage: But Castor being at length killed, Pollux obtained leave to share his own immortality with him; so that they are said to live and die alternately every day: for, being translated into the skies, they form the constellation of Gemini, one of which stars rises as the other sets.

A martial dance, called the *Pyrrhic* or *Castorian* dance, was invented in honour of those deities, whom the Cephelenses placed among the Dii Magni, and offered to them white lambs. The Romans also paid them particular honours on account of the assistance they are said to have given them in an engagement against the Latins; in which, appearing mounted on white horses, they turned the scale of victory in their favour, for which a temple was erected to them in the forum.

CASTOR and Pollux, a fiery meteor, which at sea appears sometimes sticking to a part of the ship, in form of one, two, or even three or four fire-balls: when one is seen alone, it is more properly called *Helena*; two are denominated Castor and Pollux, and sometimes Tyndaridæ. Castor and Pollux are called by the Spaniards, San Elmo; by the French St Elme, St Nicholas, St Clare, St Helene; by the Italians, Hermo; by the Dutch, Tree Vuuren.

Castor and Pollux are commonly judged to portend a cessation of the storm, and a future calm; being rarely seen till the tempest is nigh spent. Helena alone portends ill, and witnesses the severest part of the storm yet behind. When the meteor sticks to the masts, yards, &c. they conclude, from the air's not having motion enough to dissipate this flame, that a profound calm is at hand; if it flutter about, it indicates a storm.

Castoreum. CASTOREUM, in the *Materia Medica*, CASTOR; the inguinal glands of the beaver. The ancients had a notion that it was lodged in the testicles; and that the animal when hard pressed, would bite them off, and leave them to its pursuers, as if conscious of what they wanted to destroy him for. The best sort of castor is what comes from Russia. So much is Russian castor superior to the American, that two guineas per pound are paid for the former, and only 8s. 6d. for the latter. The Russian castor is in large hard round cods, which appear, when cut, full of a brittle, red, liver-coloured substance, interspersed with membranes and fibres exquisitely interwoven. An inferior sort is brought from Dantzic, and is generally fat and moist. The American castor, which is the worst of all, is in longish thin cods. Russia castor has a strong disagreeable smell; and an acrid, bitterish, and nauseous taste. Water extracts the nauseous part, with little of the finer bitter; rectified spirit extracts this last without much of the nauseous; proof spirit both: water elevates the whole of its flavour in distillation; rectified spirit brings over nothing. Castor is looked upon as one of the capital nervine and antihysteric medicines; some celebrated practitioners, nevertheless, have doubted its virtues; and Neumann and Stahl declare

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clare it insignificant. Experience, however, has shewn that the virtues of castor are considerable, though less than they have been generally supposed.

CASTRATION, in *Surgery*, the operation of gelding, *i. e.* of cutting off the testicles, and putting a male animal out of the capacity of generation.

Castration is in much use in Asia, especially among the Turks, who practise it on their slaves, to prevent any commerce with their women. The Turks often make a general amputation.

Castration also obtains in Italy, where it is used with a view to preserve the voice for singing. See EUNUCH.

The Persians, and other eastern nations, have divers methods of making eunuchs, different from those which obtain in Europe; we say, of making eunuchs, for it is not always done among them by cutting, or even collision. Cicuta and other poisonous herbs do the same office, as is shown by Paulus Ægineta. Those eunuchised in this manner are called *thlibiæ*. Besides which there is another sort, called *thlasiæ*, in whom the genitals are left entire, and only the veins which should feed them are cut; by which means the parts do indeed remain, but so lax and weak, as to be of no use.

Castration was for some time the punishment of adultery. By the laws of the Visigoths, sodomites underwent the same punishment.

By the civil law it is made penal in physicians and surgeons to castrate, even with consent of the party, who is himself included in the same penalty, and his effects forfeited. The offence of mayhem by castration is, according to all our old writers, felony; though committed upon the highest provocation. See a record to this purpose of Henry III. transcribed by Sir Edward Coke, 3 Inst. 62. or Blackstone's Com. vol. iv. p. 206.

Castration is sometimes found necessary on medicinal considerations, as in mortifications, and some other diseases of the testicles, especially the *sarcocele* and *varicocele*. Some have also used it in maniac cases.

CASTRATION is also in some sort practised on women. Athenæus mentions that King Andramytes was the first who castrated women. Hesychius and Suidas say Gyges did the same thing. Galen observes, that women cannot be castrated without danger of life; and Dalechampius, on the fore-mentioned passage of Athenæus, holds, that it is only to be understood of simple padlocking.

CASTRATION, in respect of brutes, is called GELDING and SPAYING.

CASTRATION also denotes the art of retrenching, or cutting away any part of a thing from its whole.—Castrating a book, among booksellers, is the taking out some leaf, sheet, or the like, which renders it imperfect and unfit for sale. The term is also applied to the taking away particular passages, on account of their obscenity, too great freedom with respect to government, &c.

CASTRATION, among botanists, a term derived from the fancied analogy betwixt plants and animals. The castration of plants consists in cutting off the *antheræ*, or tops of the stamina, before they have attained maturity and dispersed the pollen or fine dust contained within their substance. This operation has been frequently practised by the moderns, with a view to establish or confute the doctrine of the sexes of plants; the antheræ or tops being considered by the sexualists as the male organs of generation. The experiment of castration succeeds principally on plants which, like the melon, have their male flowers detached from the female. In such as have both male and female flowers contained within the same covers, this operation cannot be easily performed without endangering the neighbouring organs. The result of experiments on this subject by Linnæus, Alston, and other eminent botanists, may be seen under the article BOTANY.

CASTREL, a kind of hawk resembling the lanner in shape, but the hobby in size. The castrel is also called kestrel, and is of a slow and cowardly kind; her game is the grouse, though she will kill a partridge.

CASTRES, a city of Languedoc, in France, about 35 miles east of Thoulouse, containing 12,400 inhabitants. E. Long. 2. 20. N. Lat. 43. 40.

CASTRO, the capital of the island of Chiloe, on the coast of Chili in South America. W. Long. 82. 0. S. Lat. 43. 0.

CASTRO is also the capital of a duchy of the same name in the pope's territories in Italy, situated on the confines of Tuscany. E. Long. 12. 35. N. Lat. 42. 30.

CASTRO, *Pietro de*, a celebrated painter, who flourished about the middle of the 17th century. The subjects which this great artist chose to paint, were what are distinguished by the name of still life; vases, shells, musical instruments, gems, vessels of gold, silver, and crystal, books, and rich bracelets: and in those subjects his choice and disposition were elegant, and his execution admirable.

CASTRUCCIO CASTRACANI, a celebrated Italian general, was born (nobody knows of whom) at Lucca in Tuscany in 1284, and left in a vineyard covered with leaves, where he was found by Dianora a widow lady, the sister of Antonio, a canon of St Michael in Lucca, who was descended from the illustrious family of the Castracani. The lady having no children, she resolved to bring him up, and educated him as carefully as he had been her own. She intended him for a priest; but he was scarcely 14 years old when he began to devote himself to military sports, and those violent exercises which suited his great strength of body. The factions named the *Guelfs* and *Gibelines* then shared all Italy between them; divided the popes and the emperors; and engaged in their different interest not only the members of the same town, but even those of the same family. Francisco, a considerable person on the side of the Gibelines, observing Castruccio's uncommon spirit and great qualities, prevailed with Antonio to let him turn soldier; on which Castruccio soon became acquainted with every thing belonging to that profession, and was made a lieutenant of a company of foot by Francisco Guinigi. In his first campaign he gave such proofs of his courage and conduct as spread his fame all over Lombardy; and Guinigi, dying soon after, committed to him the care of his son and the management of his estate. Still distinguishing himself by his exploits, he filled his commander in chief with such jealousy and envy, that he was imprisoned by stratagem in order to be put to death. But the people of Lucca soon released him, and afterwards chose him for their sovereign prince.—The Gibelines considered him as the chief of their party;

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party; and those who had been banished from their country fled to him for protection, and unanimously promised, that if he could restore them to their estates, they would serve him so effectually that the sovereignty of their country should be his reward. Flattered by these promises, he entered into a league with the prince of Milan. He kept his army constantly on foot, employing it as best suited his own designs. For services he had done the pope, he was made senator of Rome with more than ordinary ceremony; but while there, received news which obliged him to hasten back to Lucca. The Florentines entered into a war with him, but Castruccio fought his way through them; and the supreme authority of Tuscany was ready to fall into his hands, when a period was put to his life. In May 1328 he gained a complete victory over his enemies, who amounted to 30,000 foot and 10,000 horse; in which 22,000 of them were slain, with the loss of not quite 1600 of his own men; but as he was returning from the field of battle, tired with the action, and covered with sweat, he halted a little, in order to thank and caress his soldiers as they passed; when, the north wind blowing upon him, he was immediately seized with an ague, which he at first neglected, but it carried him off in a few days, in the 44th year of his age.

Machiavel, who has written the life of Castruccio, says, that he was not only an extraordinary man in his own age, but he would have been so in any other. He was of a noble aspect, and of the most winning address. He had all the qualities that make a man great; was grateful to his friends, just to his subjects, terrible to his enemies. No man was more forward to encounter dangers; no man more careful to escape them. He had an uncommon presence of mind, and often made repartees with great smartness. Some of them are recorded, which discover a singular turn of humour; and, for a specimen, we shall mention three or four of them.—Passing one day through a street where there was a house of bad fame, he surprised a young man, who was just coming out, and who, upon seeing him, was all over blushes and confusion: "Friend, you should not be ashamed when you come out, but when you go in."—One asking a favour of him with a thousand impertinent and superfluous words: "Hark you friend; when you would have any thing with me for the future, send another man to ask it."—Another great talker having tired him with a tedious discourse, excused himself at last, by saying, he was afraid he had been troublesome. "No indeed (replied he), for I did not mind one word you said."—He was forced to put a citizen of Lucca to death, who had formerly been a great instrument of his advancement; and being reproached by somebody for having dealt so severely with an old friend, replied, "No, you are mistaken, it was with a new foe."—One of his courtiers, desirous to regale him, made a ball and invited him to it. Castruccio came, entertained himself among the ladies, danced, and did other things, which did not seem to comport with the dignity of his rank. One of his friends intimating that such freedoms might diminish the reverence that ought to be paid him; "I thank you for your caution; but he who is reckoned wise all the day, will never be reckoned a fool at night."

CASTRUM DOLORIS, in middle age writers, denotes a catafalco, or a lofty tomb of state, erected in honour of some person of eminence, usually in the church where the body is interred; and decorated with arms, emblems, lights, and the like.

Ecclesiastical writers speak of a ceremony of consecrating a *castrum doloris;* the edifice was to be made to represent the body of the deceased, and the priest and deacon were to take their posts, and say the prayers after the same manner as if the corpse were actually present.

CASTS. See CASTING.

CASU CONSIMILI, in *Law*, a writ of entry granted where a tenant, by courtesy or for life, aliens either in fee, in tail, or for the term of another's life. It is brought by him in reversion against the person to whom such tenant does so alien to the prejudice of the reversioner in the tenant's lifetime.

Casu Proviso, in *Law*, a writ of entry founded on the statute of Gloucester, where a tenant in dower aliens the lands she so holds in fee or for life; and lies for the party in reversion against the alliance.

CASUAL, something that happens fortuitously, without any design, or any measures taken to bring it to pass.

Casual Revenues, are those which arise from forfeitures, confiscations, deaths, attainders, &c.

Casual Theology, a denomination given to what is more frequently called CASUISTRY.

CASUALTY, in a general sense, denotes an accident, or a thing happening by chance, not design. It is particularly used for an accident producing unnatural death.

CASUALTY, in *Scots Law*. *Casualties of a superior*, are those duties and emoluments which a superior has a right to demand out of his vassal's estate, over and besides the constant yearly duties established by the *reddendo* of his charter upon certain casual events.

CASUALTY, in *Metallurgy*. See CAUSALTY.

CASUIST, a person who proposes to resolve cases of conscience. Escobar has made a collection of the opinions of all the casuists before him. M. le Feore, preceptor of Louis XIII. called the books of the casuists the art of quibbling with God: which does not seem far from truth, by reason of the multitude of distinctions and subtleties they abound withal. Mayer has published a bibliotheca of casuists, containing an account of all the writers on cases of conscience, ranged under three heads; the first comprehending the Lutheran, the second the Calvinist, and the third the Romish casuists.

CASUISTRY, the doctrine and science of conscience and its cases, with the rules and principles of resolving the same; drawn partly from natural reason or equity; partly from authority of Scripture, the canon law, councils, fathers, &c. To casuistry belongs the decision of all difficulties arising about what a man may lawfully do or not do; what is sin or not sin; what things a man is obliged to do in order to discharge his duty, and what he may let alone without breach of it.

CASUS AMISSIONIS, in *Scots Law*. In actions proving the tenor of obligations inextinguishable by the debtor's retiring or cancelling them, it is necessary for the pursuer, before he is allowed a proof of the tenor, to condescend upon such a *casus amissionis*, or accident

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by which the writing was destroyed, as shows it was lost while in the writer's possession.

CAT, in *Zoology*. See FELIS, MAMMALIA *Index*.

CAT, in sea affairs, a ship employed in the coal trade, formed from the Norwegian model. It is distinguished by a narrow stern, projecting quarters, a deep waists, and by having ornamental figures on the prow. These vessels are generally built remarkably strong, and carry from four to six hundred tons, or, in the language of their own mariners, from 20 to 30 *keels* of coals.

CAT, is also a sort of strong tackle, or combination of pulleys, to hook and draw the anchor perpendicularly up to the *cat-head*. See *CAT-Heads*.

CAT's-Eye, or *Sun-stone* of the Turks, a kind of gem found chiefly in Siberia. Cat's eye is by the Latins called *oculus cati*, and sometimes *onycopalus*, as having white zones or rings like the onyx, and its colours variable like OPAL, from which last it differs chiefly by its superior hardness. It is very hard, and semitransparent, and has different points, from whence the light is reflected with a kind of yellowish radiation somewhat similar to the eyes of cats, from whence it had its name. The best of them are very scarce, and jewellers cut them round to the greatest advantage. One of these stones, an inch in diameter, was in the possession of the duke of Tuscany.

CAT-fish, in *Ichthyology*. See SQUALUS, ICHTHYOLOGY *Index*.

CAT-Gut, a denomination given to small strings for fiddles, and other instruments, made of the intestines of sheep or lambs, dried and twisted together, either singly, or several together. These are sometimes coloured red, sometimes blue, but are commonly left whitish or brownish, the natural colour of the gut. They are also used by watchmakers, cutlers, turners, and other artificers. Great quantities are imported into England, and other northern countries, from Lyons and Italy.

CAT-Harpings, a purchase of ropes employed to brace in the shrouds of the lower masts behind their yards, for the double purpose of making the shrouds more tight, and of affording room to draw in the yards more obliquely, to *trim* the sails for a side-wind, when they are said to be close-hauled.

CAT-Heads, two strong short beams of timber, which project almost horizontally over the ship's bows on each side of the bowsprit; being like two radii which extend from a centre taken in the direction of the bowsprit. That part of the cat-head which rests upon the forecastle is securely bolted to the beams; the other part projects like a crane, as above described, and carries in its extremity two or three small wheels or *sheaves* of brass or strong wood, about which a rope, called the *cat-fall*, passes and communicates with the cat-block, which also contains three sheaves. The machine formed by this combination of pulleys is called the *Cat*, which serves to pull the anchor up to the cat-head, without tearing the ship's sides with its flukes. The cat-head also serves to suspend the anchor clear of the bow, when it is necessary to let it go; it is supported by a sort of knee, which is generally ornamented with sculpture. See Plate CXXXVI.

The cat-block is fitted with a large and strong hood, which catches the ring of the anchor when it is to be drawn up.

CAT-Mint. See MENTHA, BOTANY *Index*.

CAT-Salt, a name given by our salt-workers to a very beautifully granulated kind of common salt. It is formed out of the bittern, or leach brine, which runs from the salt when taken out of the pan. When they draw out the common salt from the boiling pans, they put it into long wooden troughs, with holes bored at the bottom for the brine to drain out; under these troughs are placed vessels to receive this brine, and across them small sticks to which the cat-salt affixes itself in very large and beautiful crystals. This salt contains some portion of the bitter purging salt, is very sharp and pungent, and is white when powdered, though pellucid in the mass. It is used by some for the table, but the greatest part of what is made of it is used by the makers of hard soap.

CAT-Silver. See MICA.

CATACAUSTIC CURVES, in the higher geometry, that species of caustic curves which are formed by reflection. See FLUXIONS.

CATACHRESIS, in *Rhetoric*, a trope which borrows the name of one thing to express another. Thus Milton, describing Raphael's descent from the empyreal heaven to paradise, says,

"Down thither prone in flight
"He speeds, and through the vast ethereal sky
"Sails between worlds and worlds."

CATACOMB, a grotto, or subterraneous place for the burial of the dead.

Some derive the word *catacomb* from the place where ships are laid up, which the modern Latins and Greeks called *cumba*. Others say, that *cata* was used for *ad*, and *catacumbas* for *adtumbas*; accordingly, Dadin says, they anciently wrote *catatumbas*. Others fetch the word from the Greek, κατα, and τυμβος, a hollow, cavity, or the like.

Anciently the word *catacomb* was only understood of the tombs of St Peter and St Paul; and M. Chastelain observes, that, among the more knowing of the people of Rome, the word *catacomb* is never applied to the subterraneous burying-places hereafter mentioned, but only to a chapel in St Sebastian, one of the seven stational churches; where the ancient Roman kalendars say the body of St Peter was deposited, under the consulate of Tuscus and Bassus, in 258.

CATACOMBS of Italy; a vast assemblage of subterraneous sepulchres about Rome, chiefly at about three miles from that city, in the Via Appia; supposed to be the sepulchre of the martyrs; and which are visited accordingly out of devotion, and relics thence taken and dispersed throughout the catholic countries, after having been first baptized by the pope under the name of some saint. These *catacombs* are said by many to be caves or cells wherein the primitive Christians hid and assembled themselves together, and where they interred such among them as were martyred. Each *catacomb* is three feet broad, and eight or ten high; running in form of an alley or gallery, and communicating with others; in many places they extend within a league of Rome. There is no masonry or vaulting therein, but each supports itself; the two sides, which

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Catacombs. which we may look on as the *parietes* or walls, were the places where the dead were deposited; which were laid lengthwise, three or four rows over one another, in the same *catacomb*, parallel to the alley. They were commonly closed with large thick tiles, and sometimes pieces of marble, cemented in a manner inimitable by the moderns. Sometimes, though very rarely, the name of the deceased is found on the tile: frequently a palm is seen, painted or engraven, or the cypher Xρ, which is commonly read *pro Christo*. The opinion held by many Protestant authors is, that the *catacombs* are heathen sepulcres, and the same with the puticuli mentioned by Festus Pompeius; maintaining, that whereas it was the practice of the ancient Romans to burn their dead, the custom was, to avoid expence, to throw the bodies of their slaves to rot in holes of the ground; and that the Roman Christians, observing at length the great veneration paid to relicks, resolved to have a stock of their own: entering therefore the *catacombs*, they added what cyphers and inscriptions they pleased, and then shut them up again, to be opened on a favourable occasion. Those in the secret, add they, dying or removing, the contrivance was forgot, till chance opened them at last. But this opinion has even less of probability than the former. Mr Monro, in the *Philosophical Transactions*, supposes the *catacombs* to have been originally the common sepulchres of the first Romans, and dug in consequence of these two opinions, viz. that shades hate the light; and that they love to hover about the places where the bodies are laid.

Though the catacombs of Rome have made the greatest noise of any in the world, there are such belonging to many other cities. Those of Naples, according to Bishop Burnet, are much more noble and spacious than the catacombs of Rome. Catacombs have also been discovered at Syracuse and Catanea in Sicily, and in the island of Malta. The Roman catacombs take particular names from the churches in their neighbourhood, and seem to divide the circumference of the city without the walls between them, extending their galleries everywhere under, and a vast way from it; so that all the ground under Rome, and for many miles about it, some say 20, is hollow. The largest, and those commonly shown to strangers, are the catacombs of San Sebastiano, those of Saint Agnese, and the others in the fields a little off Saint Agnese. Women are only allowed to go into the catacombs in the churchyard of the Vatican on Whitsun Monday, under pain of excommunication. There are men kept constantly at work in the catacombs. As soon as these labourers discover a grave with any of the supposed marks of a saint upon it, intimation is given to the cardinal camerlingo, who immediately sends men of reputation to the place, where finding the palm, the monogram, the coloured glass, &c. the remains of the body are taken up with great respect, and translated to Rome. After the labourers have examined a gallery, they stop up the entry that leads to it; so that most of them remain thus closed up; only a few being left open to keep up the trade of showing them to strangers. This, they say, is done to prevent people from losing themselves in these subterraneous labyrinths, which indeed has often happened; but more probably to deprive the public of the means of knowing whither and how far the catacombs are carried. Catacombs, Catalauni.

The method of preserving the dead in catacombs seems to have been common to a number of the ancient nations. The catacombs of Egypt are still extant about nine leagues from the city of Grand Cairo, and two miles from the city of Zaccara. They extend from thence to the pyramids of Pharoah, which are about eight miles distant. They lie in a field covered with a fine running sand, of a yellowish colour. The country is dry and hilly; the entrance of the tombs is choked up with sand; there are many open, but more that are still concealed.

The bodies found in catacombs, especially those of Egypt, are called *mummies*; and as their flesh was formerly reckoned an efficacious medicine, they were much sought after. In this work the labourers were often obliged to clear away the sand for weeks together, without finding what they wanted. Upon coming to a little square opening of about 18 feet in depth, they descend into it by holes for the feet placed at proper intervals; and there they are sure of finding a mummy. These caves, or *wells* as they call them there, are hollowed out of a white free-stone, which is found in all this country a few feet below the covering of sand. When one gets to the bottom of these, which are sometimes 40 feet below the surface, there are several square openings on each side into passages of 10 or 15 feet wide; and these lead to chambers of 15 or 20 feet square. These are all hewn out in the rock; and in each of the catacombs are to be found several of these apartments communicating with one another. They extend a great way under ground, so as to be under the city of Memphis, and in a meanner to undermine its environs. In some of the chambers the walls are adorned with figures and hieroglyphics; in others the mummies are found in tombs, round the apartment, hollowed out in the rock.

The Egyptians seem to have excelled in the art of embalming and preserving their dead bodies; as the mummies found in the Egyptian catacombs are in a better state than the bodies found either in the Italian catacombs or those of any other part of the world. See EMBALMING and MUMMY.

Laying up the bodies in caves, is certainly the original way of disposing of the dead; and appears to have been propagated by the Phœnicians throughout the countries to which they sent colonies: their interring as we now do in the open air or in temples was first introduced by the Christians. When an ancient hero died, or was killed in a foreign expedition, as his body was liable to corruption, and for that reason unfit to be transported entire, they fell on the expedient of burning, in order to bring home the ashes, to oblige the *manes* to follow; that so his country might not be destitute of the benefit of his tutelage. It was thus burning seems to have had its original; and by degrees it became common to all who could bear the expences of it, and took place of the ancient burying: thus *catacombs* became disused among the Romans, after they had borrowed the manner of burning from the Greeks, and then none but slaves were laid in the ground. See BURIAL, &c.

CATALAUNI, called also *Durocatalauni*, a town of of Gallia Belgica: *Catalauni*, the people. A name rather of the lower age than of classical antiquity. Now *Chalons sur Marne*, in Champagne. E. Long. 4. 35. N. Lat. 48. 55.

CATADROMUS, from κατα and δρεμω, *I run*, in antiquity, a stretched sloping rope in the theatres, down which the *funambuli* walked to show their skill. Some have taken the word to signify the hippodrome or decursorium, wherein the Roman knights used to exercise themselves in running and fighting on horseback. But the most natural meaning is that of a rope fastened at one end to the top of the theatre, and at the other to the bottom, to walk or run down, which was the highest glory of the ancient *schænobates*, or *funambuli*. Elephants were also taught to run down the *catadromus*, Suetonius speaks of the exploit of a Roman knight, who passed down the *catadromus* mounted on an elephant's back.

CATAGOGION, a heathen festival at Ephesus, celebrated on the 22d of January, in which the devotees ran about the streets, dressed in divers antic and unseemly manners, with huge cudgels in their hands, and carrying with them the images of their gods; in which guise they ravished the women they met with, abused and often killed the men, and committed many other disorders, to which the religion of the day gave a sanction.

CATAGRAPHA, in antiquity, denote oblique figures or views of men's faces; answering to what the moderns call *profiles*.

Catagrapha are said to be the invention of Simon Cleonæus, who first taught painters to vary the looks of their figures, and sometimes direct them upwards, sometimes downwards, and sometimes sidewards or backwards.

CATALEPSIS, or CATALEPSY, in *Medicine*, a kind of apoplexy, or drowsy disease, wherein the patient is taken speechless, senseless, and fixed in the same posture wherein the disease first seized him; his eyes open, without seeing or understanding. See MEDICINE *Index*.

CATALOGUE, a list or enumeration of the names of several books, men, or other things, disposed according to a certain order.

Catalogues of books are digested in different manners, some according to the order of the times when the books are printed, as that of Mattaire; others according to their form and size, as the common booksellers catalogues; others according to the alphabetical order of the authors names, as Hyde's catalogue of the Bodleian library; others according to the alphabetical order of matters or subjects, which are called *real* or *classical catalogues*, as those of Lipenius and Draudius; lastly, others are digested in a mixed method, partaking of several of the former, as De Seine's catalogue of Cardinal Slusius's library, which is first divided according to the subjects or sciences, and afterwards the books in each are recited alphabetically.

The most applauded of all catalogues is that of Thuanus's library, in which are united the advantages of all the rest. It was first drawn up by the two Puteani in the alphabetical order, then digested according to the sciences and subjects by Ishm. Bulliáldus, and published by F. Quesnel at Paris in 1679; and reprinted, though incorrectly, at Hamburgh, in 1704. The books are here ranged with justness under their several sciences and subjects, regard being still had to the nation, sect, age, &c. of every writer. Add, that only the best and choicest books on every subject are found here, and the most valuable editions. Yet the catalogue of M. le Telliers archbishop of Rheims's library, made by M. Clement, is not inferior to any published in our age, either on account of the number and choice of the books, or the method of its disposition. One advantage peculiar to this catalogue is, the multitude of anonymous and pseudonymous authors detected in it, scarce to be met with elsewhere. Some even prefer it to Thuanus's catalogue, as containing a greater variety of classes and books on particular subjects.

The conditions required in a catalogue are, that it indicate at the same time the order of the authors and of the matters, the form of the book, the number of volumes, the chronological order of the editions, the language it is written in, and its place in the library; so as that all these circumstances may appear at once in the shortest, clearest, and exactest manner possible. In this view all the catalogues yet made will be found to be defective.

An anonymous French writer has laid down a new plan of a catalogue, which shall unite all the advantages, and avoid all the inconveniences of the rest.

The Jesuits of Antwerp have given us a catalogue of the popes; which makes what they call their *Propilæum*.

CATALOGUE *of the Stars*, is a list of the fixed stars, disposed in their several constellations; with the longitudes, latitudes, &c. of each; or according to their right ascensions, that is, the order of their passing over the meridian.

The first who undertook to reduce the fixed stars into a catalogue was Hipparchus Rhodius, about 120 years before Christ; in which he made use of the observations of Timocharis and Aristyllus for about 180 years before him. Ptolemy retained Hipparchus's catalogue containing 1026 fixed stars; though he himself made abundance of observations, with a view to a new catalogue, A. D. 140. About the year of Christ 880, Albategni, a Syrian, brought down the same to his time. Anno 1437, Ulugh Beigh, king of Parthia and India, made a new catalogue of 1022 fixed stars, since translated out of Persian into Latin by Dr Hyde. The third who made a catalogue from his own observations was Tycho Brahe, who determined the places of 777 stars for the year 1600, which Kepler from other observations of Tycho afterwards increased to the number of 1000 in the Rudolphine tables; adding those of Ptolemy omitted by Tycho, and of other authors; so that his catalogue amounts to above 1160. At the same time, William, landgrave of Hesse, with his mathematicians, Christopher Rothmannus and Justus Byrgius, determined the places of 400 fixed stars by his own observations, with their places rectified for the year 1593; which Hevelius prefers to those of Tycho's. Ricciolus, in his *Astronomia Reformata*, determined the places of 101 stars for the year 1700, from his own observations; for the rest he followed Tycho's catalogue, altering it where he thought fit. Anno 1667, Dr Halley, in the island of St Helena, observed

Catalogue of the Stars.

observed 350 southern stars not visible in our horizon. The same labour was repeated by F. Noel in 1710, who published a new catalogue of the same stars constructed for the year 1687.

Bayer, in his *Uranometria*, published a catalogue of 1160 stars, compiled chiefly from Ptolemy and Tycho, in which every star is marked with some letter of the Greek alphabet; the biggest star in any constellation being denoted by the first letter, the next by the second, &c. and if the number exceeds the Greek alphabet, the remaining stars are marked by letters of the Roman alphabet, which letters are preserved by Flamsteed, and by Senex on his globes. The celebrated Hevelius composed a catalogue of 1888 stars, 1553 of which were observed by himself; and their places are computed for the year 1660.

The last and greatest is the Britannic catalogue, compiled from the observations of the accurate Mr Flamsteed; who for a long series of years devoted himself wholly thereto. As there was nothing wanting either in the observer or apparatus, we may look on this as a perfect work so far as it goes. It is to be regretted the impression had not passed through his own hands: that now extant was published by authority, but without the author's consent: it contains 2734 stars. There was another published in 1725, pursuant to his testament; containing no less than 3000 stars, with their places rectified for the year 1689: to which is added Mr Sharp's catalogue of the southern stars not visible in our hemisphere, adapted to the year 1726.

The first catalogue, we believe, that was printed in the new or second form, according to the order of the right ascension, is that of De la Caille, given in his Ephemerides for the ten years between 1755 and 1765, and printed in 1755. It contains the right ascensions and declinations of 307 stars, adapted to the beginning of the year 1750. In 1757 De la Caille published his *Astronomia Fundamenta*, containing a catalogue of the right ascensions and declinations of 398 stars, likewise adapted to the beginning of 1750. And in 1763, the year after his death, was published the *Cœlum Australe Stelliferum* of the same author; containing a catalogue of the places of 1942 stars, all situated to the southward of the tropic of Capricorn, and observed by him while he was at the Cape of Good Hope in 1751 and 1752; their places being also adapted to the beginning of 1750. In the same year was published his Ephemerides for the ten years between 1765 and 1775; in the introduction to which are given the places of 515 zodiacal stars, all deduced from the observations of the same author; the places adapted to the beginning of the year 1765.

In the Nautical Almanack for 1773, is given a catalogue of 387 stars, in right ascension, declination, longitude and latitude, derived from the observations of the late celebrated Dr Bradley, and adjusted to the beginning of the year 1760. This small catalogue, and the results of about 200 observations of the moon, are all that the public have yet seen of the multiplied labours of this most accurate and indefatigable observer, although he has now (1798) been dead upwards of 36 years.

In 1775 was published a thin volume, entitled, *Opera Inedita*, containing several papers of the late Tobias Mayer, and among them a catalogue of the right ascensions and declinations of 998 stars, which may be occulted by the moon and planets; the places being adapted to the beginning of the year 1756.

At the end of the first volume of "Astronomical Observations made at the Royal Observatory at Greenwich," published in 1776, Dr Maskelyne, the present astronomer royal, has given a catalogue of the places of 34 principal stars, in right ascension and north polar distance, adapted to the beginning of the year 1770.

These, being the result of several years repeated observations, made with the utmost care, and the best instruments, it may be presumed, are exceedingly accurate.

In 1782 M. Bode of Berlin published a very extensive catalogue of 5058 of the fixed stars, collected from the observations of Flamsteed, Bradley, Hevelius, Mayer, De la Caille, Messier, Monnier, D'Arquier, and other astronomers; all adapted to the beginning of the year 1780; and accompanied with a celestial atlas or set of maps of the constellations, engraved in a most delicate and beautiful manner.

To these may be added Dr Herschel's catalogue of double stars, printed in the Phil. Trans. for 1782 and 1783; Messier's nebulæ and clusters of stars, published in the *Connoissance des Temps* for 1784; and Herschel's catalogue of the same kind given in the Phil. Trans. for 1786.

In 1789 Mr Francis Wollaston published "A Specimen of a General Astronomical Catalogue, in Zones of North-polar Distance, and adapted to January 1. 1790." These stars are collected from all the catalogues before-mentioned, from that of Hevelius downwards. This work contains five distinct catalogues; viz. Dr Maskelyne's new catalogue of 36 principal stars; a general catalogue of all the stars, in zones of north polar distance; an index to the general catalogue; a catalogue of all the stars in the order in which they pass the meridian; and a catalogue of zodiacal stars, in longitude and latitude.

Finally, in 1792, Dr Zach published at Gotha, *Tabulæ Motuum Solis*; to which is annexed a new catalogue of the principal fixed stars, from his own observations made in the years 1787, 1788, 1789, 1790. This catalogue contains the right ascensions and declinations of 381 principal stars, adapted to the beginning of the year 1800. *Hutton's Math. Dict.*

Besides these two methods of forming *catalogues* of the stars, Dr Herschel has proposed a new one, in which the comparative brightness of the stars is accurately expressed. It is long since astronomers were first led to arrange the stars in classes of different magnitudes by their various degrees of brilliancy or lustre. Brightness and size have at all times been considered as synonymous terms; so that the brightest stars have been referred to the class comprehending those of the first magnitude; and as the subsequent orders of stars have been supposed to decrease in lustre, their magnitude has been determined in the same decreasing progression; but the want of some fixed and satisfactory standard of lustre has been the source of considerable confusion and uncertainty in settling the relative magnitude of the stars. A star marked 1.2m. is supposed to be between the first and second magnitude; but 2.1m. intimates, that the star is nearly of the second magnitude,

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magnitude, and that it partakes somewhat of the lustre of a star of the first order. Such subdivisions may be of some use in ascertaining stars of the first, second, and third classes; but the expressions 5m. 5:6m. 6.5m. 6m. must be very vague and indefinite. Dr Herschel observes that he has found them so in fact; and he therefore considers this method of pointing out the different lustre of stars as a reference to an imaginary standard. If any dependence could be placed on this method of magnitudes, "it would follow, that no less than 11 stars in the constellation of the Lion, namely, β, σ, ψ, π, ξ, A, *b*, *c*, *d*, 54, 48, 72, had all undergone a change in their lustre since Flamsteed's time: For if the idea of magnitudes had been a clear one, our author, who marked β 1.2m. and γ 2m. ought to be understood to mean that β is larger than γ; but we now find that actually γ is larger than β. Every one of the eleven stars (says Dr Herschel) which I have pointed out may be reduced to the same contradiction."

The author has pointed out the instances of the insufficiency of this method, and of the uncertain conclusions that are deduced from it, in determining the comparative brightness of stars found not only in Mr Flamsteed's catalogue, but also in the catalogues of other astronomers. It is sufficiently apparent that the present method of expressing the brightness of the stars is very defective. Dr Herschel therefore proposes a different mode, that is more precise and satisfactory.

"I place each star (says he,) instead of giving its magnitude, into a short series, constructed upon the order of brightness of the nearest proper stars. For instance, to express the lustre of D, I say CDE. By this short notation, instead of referring the star D to an imaginary uncertain standard, I refer it to a precise and determined existing one. C is a star that has a greater lustre than D, and E is another of less brightness than D. Both C and E are neighbouring stars, chosen in such a manner that I may see them at the same time with D, and therefore may be able to compare them properly. The lustre of C is in the same manner ascertained by BCD; that of B by ABC; and also the brightness of E by DEF; and that of F by EFG.

"That this is the most natural, as well as the most effectual way to express the brightness of a star, and by that means to detect any change that may happen in its lustre, will appear, when we consider what is requisite to ascertain such a change. We can certainly not wish for a more decisive evidence, than to be assured, by actual inspection, that a certain star is now no longer more or less bright than such other stars to which it has been formerly compared; provided we are at the same time assured that those other stars remain still in their former unaltered lustre. But if the star D will no longer stand in its former order CDE, it must have undergone a change; and if that order is now to be expressed by CED, the star has lost some part of its lustre; if, on the contrary, it ought now to be denoted by DCE, its brightness must have had some addition. Then, if we should doubt the stability of C and E, we have recourse to the orders BCD and DEF, which express their lustre; or even to ABC and EFG, which continue the series both ways. Now having before us the series BCDEF, or if necessary even the more extended one ABCDEFG, it will be impossible to mistake a change of brightness in D, when every member of the series is found in its proper order except D."

In the author's journal or catalogue, in which the order of the lustre of the stars is fixed, each star bears its own proper name or number, *e. g.* "the brightness of the star δ Leonis may be expressed by β δ ι Leonis, or better by 94—68—17 Leonis; these being the numbers which the three above stars bear in the British catalogue of fixed stars."

This method of arrangement occurred to Dr Herschel so early as the year 1782; but he was diverted from the regular pursuit of it by a variety of other astronomical engagements. After many trials, he proposed, in the Transactions of the Royal Society of London for 1796, the plan which appeared to him the most eligible. It is as follows:—Instead of denoting particular stars by letters, he makes use of numbers; and in the choice of the stars which are to express the lustre of any particular one, he directs his first view to perfect equality. When two stars seem to be similar both in brightness and magnitude, he puts down their numbers together, separated merely by a point, as 30.24 Leonis; but if two stars, which at first seemed alike in their lustre, appeared on a longer inspection to be different, and the preference should be always decidedly in favour of the same star, he separates these stars by a comma, thus, 41,94 Leonis. This order must not be varied; nor can three such stars, as 20, 40, 39, Libræ, admit of a different arrangement. If the state of the heavens should be such as to require a different order in these numbers, we may certainly infer that a change has taken place in the lustre of one or more of them. When two stars differ very little in brightness, but so that the preference of the one to the other is indisputable, the numbers that express them are separated by a short line, as —17—70 Leonis, or 68—17—70 Leonis. When two stars differ so much in brightness, that one or two other stars might be interposed between them, and still leave sufficient room for distinction, they are distinguished by a line and comma, thus, —, or by two lines, as 32— —41 Leonis. A greater difference than this is denoted by a broken line, thus, - - - - -29 Bootis. On the whole, the author observes, the marks and distinctions which he has adopted cannot possibly be mistaken; "a point denoting equality of lustre; a comma indicating the least perceptible difference; a short line to mark a decided but small superiority; a line and comma, or double line, to express a considerable and striking excess of brightness; and a broken line to mark any other superiority which is to be looked upon as of no use in estimations that are intended for the purpose of directing changes."

The difficulties that attend this arrangement are not disguised; but the importance and utility of it more than compensate for the labour which it must necessarily require. By a method of this kind, many discoveries of changeable and periodical stars might probably have been made, which have escaped the most diligent and accurate observers. We might then, as the author suggests, be enabled to resolve a problem in which we are all immediately concerned.

"Who, for instance, would not wish to know what degree of permanency we ought to ascribe to the lustre of our sun? Not only the stability of our climates, but the

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Catalogue of the Stars.

the very existence of the whole animal and vegetable creation itself, is involved in the question. Where can we hope to receive information upon this subject but from astronomical observations? If it be allowed to admit the similarity of stars with our sun as a point established, how necessary will it be to take notice of the fate of our neighbouring *suns*, in order to guess at that of our own! That *star*, which among the multitude we have dignified by the name of *sun*, to-morrow may slowly begin to undergo a gradual decay of brightness, like β Leonis, α Ceti, α Draconis, δ Ursæ majoris, and many other diminishing stars that will be mentioned in my catalogues. It may suddenly increase, like the wonderful star in the back of Cassiopeia's chair, and the no less remarkable one in the foot of Serpentarius; or gradually come on, like β Geminorum, β Ceti, ζ Sagittarii, and many other increasing stars, for which I also refer to my catalogues; and, lastly, it may turn into a periodical one of 25 days duration, as Algol is one of three days, δ Cephei of five, β Lyræ of six, η Antinoi of seven days, and as many others as are of various periods."

Having thus explained the general principle on which this catalogue is formed, as we find it in the author's first memoir on the subject, we must refer the reader to the doctor's own account for its particular arrangement, observing only that the catalogue subjoined comprehends nine constellations, which are arranged in alphabetical order, with the comparative brightness of the stars accurately stated. In a subsequent paper published in the same volume, he has completely verified the utility of his method by experience, and shewn that there is no permanent change of lustre in the stars. In the notes to his first catalogue he mentioned α Herculis as a periodical star. By a series of observations on this star, compared with κ Ophiuchi, which was most conveniently situated for his purpose, he has been able not only to confirm this opinion, but to ascertain its period. His observations are arranged in a table, by means of which he determines that this star had gone through four successive changes in an interval of 241 days; and therefore the duration of its period must be about 60 days and a quarter. This fact concurs with other circumstances in evincing the rotatory motion of the stars on their axes. "Dark spots, or large portions of the surface less luminous than the rest, turned alternately in certain directions, either towards or from us, will account for the phenomena of periodical changes in the lustre of the stars, so satisfactorily, that we certainly need not look out for any other cause." If it be alleged that the periods in the change of lustre of some stars, such as Algol, β Lyræ, δ Cephei, and η Antinoi, are short, being only 3, 5, 6, and 7 days respectively; while those of ο Ceti, and of the changeable star in Hydra, and that in the neck of the Swan, are long, amounting to 331, 394, and 497 days; and that we cannot ascribe phenomena so different in their duration to the same cause—it may be answered to this objection, that the force of it is founded on our limited acquaintance with the state of the heavens. To the seven stars, the periodical changes of which were before known, we may now add α Herculis, which performs a revolution of its changes in 60 days.

"The step from the rotation of α Herculis to that of ο Ceti is far less considerable than that from the period of Algol to the rotation of α Herculis; and thus a link in the chain is now supplied, which removes the objection that arose from the vacancy." The rotation of the fifth satellite of Saturn is proved by the change observable in its light; and "this variation of light, owing to the alternate exposition of a more or less bright hemisphere of this periodical satellite, plainly indicates, that the similar phenomenon of a changeable star arises from the various lustre of the different parts of its surface, successively turned to us by its rotatory motion."

Catalogue of the Stars ‖ Catana.

Besides, we perceive a greater similarity between the sun and the stars, by means of the spots that must be admitted to exist on their surfaces, as well as on that of the sun.

Dr Herschel farther observes, that the stars, besides a rotatory motion on their axes, may have other movements; "such as nutations or changes in the inclination of their axes; which, added to bodies much flattened by quick rotatory motions, or surrounded by rings like Saturn, will easily account for many new phenomena that then offer themselves to our extended views."

CATALONIA, a province of Spain, bounded on the north by the Pyrenean mountains, which divide it from France; by the kingdom of Arragon and Valencia on the west; and by the Mediterranean sea on the south and east. It is 155 miles in length, and 100 in breadth. It is watered by a great number of rivers; the principal of which are the Lobregat, the Ter, and the Segra. The air is temperate and healthy; but the land is mountainous, except in a few places. It produces, however, corn, wine, oil, pulse, flax, and hemp, sufficient for the inhabitants. The mountains are covered with large forests of tall trees, such as the oak, the ever-green oak, the beech, the pine, the fir, the chesnut, and many others; with cork trees, shrubs, and medicinal plants. There are several quarries of marble of all colours, crystal, alabaster, amethysts, and lapis lazuli. Gold dust has been found among the sands of one or two of the rivers; and there are mines of tin, iron, lead, alum, vitriol, and salt. They likewise fish for coral on the eastern coast. The inhabitants are hardy, courageous, active, vigorous, and good soldiers. Catalonia is the most industrious province in Spain. It has considerable manufactures of cottons, woollens, and silk, and carries on an extensive commerce. The population of the whole province in 1788 was 814,000, of whom 12,400 were ecclesiastics, secular or regular. In the agriculture of the country, irrigation is practised to a great extent. There are in the province, one university, one archbishopric, one grand priory, seven bishoprics, sixteen commanderies of the order of Malta, and about 300 religious establishments. The principal towns are Barcelona the capital, Tarragona, Tortosa, Lerida, Solsonia, Cardona Vich, Girona, Seu d'Urgel, Pui Cerda, and Cervera. Catalonia was the last province in Spain which submitted to Philip in the succession war.

CATAMENIA, in *Medicine*. See MENSES.

CATAMITE, a boy kept for sodomitical practices.

CATANA, or CATINA, in *Ancient Geography*, a town of Sicily, situated opposite to Ætna, to the south-east; one of the five Roman colonies: anciently built by the people of Naxus seven years after the building of Syracuse, 728 years before Christ. It was the country of

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of Charondas the famous lawgiver. The town is still called *Catanea*. See CATANEA.

CATANANCHE, CANDIA LIONS-FOOT. See BOTANY *Index*.

CATANEA, or CATANIA, a city of Sicily, seated on a gulf of the same name, near the foot of Mount Ætna, or Gibel. It was founded by the Chalcidians soon after the settlement of Syracuse, and enjoyed great tranquillity till Hiero I. expelled the whole body of citizens; and after replenishing the town with a new stock of inhabitants, gave it the name of *Ætna*: immediately after his decease, it regained its ancient name, and its citizens returned to their abodes. Catania fell into the hands of the Romans, among their earliest acquisitions in Sicily, and became the residence of a prætor. To make it worthy of such an honour, it was adorned with sumptuous buildings of all kinds, and every convenience was procured to supply the natural and artificial wants of life. It was destroyed by Pompey's son, but restored with superior magnificence by Augustus. The reign of Decius is famous in the history of this city, for the martyrdom of its patroness St Agatha. On every emergency her intercession is implored. She is piously believed to have preserved Catanea from being overwhelmed by torrents of lava, or shaken to pieces by earthquakes; yet its ancient edifices are covered by repeated streams of volcanic matter; and almost every house, even her own church, has been thrown to the ground. In the reign of William the Good, 20,000 Catanians, with their pastor at their head, were destroyed before the sacred veil could be properly placed to check the flames. In the last century the eruptions and earthquakes raged with redoubled violence, and Catania was twice demolished See ÆTNA.

The present prince of Biscari has been at infinite pains, and spent a large sum of money, in working down to the ancient town, which, on account of the numerous torrents of lava that have flowed out of Mount Ætna for these last thousand years, is now to be sought for in dark caverns many feet below the present surface of the earth. Mr Swinburne informs us that he descended into baths, sepulchres, an amphitheatre, and a theatre, all very much injured by the various catastrophes that have befallen them. They were erected upon old beds of lava, and even built with square pieces of the same substance, which in no instance appears to have been fused by the contact of new lavas: The sciarra, or stones of cold lava, have constantly proved as strong a barrier against the flowing torrent of fire as any other stone could have been, though some authors were of opinion that the hot matter would melt the old mass and incorporate with it.

This city has been frequently defended from the burning streams by the solid mass of its own ramparts, and by the air compressed between them and the lava; as appears by the torrent having stopt within a small distance of the walls, and taken another direction. But when the walls were broken or low, the lava collected itself till it rose to a great height, and then poured over in a curve. A similar instance is seen at the Torre del Greco near Naples, where the stream of liquid fire from Vesuvius divided itself into two branches, and left a church untouched in the middle. There is a well at the foot of the old walls of Catania, where the lava, after running along the parapet, and then falling forwards, has produced a very complete lofty arch over the spring.

The church here is a noble fabric. It is accounted the largest in Sicily, though neither a porch nor cupola has been erected, from a doubt of the solidity of the foundations, which are no other than the bed of lava that ran out of Ætna in 1669, and is supposed to be full of cavities. The organ is much esteemed by connoisseurs in musical instruments.

Catania, according to Mr Swinburne's account, is reviving with great splendour. "It has already (he says) much more the features of a metropolis and royal residence than Palermo: the principal streets are wide, straight, and well paved with lava. An obelisk of red granite, placed on the back of an antique elephant of touchstone, stands in the centre of the great square, which is formed by the townhall, seminary, and cathedral. The cathedral erected by the abbot Angerius in the year 1094, was endowed by Earl Roger with the territories of Catania and Ætna, for the small acknowledgment of a glass of wine and a loaf of bread offered once a-year. It has suffered so much by earthquakes, that little of the original structure remains, and the modern parts have hardly any thing except their materials to recommend them. The other religious edifices of the city are profusely ornamented, but in a bad taste. The spirit of building seems to have seized upon the people, and the prince of Biscari's example adds fresh vigour. It were natural to suppose men would be backward in erecting new habitations, especially with any degree of luxury, on ground so often shaken to its centre, and so often buried under the ashes of a volcano; but such is their attachment to their native soil, and their contempt of dangers they are habituated to, that they rebuild their houses on the warm cinders of Vesuvius, the quaking plains of Calabria, and the black mountains of Sciarra at Catania: it is, however, suprising to see such embellishments lavished in so dangerous a situation. There is a great deal of activity in the disposition of this people: they know by tradition that their ancestors carried on a flourishing commerce; and that before the fiery river filled it up, they had a spacious convenient harbour, where they now have scarce a creek for a felucca: they therefore wish to restore those advantages to Catania, and have often applied to government for assistance towards forming a mole and port, an undertaking their strength alone is unequal to; but whether the refusal originates in the deficiencies of the public treasury or the jealousy of the other cities, all the projects have ended in fruitless applications. The number of inhabitants dwelling in Catania has been estimated at 50,000: A considerable portion of this number appertains to the university, the only one in the island, and the nursery of all the lawyers." E. Long. 15. 19. N. Lat. 37. 30.

CATANZARO, a city in the kingdom of Naples, the capital of Calabria Ulterior, with a bishop's see. It is the usual residence of the governor of the province, and is seated on a mountain, in E. Long. 18. 20. N. Lat. 38. 58.

CATAPHONICS, the science which considers the properties of reflected sounds. See ACOUSTICS.

CATAPHORA, in *Medicine*, the same as COMA.

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CATAPHRACTA, (from κατα, and φρασσω, *I fortify or arm*), in the ancient military art, a piece of heavy defensive armour, formed of cloth or leather, fortified with iron scales or links, wherewith sometimes only the breast, sometimes the whole body, and sometimes the horse too, was covered. It was in use among the Sarmatians, Persians, and other barbarians. The Romans also adopted it early for their foot; and, according to Vegetius, kept to it till the time of Gratian, when the military discipline growing remiss, and field exercises and labour discontinued, the Roman foot thought the cataphracta as well as the helmet too great a load to bear, and therefore threw both by, choosing rather to march against the enemy bare-breasted; by which, in the war with the Goths, multitudes were destroyed.

Cataphractæ Naves, ships armed and covered in fight, so that they could not be easily damaged by the enemy. They were covered over with boards or planks, on which the soldiers were placed to defend them; the rowers sitting underneath, thus screened from the enemy's weapons.

CATAPHRACTUS, denotes a thing defended or covered on all sides with armour.

CATAPHRACTUS, or *Cataphractarius*, more particularly denotes a horseman, or even horse, armed with a cataphracta. The *cataphracti equites* were a sort of cuirassiers, not only fortified with armour themselves, but having their horses guarded with solid plates of brass or other metals, usually lined with skins, and wrought into plumes or other forms. Their use was to bear down all before them, to break in upon the enemy's ranks, and spread terror and havock wherever they came, as being themselves invulnerable and secure from danger. But their disadvantage was their unwieldiness, by which, if once unhorsed, or on the ground, they were unable to rise, and thus fell a prey to the enemy.

CATAPHRYGIANS, a sect in the second century, so called as being of the country of Phrygia. They were orthodox in every thing, setting aside this, that they took Montanus for a prophet, and Priscilla and Maximilla for true prophetesses, to be consulted in every thing relating to religion; as supposing the Holy Spirit had abandoned the church. See MONTANIST.

CATAPLASMA, a poultice; from καταπλασσω, *illino*, to spread like a plaster. Cataplasms take their name sometimes from the part to which they are applied, or effects they produce; so are called *anacollema, frontale, epicarpium, epispasticum, vesicatorium*; and when mustard is an ingredient, they are called *sinapisms*.

These kinds of applications are softer and more easy than plasters or ointments. They are formed of some vegetable substances, and applied of such a consistence as neither to adhere nor run; they are also more useful when the intention is effected by the perpetuity of the heat or cold which they contain, for they retain them longer than any other kind of composition.

When designed to *relax*, or to promote suppuration, they should be applied warm. Their warmth, moisture, and the obstruction they give to perspiration, is the method of their answering that end. The proper heat, when applied warm, is no more than to promote a kindly pleasant sensation; for great heat prevents the design for which they are used. They should be renewed as often as they cool. For relaxing and suppurating, none excel the white bread poultice, made with the crumb of an old loaf, a sufficient quantity of milk to boil the bread in until it is soft, and a little oil; which last ingredient, besides preventing the poultice from drying and sticking to the skin, also retains the heat longer than the bread and milk alone would do. To preserve the heat longer, the poultice, when applied, may be covered with a strong ox's bladder.

When designed to *repel*, they should be applied cold, and ought to be renewed as oft as they become warm. A proper composition for this end is a mixture of oatmeal and vinegar.

CATAPULTA, in antiquity, a military engine contrived for the throwing of arrows, darts, and stones upon the enemy.—Some of these engines were of such force that they would throw stones of an hundred weight. Josephus takes notice of the surprising effects of these engines, and says, that the stones thrown out of them beat down the battlements, knocked off the angles of the towers, and would level a whole file of men from one end to the other, was the phalanx ever so deep. This was called the

Battering Catapulta, and is represented on Plate CXXXV. This catapulta is supposed to carry a stone, &c. of an hundred weight; and therefore a description of it will be sufficient to explain the doctrine of all the rest; for such as threw stones of 500 and upwards, were constructed on the same principles.

The base is composed of two large beams 2, 3. The length of these beams is fifteen diameters of the bore of the capitals 9. At the two extremities of each beam, two double mortises are cut to receive the eight tenons of two cross beams, each of them four of the diameters in length. In the centre of each of the beams of the base, and near two-thirds of their length, a hole, perfectly round, and 16 inches in diameter, should be bored; these holes must be exactly opposite to each other, and should increase gradually to the inside of the beams, so that each of them, being 16 inches on the outside towards the capitals 9, should be $17\frac{1}{2}$ at the opening on the inside, and the edges carefully rounded off. The capitals 9 are, in a manner, the soul of the machine, and serve to twist and strain the cordage, which forms its principle or power of motion.

The capitals are either of cast brass or iron; each consisting of a wheel with teeth, C 10, of $2\frac{1}{2}$ inches thick. The hollow or bone of these wheels should be $11\frac{1}{4}$ inches in diameter, perfectly round, and the edges smoothed down. As the friction would be too great if the capitals rubbed against the beams by the extreme straining of the cordage, which draws them towards these beams, that inconvenience is remedied by the means of eight friction wheels, or cylinders of brass, about the 13th of an inch in diameter, and an inch and one sixth in length, placed circularly, and turning upon axes, as represented at D 13, B 12. One of these friction wheels at large, with its screw, by which it is fastened into the beam, is represented at A.

Upon this number of cylindrical wheels the capitals 9 must be placed in the beams 2, 3, so that the cylinders

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Catapulta. ders do not extend to the teeth of the wheels, which must receive a strong pinion 14. By means of this pinion the wheel of the capital is made to turn for straining the cordage with the key 15. The capital wheel has a strong catch 16, and another of the same kind may be added, to prevent any thing from giving way through the extreme and violent force of the strained cordage.

The capital piece of the machine is a nut or cross pin of iron, 17, seen at C, and hammered cold into its form. It divides the bore of the capitals exactly in two equal parts, and fixed in grooves about an inch deep. This piece, or nut, ought to be about two inches and one-third thick at the top 18, as represented in the section at B; and rounded off and polished as much as possible, that the cords folded over it may not be hurt or cut by the roughness or edges of the iron. Its height ought to be eight inches, decreasing gradually in thickness to the bottom, where it ought to be only one inch. It must be very exactly inserted in the capitals.

After placing the two capitals in the holes of the two beams in a right line with each other, and fixing the two cross diametrical nuts or pieces over which the cordage is to wind, one end of the cord is reeved through a hole in one of the capitals in the base, and made fast to a nail withinside of the beam. The other side of the cord is then carried through the hole in the opposite beam and capital, and so wound over the cross pieces of iron in the centre of the two capitals, till they are full, the cordage forming a large skain. The tension or straining of the cordage ought to be exactly equal, that is, the several foldings of the cord over the capital pieces should be equally strained, and so near each other as not to leave the least space between them. As soon as the first folding or skain of cord has filled up one whole space or breadth of the capital pieces, another must be carried over it; and so on, always equally straining the end till no more will pass through the capitals, and the skain of cordage entirely fills them, observing to rub it from time to time with soap.

At three or four inches behind the cordage, thus wound over the capital pieces, two very strong upright beams 21 are raised; these are posts of oak 14 inches thick, crossed over at top by another of the same solidity. The height of the upright beams is $7\frac{1}{8}$ diameters; each supported behind with very strong props 25, fixed at bottom in the extremities of the base 2, 3. The cross beam 24 is supported in the same manner by a prop in the centre.

The tree, arm, or stylus 22, should be of sound ash. Its length is from 15 to 16 diameters of the bore of the capitals. The end at the bottom, or that fixed in the middle of the skain, is 10 inches thick, and 14 broad. To strengthen the arm or tree, it should be wrapped round with a cloth dipped in strong glue like the tree of a saddle, and bound very hard with waxed thread of the sixth of an inch in diameter, from the large end at bottom, almost to the top, as represented in the figure.

At the top of the arm, just under the iron hand or receiver 27, a strong cord is fastened, with two loops twisted one within another, for the greater strength. Into these two loops the hook of a brass pulley 28 is put. The cord 29 is then reeved through the pulley, Catapulta
and fastened to the roll 30. The cock or trigger 31, ‖
which serves as a stay, is then brought to it, and Cataractes.
made fast by its hook to the extremity of the hand 27, in which the body to be discharged is placed. The pulley at the neck of the arm is then unhooked; and when the trigger is to let it off, a stroke must be given upon it with an iron bar or crow of about an inch in diameter; on which the arm flies up with a force almost equal to that of a modern mortar. The cushion or stomacher 23, placed exactly in the middle of the cross-beam 24, should be covered with tanned ox-hide, and stuffed with hair, the arm striking against it with inconceivable force. It is to be observed, that the tree or arm 22 describes an angle of 90 degrees, beginning at the cock, and ending at the stomacher or cushion.

CATAPULTA for Arrows, Spears, or Darts. Some of the spears, &c. thrown by these engines, are said to have been 18 feet long, and to have been thrown with such velocity as to take fire in their course.

ABCD is the frame that holds the darts or arrows, Fig. 2.
which may be of different numbers, and placed in different directions. EF is a large and strong iron spring, which is bent by a rope that goes over three pulleys, I, K, L, and is drawn by one or several men; this rope may be fastened to a pin at M. The rope, therefore, being set at liberty, the spring must strike the darts with great violence, and send them, with surprising velocity, to a great distance. This instrument differs in some particulars from the description we have of that of the ancients; principally in the throwing of several darts at the same time, one only being thrown by theirs.

CATARACT, in *Hydrography*, a precipice in the channel of a river, caused by rocks, or other obstacles, stopping the course of the stream, from whence the water falls with greater noise and impetuosity. The word comes from καταῤῥασσω, "I tumble down with violence;" compounded of κατα, "down," and ῥασσω, *dejicio*, "I throw down."—Such are the cataracts of the Nile, the Danube, Rhine, &c. In that of Niagara, the perpendicular fall of the water is 137 feet; and in that of Pistil Rhaiadr, in North Wales, the fall of water is near 240 feet from the mountain to the lower pool.

Strabo calls that a *cataract* which we call a *cascade*: and what we call a *cataract*, the ancients usually called a *catadupa*. Herminius has an express dissertation, "De admirandis mundi Cataractis supra et subterraneis;" where he uses the word in a new sense; signifying by cataract, any violent motion of the elements.

CATARACT, in *Medicine* and *Surgery*, a disorder of the humours of the eye, by which the pupilla, that ought to appear transparent and black, looks opaque, blue, gray, brown, &c. by which vision is variously impeded, or totally destroyed. See SURGERY.

CATARA, a town of Dalmatia, and capital of the territory of the same name, with a strong castle, and a bishop's see. It is subject to Venice, and is seated on a gulf of the same name. E. Long. 19. 19. N. Lat. 42. 25.

CATARACTES, the trivial name of a species of LARUS. See ORNITHOLOGY *Index*.

CATARRH,

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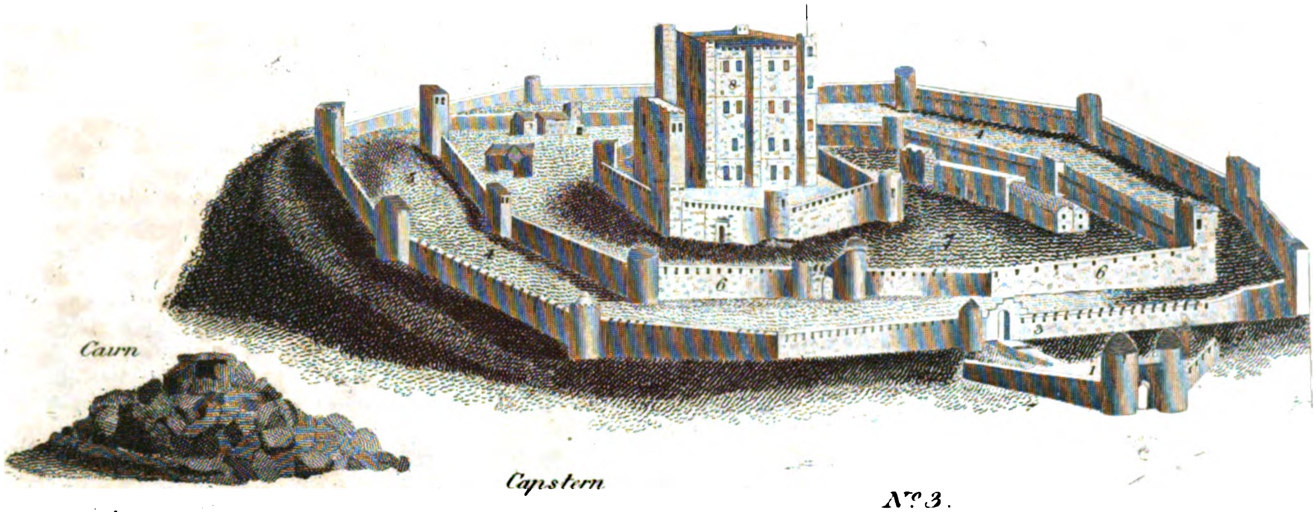

Capstern

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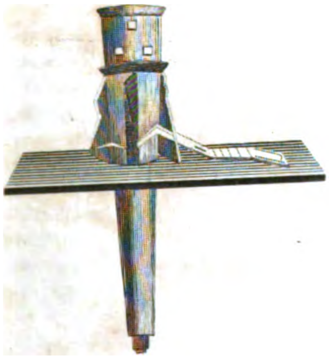

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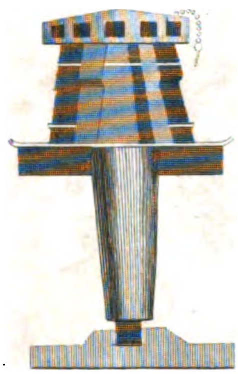

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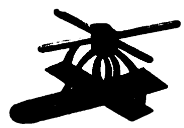
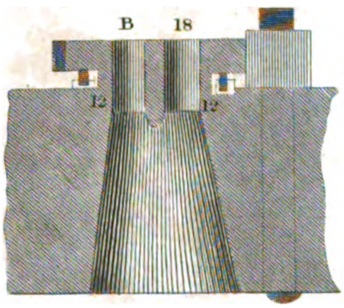
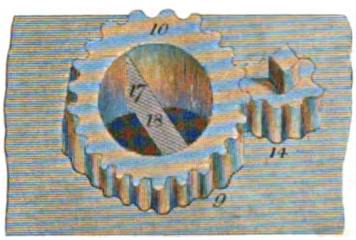


Catapulta

A



C



D

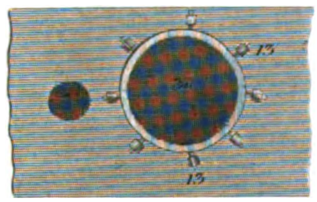
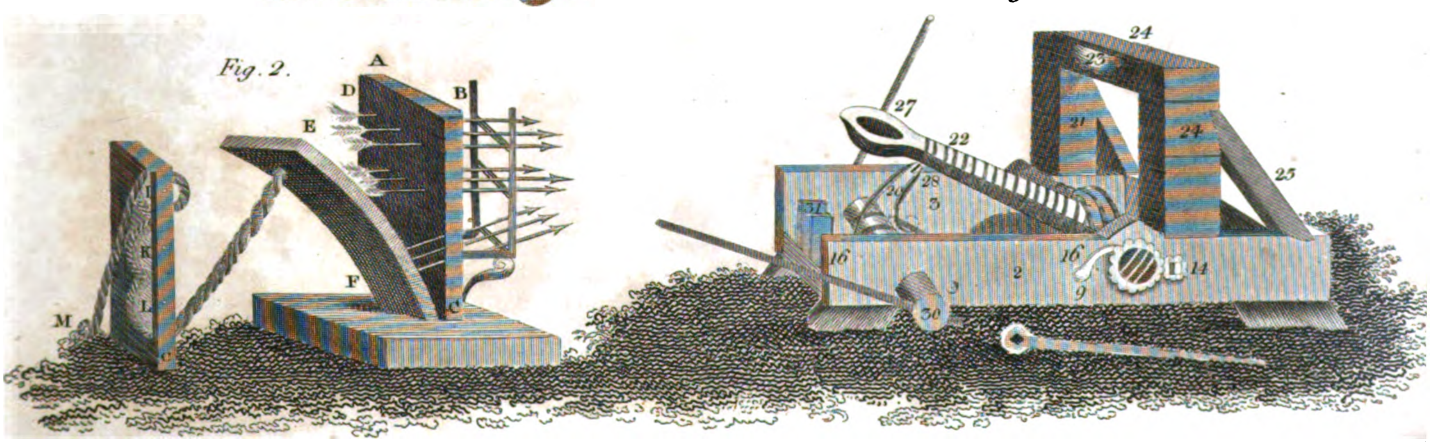


Fig. 1.



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CATARRH, in *Medicine*, a distillation or defluxion from the head upon the mouth and aspera arteria, and through them upon the lungs. See MEDICINE *Index*.

CATASTASIS, in *Poetry*, the third part of the ancient drama; being that wherein the intrigue, or action, set forth in the epitasis, is supported, carried on, and heightened, till it be ripe for the unravelling in the catastrophe. Scaliger defines it, the full growth of the fable, while things are at a stand in that confusion to which the poet has brought them.

CATASTROPHE, in *Dramatic Poetry*, the fourth and last part in the ancient drama; or that immediately succeeding the catastasis: or, according to others, the third only; the whole drama being divided into protasis, epitasis, and catastrophe; or in the terms of Aristotle, prologue, epilogue, and exode.

The catastrophe clears up every thing, and is nothing else but the discovery or winding up of the plot. It has its peculiar place: for it ought entirely to be contained, not only in the last act, but in the very conclusion of it: and, when the plot is finished, the play should be so also. The catastrophe ought to turn upon a single point, or start up on a sudden.

The great art in the catastrophe is, that the clearing up of all difficulties may appear wonderful, and yet easy, simple, and natural.

It is a very preposterous artifice in some writers to show the catastrophe in the very title of the play. Mr Dryden thinks that a catastrophe resulting from a mere change in the sentiments and resolutions of a person, without any other machinery, may be so managed as to be exceedingly beautiful.

It is a dispute among the critics, whether the catastrophe should always fall out favourably on the side of virtue or not. The reasons on the negative side seem the strongest. Aristotle prefers a shocking catastrophe to a happy one.—The catastrophe is either simple or complex. The first is that in which there is no change in the state of the principal persons, nor any discovery or unravelling, the plot being only a mere passage out of agitation into quiet repose. In the second, the principal persons undergo a change of fortune, in the manner already defined.

CATCH, in the musical sense of the word, a fugue in unison, wherein, to humour some conceit in the words, the melody is broken, and the sense interrupted in one part, and caught again or supported by another; as in the catch in Shakespeare's play of the Twelfth Night, where there is a catch sung by three persons, in which the humour is, that each who sings, calls and is called *knave* in turn: Or, as defined by Mr Jackson, "a catch is a piece for three or more voices, one of which leads, and the others follow in the same notes. It must be so contrived, that rests (which are made for the purpose) in the music of one line be filled up with a word or two from another line; these form a cross purpose, or catch, from whence the name."

CATCH-Fly. See LYCHNIS, BOTANY *Index*.

CATCH-Pole, (quasi one that *catches* by the *pole*), a term used, by way of reproach, for the bailiff's follower or assistant.

CATCH-Word, among printers, that placed at the bottom of each page, being always the first word of the following page.

CATECHESIS, in a general sense, denotes an instruction given any person in the first rudiments of an art or science; but more particularly of the Christian religion. In the ancient church, catechesis was an instruction given *viva voce*, either to children or adult heathens, preparatory to their receiving of baptism. In this sense, *catechesis* stands contradistinguished from *mystagogica*, which were a higher part of instruction given to those already initiated, and containing the mysteries of faith. Those who give such instructions are called *catechists;* and those who receive them, *catechumens*.

CATECHETIC, or CATECHETICAL, something that relates to oral instruction in the rudiments of Christianity.—Catechetic schools were buildings appointed for the office of the catechist, adjoining to the church, and called *catechumena:* such was that in which Origen and many other famous men read catechetical lectures at Alexandria. See CATECHUMEN.

CATECHISM, in its primary sense, an instruction, or institution, in the principles of the Christian religion, delivered *viva voce*, and so as to require frequent repetitions, from the disciple or hearer, of what has been said. The word is formed from κατηχεω, a compound of κατα and ηχεω, q. d. *circumsono;* alluding to the noise or din made in this sort of exercise, or to the zeal and earnestness wherewith things are to be inculcated over and over on the learners.—Anciently the candidates for baptism were only to be instructed in the secrets of their religion by tradition, *viva voce*, without writing; as had also been the case among the Egyptian priests, and the British and Gaulish druids, who only communicated the mysteries of their theology by word of mouth.

CATECHISM is more frequently used in modern times for an elementary book, wherein the principal articles of religion are summarily delivered in the way of question and answer.

CATECHIST, (κατηχητης, *catecheta*), he that catechises, *i. e.* he that instructs novices in the principles of religion.

CATECHIST more particularly denotes a person appointed by the church to instruct those intended for baptism, by word of mouth, in the fundamental articles of the Christian faith. The catechists of churches were ministers usually distinct from the bishops and presbyters, and had their auditors or *catechumena* apart. Their business was to instruct the catechumens, and prepare them for the reception of baptism. But the catechists did not constitute any distinct order of the clergy, but were chosen out of any other order. The bishop himself sometimes performed the office; at other times presbyters, or even readers or deacons, were the catechists. Origen seems to have had no higher degree in the church than reader, when he was made catechist at Alexandria, being only 18 years of age, and consequently incapable of the deaconship.

CATECHU, in the *Materica Medica*, a name given to the extract otherwise known by the name of *Terra-Japonica*, or Japan earth. See *ARECA* and *MIMOSA*.

CATECHUMEN,

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CATECHUMEN, a candidate for baptism, or one who prepares himself for the receiving thereof.

The catechumens, in church history, were the lowest order of Christians in the primitive church. They had some title to the common name of Christian, being a degree above pagans and heretics, though not consummated by baptism. They were admitted to the state of catechumens by the imposition of hands, and the sign of the cross. The children of believing parents were admitted catechumens, as soon as ever they were capable of instruction: but at what age those of heathen parents might be admitted, is not so clear. As to the time of their continuance in this state, there were no general rules fixed about it; but the practice varied according to the difference of times and places, and the readiness and proficiency of the catechumens themselves.

There were four orders or degrees of catechumens; the first were those instructed privately without the church, and kept at a distance for some time, from the privilege of entering the church, to make them the more eager and desirous of it. The next degree were the *audientes*, so called from their being admitted to hear sermons and the Scriptures read in the church, but were not allowed to partake of the prayers. The third sort of catechumens were the *genu-flectentes*, so called because they received imposition of hands kneeling. The fourth order was the *competentes et electi*, denoting the immediate candidates for baptism, or such as were appointed to be baptized the next approaching festival; before which, strict examination was made into their proficiency under the several stages of catechetical exercises.

After examination, they were exercised for twenty days together, and were obliged to fasting and confession: some days before baptism they went veiled; and it was customary to touch their ears, saying, *Ephatha*, *i. e.* be opened; as also to anoint their eyes with clay; both ceremonies being in imitation of our Saviour's practice, and intended to shadow out to the catechumens their condition both before and after their admission into the Christian church.

CATEGORICAL, in a general sense, is applied to those things ranged under a CATEGORY.

CATEGORICAL also imports a thing to be absolute, and not relative; in which sense it stands opposed to *hypothetical*. We say, a *categorical* proposition, a *categorical* syllogism, &c.

A *categorical* answer denotes an express and pertinent answer made to any question or objection proposed.

CATEGORY, in *Logic*, a series or order of all the predicates or attributes contained under any genus.

The school philosophers distribute all the objects of our thoughts and ideas into certain *genera* or classes, not so much, say they, to learn what they do not know, as to communicate a distinct notion of what they do know; and these classes the Greeks called *categories*, and the Latins *predicaments*.

Aristotle made ten categories, viz. substance, quantity, quality, relation, action, passion, time, place, situation, and habit, which are usually expressed by the following technical distich:

Arbor, sex, servos, ardore, refrigerat, ustos,
Rure cras stabo, nec tunicatus ero.

CATEK. See BENGAL.

CATENARIA, in the higher geometry, the name of a curve line formed by a rope hanging freely from two points of suspension, whether the points be horizontal or not. See FLUXIONS.

CATERPILLAR, in *Zoology*, the name of all winged insects when in their reptile or worm state. See ENTOMOLOGY *Index*.

Method of destroying CATERPILLARS *on Trees.*—Take a chafing dish with lighted charcoal, and placing it under the branches that are loaded with caterpillars, throw some pinches of brimstone upon the coals. The vapour of the sulphur, which is mortal to these insects, will not only destroy all that are on the tree, but prevent it from being infested with them afterwards. A pound of sulphur will clear as many trees as grow on several acres. This method has been successfully tried in France. In the *Journal Oeconomique*, the following is said to be infallible against the caterpillars feeding on cabbage, and perhaps may be equally serviceable against those that infest other vegetables. Sow with hemp all the borders of the ground where you mean to plant your cabbage; and, although the neighbourhood is infested with caterpillars, the space enclosed with the hemp will be perfectly free, not one of the vermine will approach it.

CATERPILLAR-*Eaters*, a name given by some authors to a species of worms bred in the body of the caterpillar, and which eat its flesh; these are owing to a certain kind of fly that lodges her eggs in the body of this animal, and they, after their proper changes, become flies like their parents.

M. Reaumur has given us, in his history of insects, some very curious particulars in regard to these little worms. Every one of them, he observes, spins itself a very beautiful case of a cylindric figure, made of a very strong sort of silk; these are the cases in which this animal spends its state of chrysalis; and they have a mark by which they may be known from all other animal productions of this kind, which is, that they have always a broad stripe or band surrounding their middle, which is black when the rest of the case is white, and white when that is black. M. Reaumur has had the pains and patience to find out the reason of this singularity, which is this: the whole shell is spun of a silk produced out of the creature's body; this at first runs all white, and towards the end of the spinning turns black. The outside of the case must necessarily be formed first, as the creature works from within: consequently this is truly white all over, but it is transparent, and shows the last spun or black silk through it. It might be supposed that the whole inside of the shell should be black; but this is not the case: the whole is fashioned before this black silk comes; and this is employed by the creature, not to line the whole, but to fortify certain parts only; and therefore is all applied either to the middle, or to the two ends omitting the middle; and so gives either a black band in the middle, or a blackness at both ends, leaving the white in the middle to appear. It is not unfrequent

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unfrequent to find a sort of small cases, lying about garden walks, which move of themselves; when these are opened, they are found to contain a small living worm. This is one of the species of those caterpillar-eaters; which, as soon as it comes out of the body of that animal, spins itself a case for its transformation long before that happens, and lives in it without food till that change comes on; and it becomes a fly like that to which it owed its birth.

CATERVA, in ancient military writers, a term used in speaking of the Gaulish or Celtiberian armies, denoting a body of 6000 armed men. The word *caterva*, or *catervarius*, is also frequently used by ancient writers to denote a party or corps of soldiers in disorder or disarray; by which it stands distinguished from cohort or turma, which were in good order.

CATESBÆA, the LILYTHORN. See BOTANY *Index*.

CATHÆRETICS, in *Pharmacy*, medicines of a caustic nature, serving to eat off fungous flesh.

CATHARINE. *Knights of St CATHARINE of Mount Sinai*, an ancient military order, erected for the assistance and protection of pilgrims going to pay their devotion to the body of St Catharine, a virgin of Alexandria, distinguished for her learning, and said to have suffered martyrdom under Maximin. The body of the martyr having been discovered on Mount Sinai, caused a great concourse of pilgrims; and travelling being very dangerous, by reason of the Arabs, an order of knighthood was erected in 1063, on the model of that of the holy sepulchre, and under the patronage of St Catharine; the knights of which obliged themselves by oath to guard the body of the saint, keep the roads secure, observe the rule of St Basil, and obey their grand master. Their habit was white, and on it were represented the instruments of martyrdom whereby the saint had suffered; viz. a half wheel armed with spikes, and traversed with a sword stained with blood.

CATHARINE. *Fraternity of St Catharine at Sienna*, a sort of religious society, instituted in that city in honour of St Catharine, a saint famous for her revelations, and for her marriage with Jesus Christ, whose wedding ring is still preserved as a valuable relick. This fraternity yearly endows a certain number of destitute virgins, and has the privilege of redeeming annually two criminals condemned for murder, and the same number of debtors, by paying their debts.

CATHARTICS, in *Medicine*, remedies which promote evacuation by stool. See MATERIA MEDICA.

CATHEDRA, in a general sense, a chair. The word is more particularly used for a professor's chair, and a preacher's pulpit.

CATHEDRA is also used for the bishop's see, or throne in a church.

CATHEDRAL, a church wherein is a bishop's see or seat: See CHURCH and BISHOP. The word comes from the Greek καθεδρα, "chair," of καθεζομαι, *sedeo*, "I sit." The denomination *cathedral* seems to have taken its rise from the manner of sitting in the ancient churches, or assemblies of primitive Christians: in these, the council, *i. e.* the elders and priests, was called *Presbyterium*; at their head was the bishop, who held the place of chairman, *Cathedralis*, or *Ca-*

thedraticus; and the presbyters, who sat on either side, were also called by the ancient fathers, *Assessores Episcoporum*. The episcopal authority did not reside in the bishop alone; but in all the presbyters, whereof the bishop was president. A *cathedral*, therefore, originally, was different from what it is now; the Christians, till the time of Constantine, having no liberty to build any temple: by their churches they only meant their assemblies; and by *cathedrals*, nothing more than consistories.

CATHERINE PARR. See PARR.

CATHERINE I. *Empress of Russia*, a most extraordinary personage, whose history deserves to be given in detail. She was the natural daughter of a country girl; and was born at Ringen, a small village upon the lake Virtcherve, near Dorpt, in Livonia. The year of her birth is uncertain; but according to her own account, she came into the world on the 5th of April 1687. Her original name was Martha, which she changed for Catherine when she embraced the Greek religion. Count Rosen, a lieutenant-colonel in the Swedish service, who owned the village of Ringen, supported, according to the custom of the country, both the mother and the child; and was, for that reason, supposed by many persons to have been her father. She lost her mother when she was but three years old; and, as Count Rosen died about the same time, she was left in so destitute a situation, that the parish-clerk of the village received her into his house. Soon afterwards Gluck, Lutheran minister of Marienburgh, happening, in a journey through those parts, to see the foundling, took her under his protection, brought her up in his family, and employed her in attending his children. In 1701, and about the 14th year of her age, she espoused a dragoon of the Swedish garrison of Marienburgh. Many different accounts are given of this transaction: one author of great credit affirms that the bride and bridegroom remained together eight days after their marriage; another, of no less authority, asserts, on the contrary, that on the morning of the nuptials her husband being sent with a detachment for Riga, the marriage was never consummated. This much is certain, that the dragoon was absent when Marienburgh surrendered to the Russians, and Catherine, who was reserved for a higher fortune, never saw him more.

General Bauer, upon the taking of Marienburgh, saw Catherine among the prisoners; and, being smitten with her youth and beauty, took her to his house, where she superintended his domestic affairs, and was supposed to be his mistress. Soon afterwards she was received into the family of Prince Menzikof, who was no less struck with the attractions of the fair captive. With him she lived until 1704; when, in the 17th year of her age, she became the mistress of Peter the Great, and won so much upon his affections, that he espoused her on the 29th of May 1711. The ceremony was secretly performed at Jawerof in Poland, in the presence of General Bruce; and on the 20th of February 1712, it was publicly solemnized with great pomp at Petersburgh.

Catherine, by the most unwearied assiduity and unremitted attention, by the softness and complacency of her disposition, but above all by an extraordinary liveliness

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Catherine. liveliness and gaiety of temper, acquired a wonderful ascendency over the mind of Peter. The latter was subject to occasional horrors, which at times rendered him gloomy and suspicious, and raised his passions to such a height as to produce a temporary madness. In these dreadful moments Catherine was the only person who durst venture to approach him; and such was the kind of fascination she had acquired over his senses, that her presence had an instantaneous effect, and the first sound of her voice composed his mind and calmed his agonies. From these circumstances she seemed necessary not only to his comfort, but even to his very existence; she became his inseparable companion on his journeys to foreign countries, and even in all his military expeditions.

The peace of Pruth, by which the Russian army was rescued from certain destruction, has been wholly attributed to Catherine, though she was little more than an instrument in procuring the consent of Peter. The latter, in his campaign of 1711 against the Turks, having imprudently led his troops into a disadvantageous situation, took the desperate resolution of cutting his way through the Turkish army in the night. With this resolution he retired to his tent in an agony of despair, and gave positive orders that no one should be admitted under pain of death. In this important juncture the principal officers and the vice-chancellor Shassirof assembled in the presence of Catherine, and drew up certain preliminaries in order to obtain a truce from the grand vizier. In consequence of this determination, plenipotentiaries were immediately despatched without the knowledge of Peter, to the grand vizier, and a peace obtained upon more reasonable conditions than could have been expected. With these conditions Catherine, notwithstanding the orders issued by Peter, entered his tent, and prevailed upon him to sign them. Catherine, by her conduct on this occasion, acquired great popularity; and the emperor particularly specifies her behaviour at Pruth as one of the reasons which induced him to crown her publicly at Moscow with his own hand. This ceremony was performed in 1724; and although designed by Peter only as a proof of his affection, was the principal cause of her subsequent elevation.

Her influence continued undiminished until a short time before the death of the emperor, when some circumstances happened which occasioned such a coldness between them as would probably have ended in a total rupture, if his death had not fortunately intervened. The original cause of this misunderstanding arose from the following discovery of a secret connection between Catherine and her first chamberlain, whose name was Mons. The emperor, who was suspicious of this connection, quitted Petersburgh under pretence of removing to a villa for a few days, but privately returned to his winter palace in the capital. From thence he occasionally sent one of his confidential pages, with a complimentary message to the empress, as if he had been in the country, and with secret orders to observe her motions. From the page's information the emperor, on the third night, surprised Catherine in an arbour of the garden with her favourite Mons; while his sister, Madame Balke, who was first lady of the bedchamber to the empress, was, in company with a page, upon the watch without the arbour.

Peter, whose violent temper was inflamed by this discovery, struck Catherine with his cane, as well as the page, who endeavoured to prevent him from entering the arbour, and then retired without uttering a single word either to Mons or his sister. A few days after this transaction these persons were taken into custody, and Mons was carried to the winter palace, where no one had admission to him but Peter, who himself brought him his provisions. A report was at the same time circulated, that they were imprisoned for having received bribes, and making their influence over the empress subservient to their own mercenary views. Mons being examined by Peter, in the presence of Major-general Uschacoff, and threatened with the torture, confessed the corruption which was laid to his charge. He was beheaded; his sister received five strokes of the knout, and was banished into Siberia; two of her sons, who were chamberlains, were also degraded, and sent as common soldiers among the Russian troops in Persia. On the day subsequent to the execution of the sentence, Peter conveyed Catherine in an open carriage under the gallows to which was nailed the head of Mons. The empress, without changing colour at this dreadful sight, exclaimed, "What a pity it is that there is so much corruption among courtiers!"

This event happened in the latter end of the year 1724; and as it was soon followed by Peter's death, and Catherine upon her accession recalled Madame Balke, it has been suspected that she shortened the days of her husband by poison. But notwithstanding the critical situation for Catherine in which he died, and her subsequent elevation, this charge is totally destitute of the least shadow of proof; for the circumstances of Peter's disorder were too well known, and the peculiar symptoms of his last illness sufficiently account for his death, without the necessity of recurring to poison.

While Peter was yet lying in the agonies of death, several opposite parties were caballing to dispose of the crown. At a considerable meeting of many among the principal nobility, it was secretly determined, on the moment of his dissolution, to arrest Catherine, and to place Peter Alexievitch upon the throne. Bassevitz, apprised of this resolution, repaired in person to the empress, although it was already night. "My grief and consternation," replied Catherine, "render me incapable of acting myself: do you and Prince Menzikof consult together, and I will embrace the measures which you shall approve in my name." Bassevitz, finding Menzikof asleep, awakened and informed him of the pressing danger which threatened the empress and her party. As no time remained for long deliberation, the prince instantly seized the treasure, secured the fortress, gained the officers of the guards by bribes and promises, also a few of the nobility, and the principal clergy. These partizans being convened in the palace, Catherine made her appearance; she claimed the throne in right of her coronation at Moscow; she exposed the ill effects of a minority; and promised, that, "so far from depriving the great duke of the crown, she would receive it only as a sacred deposit, to be restored to him when she should be united, in another world, to an adored husband, whom she was now upon the point of losing."

The

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Catherine.

The pathetic manner with which she uttered this address, and the tears which accompanied it, added to the previous distribution of large sums of money and jewels, produced the desired effect: at the close of this meeting the remainder of the night was employed in making the necessary preparations to insure her accession in case of the emperor's death.

Peter at length expired on the morning of the 28th of January 1725. This event being made known, the senate, the generals, the principal nobility and clergy, hastened to the palace to proclaim the new sovereign. The adherents of the great duke seemed secure of success, and the friends of Catherine were avoided as persons doomed to destruction. At this juncture Bassevitz whispered one of the opposite party, "The empress is mistress of the treasure and the fortress; she has gained over the guards and the synod, and many of the chief nobility; even here she has more followers than you imagine; advise therefore your friends to make no opposition as they value their heads." This information being rapidly circulated, Bassevitz gave the appointed signal, and the two regiments of guards, who had been gained by a largess to declare for Catherine, and had already surrounded the palace, beat to arms. "Who has dared (exclaimed Prince Repnin, the commander in chief), to order out the troops without my knowledge?" "I, (returned General Butterlin), without pretending to dispute your authority, in obedience to the commands of my most gracious mistress." This short reply was followed by a dead silence. In this moment of suspense and anxiety Menzikof entered, preceding Catherine, supported by the duke of Holstein. She attempted to speak, but was prevented by sighs and tears from giving utterance to her words: at length, recovering herself, "I come (she said,) notwithstanding the grief which now overwhelms me, to assure you, that, submissive to the will of my departed husband, whose memory will be ever dear to me, I am ready to devote my days to the painful occupations of government, until Providence shall summon me to follow him." Then, after a short pause, she artfully added, "If the great duke will profit by my instructions, perhaps I shall have the consolation, during my wretched widowhood, of forming for you an emperor worthy of the blood and the name of him whom you have now irretrievably lost." "As this crisis (replied Menzikof) is a moment of such importance to the good of the empire, and requires the most mature deliberation, your majesty will permit us to confer, without restraint, that this whole affair may be transacted without reproach, as well in the opinion of the present age as in that of posterity." "Acting as I do (answered Catherine) more for the public good than for my own advantage, I am not afraid to submit all my concerns to the judgment of such an enlightened assembly: you have not only my permission to confer with freedom; but I lay my commands upon you all to deliberate maturely on this important subject, and I promise to adopt whatever may be the result of your decisions." At the conclusion of these words the assembly retired into another apartment, and the doors were locked.

It was previously settled by Menzikof and his party that Catherine should be empress; and the guards, who surrounded the palace with drums beating and colours flying, effectually vanquished all opposition. The only circumstance, therefore, which remained, was to give a just colour to her title, by persuading the assembly that Peter intended to have named her his successor. For this purpose Menzikof demanded of that emperor's secretary, whether his late master had left any written declaration of his intentions? The secretary replied, "That a little before his last journey to Moscow he had destroyed a will; and that he had frequently expressed his design of making another, but had always been prevented by the reflection, that if he thought his people, whom he had raised from a state of barbarism to a high degree of power and glory, could be ungrateful, he would not expose his final inclinations to the insult of a refusal; and that if they recollected what they owed to his labours, they would regulate their conduct by his intentions, which he had disclosed with more solemnity than could be manifested by any writing." An altercation now began in the assembly, and some of the nobles having the courage to oppose the accession of Catherine, Theophanes archbishop of Plescoff called to their recollection the oath which they had all taken in 1722 to acknowledge the successor appointed by Peter, and added, that the sentiments of that emperor delivered by the secretary were in effect an appointment of Catherine. The opposite party, however, denied these sentiments to be so clear as the secretary chose to insinuate; and insisted, that as their late monarch had failed to nominate his heir, the election of the new sovereign should revert to the state. Upon this the archbishop farther testified, that the evening before the coronation of the empress at Moscow, Peter had declared, in the house of an English merchant, that he should place the crown upon her head with no other view than to leave her mistress of the empire after his decease. This attestation being confirmed by many persons present, Menzikof cried out, "What need have we of any testament? A refusal to conform to the inclination of our great sovereign, thus authenticated, would be both unjust and criminal. Long live the Empress Catherine!" These words being instantaneously repeated by the greatest part of those who were present, Menzikof, saluting Catherine by the title of empress, paid his first obeisance by kissing her hand; and his example was followed by the whole assembly. She next presented herself at the window to the guards and to the people, who shouted acclamations of, "Long live Catherine!" while Menzikof scattered among them handfuls of money. Thus (says a contemporary) the empress was raised to the throne by the guards, in the same manner as the Roman emperors by the prætorian cohorts, without either the appointment of the people or of the legions.

The reign of Catherine may be considered as the reign of Menzikof, that empress having neither inclination or abilities to direct the helm of government; and she placed the most implicit confidence in a man who had been the original author of her good fortune, and the sole instrument of her elevation to the throne.

During her short reign her life was very irregular; she was extremely averse to business; would frequently, when the weather was fine, pass whole nights in the open air; and was particularly intemperate in the use

Catherine. use of tokay wine. These irregularities, joined to a cancer and a dropsy, hastened her end; and she expired on the 17th of May 1727, a little more than two years after her accession to the throne, and in about the 40th year of her age.

As the deaths of sovereigns in despotic countries are seldom imputed to natural causes, that of Catherine has also been attributed to poison; as if the disorders which preyed upon her frame were not sufficient to bring her to her grave. Some assert that she was poisoned in a glass of spirituous liquor; others by a pear given her by General Diever. Suspicions also fell upon Prince Menzikof, who, a short time before her decease, had a trifling misunderstanding with her, and who was accused of hastening her death, that he might reign with still more absolute power during the minority of Peter II. But these reports deserve not the least credit, and were merely dictated by the spirit of party, or by popular rumour.

Catherine was in her person under the middle size, and in her youth delicate and well formed, but inclined to corpulency as she advanced in years. She had a fair complexion, dark eyes, and light hair, which she was always accustomed to dye with a black colour. She could neither read nor write: her daughter Elizabeth usually signed her name for her, and particularly to her last will and testament; and Count Osterman generally put her signature to the public decrees and dispatches. Her abilities have been greatly exaggerated by her panegyrists. Gordon, who had frequently seen her, seems of all writers to have represented her character with the greatest justness, when he says, "She was a very pretty well-looked woman, of good sense, but not of that sublimity of wit, or rather that quickness of imagination, which some people have believed. The great reason why the czar was so fond of her, was her exceeding good temper; she never was seen peevish or out of humour; obliging and civil to all, and never forgetful of her former condition; withal, mighty grateful." Catherine maintained the pomp of majesty with an air of ease and grandeur united; and Peter used frequently to express his admiration at the propriety with which she supported her high station, without forgetting that she was not born to that dignity.

The following anecdotes will prove that she bore her elevation meekly; and, as Gordon asserts, was never forgetful of her former condition. When Wurmb, who had been tutor to Gluck's children at the time that Catherine was a domestic in that clergyman's family, presented himself before her after her marriage with Peter had been publicly solemnized, she recollected and addressed him with great complacency; "What, thou good man, art thou still alive! I will provide for thee." And she accordingly settled upon him a pension. She was no less attentive to the family of her benefactor Gluck, who died a prisoner at Moscow; she pensioned his widow; made his son a page; portioned the two eldest daughters; and advanced the youngest to be one of her maids of honour. If we may believe Weber, she frequently inquired after her first husband; and, when she lived with Prince Menzikof, used secretly to send him small sums of money, until, in 1705, he was killed in a skirmish with the enemy.

But the most noble part of her character was her peculiar humanity and compassion for the unfortunate. Motraye has paid a handsome tribute to this excellence. "She had, in some sort, the government of all his (Peter's) passions; and even saved the lives of a great many more persons than Le Fort was able to do: she inspired him with that humanity which, in the opinion of his subjects, nature seemed to have denied him. A word from her mouth in favour of a wretch just going to be sacrificed to his anger, would disarm him; but if he was fully resolved to satisfy that passion, he would give orders for the execution when she was absent, for fear she should plead for the victim." In a word, to use the expression of the celebrated Munich, *Elle etoit proprement la mediatrice entre le monarque et ses sujets.*"

Catherine. CATHERINE II. Empress of Russia, whose original name was Sophia Augusta Frederica, was the daughter of Christian Augustus of Anhalt Zerbst, a small district in Upper Saxony, and was born in the castle of Zerbst, on the 23d of May 1729. She was educated under the eye of her parents, along with her brother Prince Frederic Augustus, and at an early period displayed a masculine spirit. Elegant, majestic, and handsome in her person, her complexion exhibited the union of the lily and the rose, while a native dignity was tempered by a smile of beneficence. But it was early observed, that she concealed under this a certain austerity of disposition, and an ambition, which was even then considered as excessive, and proved afterwards to be insatiable.

She soon learned all the fashionable accomplishments of that day. In addition to her native language, she wrote and conversed in French; of music she acquired a competent knowledge, and excelled particularly in needlework, which she did not disdain to practise after her elevation to the throne.

The empress Elizabeth, who had pitched upon her nephew the duke of Holstein Gottorp Oldenbourg for her successor, was also desirous to choose a consort for him, and the princess of Anhalt Zerbst was selected upon this occasion, when only fourteen years of age. She was chiefly indebted for so unexpected an honour to the tender regard which her imperial majesty always entertained for the memory of her uncle, who had been her lover; and in an evil hour she united the fate of the prince, better known afterwards by the name of Peter III. to that of the princess of Anhalt Zerbst. In consequence of a special invitation, the future empress repaired to St Petersburgh, accompanied by her mother, and being admitted into the bosom of the Greek church, the ceremonial of marriage, after some delay, took place; on which these august personages were formally acknowledged, by her imperial majesty and the senate, as grand duke and duchess of Russia. Elizabeth, at the same time, presented them with the palace of Oranienbaum, delightfully situated on the gulf of Cronstadt, as a summer residence; this had formerly belonged to Menzikof, the favourite of Peter the Great, who, in this capricious court, had been by turns a pye-boy, a prince, and an exile.

The grand duke was far from being handsome; on the contrary, his person was disagreeable, and almost disgusting. His education had been greatly neglected, and he was passionately found of military parade. Frederick

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Catherine. derick of Prussia was at once his friend and his model; he kept up a secret correspondence with that monarch at the time when Russia was at open war with him; he was accustomed in his cups to kneel before a picture of this hero; and after quaffing a bumper, he would exclaim, "My brother! we shall conquer the world together."

The first moments of this union seemed to be peculiarly auspicious. The illustrious pair were accustomed to withdraw themselves daily, as if desirous to enjoy the pleasure of each other's company, in preference to the giddy dissipation of a court. It was perceived at last, that grandeur was not incompatible with happiness, and that hymeneal felicity was not confined to plebeian life.

The empress hoped that the name and pretensions of Prince Iwan would be obliterated by the issue of the grand duke, and the whole empire impatiently wished for and now expected an heir to the throne of Peter the Great. It has since been discovered, that this young couple occupied their time in a far different manner than was then suspected! His highness, it seems, retired from society on purpose to perfect himself in the Prussian exercise, and his consort on these occasions participated in his diversions, for he was accustomed to make her stand for hours together, as a centinel, with a musquet at her shoulder. This species of entertainment did not altogether suit the disposition of a young princess of an ardent temperament, and her highness accordingly began, in her own language, to think "that she was made for something else." Although she did not love, she at this period governed her husband, and even concealed his foibles; imagining at first that she could not reign but by means of him, she wisely determined to make him appear worthy of a throne.

A marriage of eight years was not productive of any issue, and strange suspicions began to be entertained. This alarmed the court, for a formidable rival, who possessed a superior claim to the throne, still existed; it is true, he was in bondage, but in a country like Russia, the interval might not be long between a dungeon and a throne. The birth of a son and daughter, soon after this, put an end to all apprehensions of this kind, and tended not a little to give stability to the empire.

The grand duke, who at times discovered noble, and even magnanimous sentiments, had about this period formed a most unfortunate connection with Elizabeth Voronsoff, a lady of high rank, but neither celebrated for her beauty nor her talents. He seldom saw his consort in private, and all the hours that were not occupied either by military exhibitions, or the pleasures of the table, were entirely devoted to his mistress.

The grand duchess, on the other hand, is said to have spent much of her time in company with a young Pole, whose history, like that of Catherine's, has since been interwoven with the annals of Europe. This was Count Poniatowski, afterwards known as Stanislaus Augustus king of Poland. He was the third son of a grandee of the same name, the favourite of Charles XII. of Sweden, by the princess Ezatoryska, who boasted the possession of the noblest blood in Poland, as she traced her descent from the Jagellon, the ancient sovereigns of Lithuania. His person was of exquisite symmetry, his air noble, his manners agreeable; in short, he possessed a charming exterior, and his mind, a circumstance extremely rare, was no less graceful than his person. At this period he was in no higher station, than a gentleman in the suite of the minister plenipotentiary from England, who had formed an intimacy with his family during a former mission at Warsaw. Being now taught to look higher, he returned to his native country, and appeared soon after at Petersburgh, as ambassador from the king of Poland. In this new capacity he did not forget to pay his respects at the little court of Oranienbaum, and the young plenipotentiary, with a view of ingratiating himself with the grand duke, smoked, drank, and praised the king of Prussia. At length Paul Petrowisch received the Polish minister with coolness, and he was actually forbidden to visit at the palace. This, however, it is said, did not deter him from concealing the order of the white eagle, and disguising himself as a mechanic, under which assumed quality he repaired one summer's evening to the gardens, in the neighbourhood of the gulf of Cronstadt; but he was discovered by his highness, who ordered him to be brought before him, and, after affecting to reprimand the captain of his guard for his disrespect to the representative of a crowned head, told him he was at liberty to depart.

From this moment the grand duchess is said to have changed both her system and her conduct. She had formerly aspired only to direct the counsels of the future emperor; she now resolved, if possible, to obtain the crown for her son, and the regency for herself. Such a task would have discouraged a common mind, for it was impossible to achieve this without prevailing on the empress to consent to dethrone her own nephew. Bestuchef, the grand chancellor, who hated the heir apparent, joined cordially in their scheme: and Elizabeth, who herself had obtained the crown by means of a revolution, was taught to tremble for her life, in consequence of the designs of her successor, who was represented as having resolved to shorten her days by poison. But a sudden and unexpected revolution in the ministry put an end to these intrigues; for Bestuchef was driven into exile, and Poniatowski recalled.

A long and melancholy interval now ensued, during which the ambition of the grand duchess was rather suspended than annihilated. She, however, had recourse to, and soothed her anguish by means of books; it was in her study that she laid the foundation of her future greatness, and rendered herself in some measure deserving of a throne. During her leisure moments she found means to gain partisans, and she acquired the favour of the soldiery, who did duty around her person, by means of her liberality and condescension. Peter, on the other hand, to the personal exertions of a common soldier, added the orgies of a debauchee. Surrounded by his male and female favourites, he consumed whole days and nights in intoxication, and forgot that he was a prince. There were some few moments, however, when he appeared great, and even magnanimous, but unfortunately they were of short duration; and it was his misfortune to have a weak woman for his mistress, and an able and ambitious one for his wife.

Such was the situation of the court when Elizabeth died, on the 5th of January 1762. This event, so productive of interesting effects, had been long foreseen

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Catherine. by Catherine, who now began to act a more conspicuous part on the theatre of public affairs. Her sorrow, which appeared unbounded, was only equalled by her devotion. She was constantly employed either at her prayers in the cathedral, or occupied in public processions, during which she scrupulously adhered to all the ceremonious practices of the Greek church. The courtiers were astonished at the sudden change, and affected to survey it with contempt; but it imposed on the populace, and the priests were highly gratified with the zeal of the empress, more especially as her consort had always treated their mysteries with indignity.

Another design, meditated with no less art, proved unsuccessful. She is said to have made use of all her eloquence to persuade Peter, that he ought to leave off the barbarous custom of being proclaimed emperor by the army, in the same manner as his predecessors: instead of this, she proposed that his title should be recognised by the senate alone, and produced a speech which she herself had composed for the occasion; but Godowitz, one of the favourites, and the only friend of the new sovereign, perceived the snare, and, partly owing to his entreaties, and partly from an attachment to every thing military, the soldiery were as usual gratified with the ceremony of saluting the czar.

The grand duke now ascended the throne, by the name of Peter III. and the commencement of the new reign appeared to be peculiarly auspicious. The catastrophe, which terminated a short reign of six months, may be attributed to three apparently trifling, but, in reality, irretrievable errors; for it is allowed on all hands, that if they did not constitute the original cause, they at least afforded the pretext for his dethronement and murder. The first of these was, the sudden peace with, and marked predilection for, the king of Prussia, certainly the greatest monarch of his age; the second, an attempt to reform a barbarous and fanatical clergy, whose power Peter I. had curbed, but whose persons he still affected to consider as sacred; the third was, the war against Denmark.

Let it be recollected, however, in honour to his memory, that the young monarch, immediately after his elevation, threw open the state prisons, recalled Munich, Biron, Lestock, and several others, who had offended him during the late reign, from Siberia; that he limited the despotism of his officers, abridged his own power, by abolishing a state inquisition, exercised under the name of *the Secret Council of Chancery*; and that he framed the memorable decree which enfranchised the nobles from compulsive service in the army, and permitted them to travel without the royal permission.

The following answer to a letter from the king of Prussia, who had requested him to be on his guard against the plot then meditating, conveys no unfavourable opinion of his heart.

"Touching the interest you express for my safety, I request you will rest contented. I am called the father of my soldiers—they prefer a male to a female government. I walk alone constantly in St Petersburgh—if any mischief is meditated, it would have been effected long since; but I am a general benefactor. I repose myself on the protection of heaven; trusting to that, I have nothing to fear."

This false security proved his ruin. While his mind was occupied with plans of reform, and he aspired to rival, and even to excel, his illustrious predecessor, whose name he had assumed, a person who had sworn fidelity to him at the altar, and who owed allegiance by the double ties of a wife and a subject, was actually employed in planning a conspiracy, and organizing a revolt, against him. It has been said that he intended to have shut up his consort and son in a convent. But did a meditated imprisonment justify treachery, treason, and murder? On the other hand, it is known that, so far from this being the intention of Peter, he was preparing for a journey to Holstein, and had actually empowered his consort to act as regent during his absence. Catherine.

The mistakes of the emperor did not escape the eagle eyes of his enemies. He purposed to carry his guards into Holstein, with a view to recover the possessions wrested from his ancestors. The regiments that had hitherto done duty at the palace, and were inured to the indulgences of the capital, revolted at the idea of a foreign war: they had been accustomed to be governed by women, and they were taught to fix their eyes on the consort of the czar.

It is not the least wonderful part of her conduct, that previously to the great catastrophe now meditating, Catherine contrived to appear abandoned by all the world. She knew how interesting a female, and more especially an empress, appeared while in distress: and she took care to heighten the sensibility of the public, by bursting at times into a flood of tears. This artful woman had found means to attach many persons to her destiny: it must be owned, however, that her adherents were neither so powerful, nor so numerous as to afford her any well-founded hopes of success. She had gained several subalterns, and some privates, of the guards: but her principal partizans consisted of the Princess D'Aschekof, niece to the new chancellor: Prince Rozamouski, who had risen from obscurity, having been originally a peasant; Odart, an intriguing Italian; and Panin, governor to the grand duke. The arrest of Passick, one of the conspirators, seemed to lead to a discovery, which would have proved fatal to the malcontents; but this very circumstance induced them to declare instantly, and in the end crowned an apparently rash attempt with success.

The empress, who was asleep at the castle of Petershoff, received intimation of their design by a common soldier, who soon after returned with a carriage and eight horses. On the faith of this man, and accompanied only by a few peasants, a German female domestic, and a French valet de chambre, she arrived at eight o'clock in the morning in the capital, and stopped opposite the barracks of the regiment of Ismailoff. There she addressed the soldiers in an eloquent speech, intermingled with sighs and tears, and actually found means to persuade them that she and her son had but that moment escaped from the bands of assassins, sent by the emperor to murder them. This story, by agitating the passions of the troops, had a wonderful effect on them, and they all swore, with the exception of only one regiment, to die in defence of her and the young archduke. On this the empress ordered a crucifix to be brought, and commanded the priests to administer a new oath of allegiance. She afterwards repaired to one of the principal churches, where she was met

Catherine. met by the bishop of Novogorod and the clergy, and, having returned thanks to Almighty God, ascended a balcony, and presented her son to the people. In a few hours she was again seen, dressed in the uniform of the guards, riding at the head of a numerous and well-appointed army against her husband.

That unfortunate prince first made a shew of resistance, and manned his Lilliputian batteries, at Oranienbaum, with his Holstein guards, in order to oppose what appeared to him to be a contemptible sedition. When it was too late, he attempted to get possession of Cronstadt. He might still have escaped to Revel, but the women in his galley were apprehensive of danger, and the courtiers shuddered at the proposition of old Munich, who wished them to assist the sailors in rowing.

On the first intelligence of the plot, this intrepid warrior had repaired to his benefactor, and advised him to march directly to the capital, at the head of his German troops." "I shall precede you, (said the generous veteran), and my dead body shall be a rampart to your sacred person." But, on the other hand, the emissaries of the empress, bathing his hands in their crocodile tears, deprecated resistance, magnified the danger, and invited him to repose in the inviolable fidelity of his consort. In short, on the 14th of July 1762, he was taken prisoner by the orders of his own wife, to whom he had been married 14 years, prevailed on by the threats and intreaties of Count Panin to renounce his crown, conveyed to the castle of Robscha, and three days afterwards put to death. Of the titled minions, who perpetrated this daring murder, one carried the guilty marks of the czar's scymitar on his forehead to the grave, and another, tortured for years by the remembrance of the last bloody scene in the tragedy of his expiring sovereign, exhibited a shocking spectacle of insanity and remorse.

The empress, on her assumption of the now vacant crown, notified the event to all the courts of Europe, under her new name of Catherine Alexiewna II. But there was still a competitor for the empire, and suspicion never slumbers near a throne. This was Prince Iwan, son to the princess of Mecklenburgh, and grand nephew to Peter the Great, and the empress Anna Iwanowna, who had destined him for her successor; but in consequence of a former revolution, he was seized while yet an infant, and doomed to lead a life of captivity. During 18 years of precarious existence, he had been shut up in the castle of Schlusselbourg, and never in all that time did he breathe the open air, or behold the sky, but once. This prince was visited by Peter III. who finding him in an arched room, 20 feet square, determined to set him at liberty; but, alas! the youth, in consequence of his long and solitary confinement had been deprived of his senses. In this situation, the emperor determined to build a house for him, with a convenient terrace, where he might take the air daily within the fortress. Such, however, are the changes of fortune, that, in three weeks, he himself was also precipitated from a throne, and exposed to a violent death. This event was but the prelude to that of Iwan; for, as orders had been given, in case of an attempt to rescue him, that an end should be put to his life; and a real or pretended plot having been hatched for this purpose, the motives and details of which have hitherto been involved in the most profound obscurity, the unhappy prince experienced the same fate as his generous protector. Catherine.

Catherine being now firmly seated on the throne, wisely determined to divert the thoughts of the nation from the late horrid scenes, and fix them on more agreeable objects. Having soothed Prussia, acquired a preponderance in the cabinet of Denmark, long become an absolute monarchy, and entered into a league with the popular party in Sweden, not yet bereft of its liberties, she cast her eyes on Courland, then governed by Prince Charles of Saxony, the second son of Augustus III. king of Poland; and, finding that country admirably situated for the increase of her present, and the extension of her future power, she, in 1762, expelled the lawful sovereign, and invested Biron, a creature of her own, with the ducal cap. Not content with this, the new duke, soon reduced to the most abject dependence, was prevented from resigning his precarious power, and the states assembled at Mittau were actually interdicted from nominating a successor. This, however, was only a prelude to far greater scenes, for she had hardly dethroned one sovereign before she undertook to create another. Augustus II. or, as he is called by some, Augustus III. of Poland, having died at Dresden, in 1763, her imperial majesty did not let slip so fair an opportunity for interfering in the appointment to the vacant throne, and even placing one of her dependents on it. Count Poniatowski, on the elevation of Catherine, had sent a friend to Petersburgh, to sound the disposition of the empress about his return to that capital, where he naturally hoped to participate in her power, and bask in the sunshine of the royal smiles. But the more prudent German, who was at this very moment meditating a splendid provision for him elsewhere, prohibited the journey from political motives. Accordingly, notwithstanding the opposition of the grand chancellor Bestucheff, and indeed of all her ministers, she determined to invest him with the ensigns of royalty. The head of the house of Brandenburgh, swayed by his hatred to Saxony and Austria, or, what is still more likely, the Prussian eagle having perhaps, even now, scented his future prey, Catherine was enabled to send 10,000 men into Poland, who, encamping on the banks of the Vistula, overawed the deliberations of the diet, assembled on the 9th of May 1764, and placed Stanislaus Augustus on the throne. Thus, by the appearance of a camp filled with Russian mercenaries, was violated one of the fundamental laws of the commonwealth, established ever since the time of Sigismund Augustus, two centuries before, in consequence of which the election of a king is deemed void while there are any foreign troops within the territories of the republic; and so justly jealous were the ancient Poles of their national independence, that the marshal of the diet, on those occasions, was accustomed to request all ambassadors to absent themselves, as he could not be answerable for the safety of their persons.

Having conferred the crown of Poland, September 7. 1764, on an amiable and accomplished prince, who, on account of his youth, his poverty, and even his dependence on Russia, would have been excluded from that painful pre-eminence had the free suffrage of the nation been collected; and who was, in consequence of,

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Catherine. of the hatred of his countrymen, still more subjected to the dominion of the empress, she began to prepare for a war against the Turks, which was accordingly declared in 1768. During this contest the Greek cross was triumphant both by sea and land. On the first of these elements her fleet, under Count Orloff, entered the straits of Gibraltar, and carried terror and desolation among the islands in the Archipelago, and throughout the defenceless shores of Asia Minor; on the second, her armies, under Galitzen and Romanzoff, achieved many important victories, seized on the fortress of Choczim, and prevailed on the Greek inhabitants of Wallachia and Moldavia to acknowledge her as their sovereign.

In the mean time, however, a dangerous insurrection broke out in the heart of her dominions, instigated by a Cossack of the name of Pugatscheff, who pretended to be Peter III. After displaying great valour and considerable talents, which had enabled him, at the head of raw and undisciplined levies, to contend against veteran troops and experienced generals, this unfortunate man was at length seized, inclosed in an iron cage, and beheaded at Moscow on the 21st of January 1775.

A peace had been concluded on the 21st of July, in the preceding year, with the Porte, which proved highly honourable to Russia; but it was productive of little benefit, for the liberty of navigating the Black sea, and a free trade with all the ports of the Turkish empire, which would have afforded inestimable advantages to a civilized people, was scarcely of any consequence to a nation unacquainted alike with commerce and manufactures.

Accordingly, we find her imperial majesty still unsatisfied. Ambition, which in a female bosom is ever insatiable, stimulated her to attempt new acquisitions, and we learn with astonishment that her diplomatic artifices proved infinitely more hostile to the Turkish crescent, than even her victorious arms. Scarcely had four years elapsed, when, after an armed negotiation, a new treaty of pacification was agreed to by the reluctant sultan, on the 21st of March 1789, in consequence of which the Crimea was declared independent: an event not calculated to close ancient jealousies, but on the contrary to produce fresh dissensions, as it afforded an opening into the very heart of the Turkish empire, and a ready pretext for future interference. New claims and new concessions immediately followed. Russia insisted on establishing consuls in the three provinces of Moldavia, Wallachia, and Bessarabia, which she was accordingly permitted to do by the treaty of 1781. Mortifying as this compliance was, it produced but a short respite. The emperor Joseph was now brought upon the political stage, and the Roman and Russian eagles, after hovering over the carcase of the Turkish empire, and meditating to devour the whole, were at last content with a part of the prey. The empress, as it may be readily believed, was not inattentive to her own interests; and by the treaty of Constantinople, signed January 9. 1784, to Russia was ceded the entire sovereignty of the Crimea, which then received its ancient name of Taurica, the isle of Taman, and part of Cuban.

It was now in the 58th year of her age, and the 25th of her reign, that Catherine may be said to have attained the very summit of her wishes. There was no one who pretended to the throne, unless her son Paul Petrowitz, an amiable prince, who had attained his 33d year, without displaying the least symptom of ambition, and who besides was superintended with the most watchful jealousy. She had triumphed over a nation, supposed to be the *natural* enemy of Russia, both by arms and negotiations, and she dazzled her barbarous subjects with the blaze of her glory, for they were eager to forget her errors, in order to contemplate a grandeur which soothed their national vanity. Knowing the effect of splendour upon ignorance, she ushered in the year 1787 with a brilliant journey to Cherson. Accompanied thither at once by a court and an army, with foreign ambassadors, an emperor and a king in her train, she intended to have assumed the high-sounding titles of Empress of the East, and Liberator of Greece. At Kiow, where she remained during three months, she was received under triumphal arches, and, having heard the petitions of the deputies from distant nations, and extended the walls of that city, she inscribed, with an arrogant anticipation, the following motto, in Greek characters, on the quarter next to Constantinople: "Through this gate lies the road to Byzantium."

Scarcely, however, had the empress, after visiting Moscow, returned to her capital, than the Turk thought proper to declare war. Her majesty, long since prepared for an event which was far from being displeasing, called forth the stipulated succours of her ally the emperor; and the combined army under the prince de Cobourg made itself master of Choczim, at the end of a siege of three months. Oczakow, after a still more obstinate resistance, was taken by storm, by the Russians alone. A diversion, however, was made by the king of Sweden, who, subsidized with Turkish gold, and directed by Prussian counsels, fought his own battles at the expence of his ally. But the exertions of this monarch were principally confined to the indecisive naval actions of Stoogland, in which both parties claimed the victory, and this was soon after followed by a convention for peace.

Disembarrassed from an active, if not a powerful enemy, the empress no longer confined her conquests to the course of the Danube, but crowned the campaign with the capture of Ismael, which was taken by storm on the 22d of December. On this occasion Suwarrow, one of her favourite generals, displayed a horrid mixture of courage and cruelty, and thus proved, to a demonstration, that personal bravery is far from being incompatible with the deadliest revenge. Incensed at the gallant resistance of the Turks, like Cæsar, he snatched a standard from a subaltern, and planted it with his own hand on the walls of the city; like Sylla, he doomed the vanquished to experience a bloody proscription, and upwards of 30,000 men, women, and children, if we are to credit the boastful account of the barbarians themselves, perished by the sword and bayonet of the unsparing Russians.

Instead of regaining the Crimea, as had been expected by the sultan, the fortress of Oczakow, and all the territories between the rivers Bog and Dniester, were assigned to the empress, who now found herself nearer

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Catherine. nearer to that Byzantium, on which she had so eagerly fixed her eye, by a whole campaign, than at the commencement of hostilities.

Having concluded a final treaty of peace with the Turk, on the 9th of January 1792, by which the river Dniester became the boundary of the two empires, and was to be navigated by both, the empress had more time to apply her attention to European politics. Part of Poland had been dismembered and partitioned during the year 1772, not only in contravention to the general rights of nations, but in direct opposition to the most solemn treaties on the part of Russia, Prussia, and Austria. The revolution which took place in that ill-fated country on May 3. 1791, and which afforded the prospect of a happy and stable government to the remains of the republic, was the signal of its annihilation. The imperial and royal spoilers seized this opportunity to fall once more in concert on their prey, which they forced to expire under their talons; and they have since cut it into shares, and attempted to disfigure it by new names, lest it should one day be reclaimed by the lawful owners. After this insult to humanity, Stanislaus, whom posterity may acknowledge as an unfortunate, but surely not as a great king, was forced soon after to abdicate, and allowed to retire into obscurity with his mistress, his children, and a pension.

Another great object had for some time engaged the attention of Catherine and her cabinet. This was the French revolution; an event pregnant with consequences that involved the claims, or, more properly speaking, the existence of all the sovereigns of Europe. With a treasury nearly exhausted by the war with the Ottoman Porte, which was not then terminated, and at a distance from the scene of action, the empress could not well engage in the contest; but she readily entered into the coalition, and soon after subsidized her late enemy the king of Sweden; but that enterprising prince met his fate, on the night of the 16th of March 1792, by the hand of an assassin.

Notwithstanding this sinister event, the head of the Greek church, compassionating the fate of the pretended father of the Christian world, promised to exert herself for the restoration of Avignon to the holy see. She also launched forth a menacing manifesto against France, and prepared for a new war.

The empress has hitherto been contemplated in her public character. It may not be amiss now to fix our eyes on the individual; to pay some attention to the sex of the sovereign, and, viewing majesty as it were in an undress, behold the woman lurking behind the princess.

It might have been supposed, that in the neighbourhood of the Hyperborean regions, the passions, if not dormant, would be at least moderate, and that the men would consequently be temperate, and the women chaste. The contrary, however, is the case; and it is left to the philosopher to determine, whether the double windows and heated rooms of St Petersburgh, added to an affectation of oriental manners, be not to the full as critical, in respect to female virtue, as the climate of Naples and Turin. Certain it is, however, that, during the reign of Catherine II. no remarkable increase of indecorum took place, and that any occasional indiscretions appear to have made but little impression on the public mind. Catherine.

Count Gregory Orloff, distinguished in Russia by the appellation of Gregorevitsch, was one of the handsomest men in the north. Gratitude and affection both conspired to procure him a favourable reception at court: and from an obscure condition he soon rose to the highest offices of the state, which he, in fact, governed. His opinion in the cabinet was listened to with deference, and he was invested with the supreme military command. Still higher honours awaited him. The empress-queen was solicited to grant him a diploma of prince of the empire; it was next in contemplation to decorate him with the titles of Duke of Ingria and Carelia, and the chancellor Bestucheff actually proposed to the empress that he should be admitted as the partner of her bed and throne. But this scheme was blasted by the interference of Count Panin; who, not content with his own remonstrances, invoked the interposition of Razumoffsky and Vorontzoff, and found means to divert Catharine from her purpose.

Soon after this the conduct of Orloff began to give dissatisfaction; for he absented himself from court; went but seldom to the palace; resided principally in the country; and, being extremely addicted to hunting, dedicated whole weeks to the chace of the bear. Panin, who had frequently experienced his arrogance, deemed this a happy opportunity to procure his disgrace. He accordingly introduced a young officer named Vissensky, who, being directed by the artful minister, behaved in such a manner as to give reason to believe that he would soon reign uncontrolled. Pride, however, on this occasion supplied the place of affection, and Orloff suddenly altering his conduct, his rival was dismissed with superb presents, and invested with an employment that required his residence in a remote province.

A new favourite soon after made his appearance in the person of Vassiltschikoff, a subaltern in the guards, and advantage was taken of the absence of Orloff to introduce him at the hermitage. This officer was young and handsome; but nature, which had been lavish to his person, seems to have been at no pains with his mind. He was immediately appointed chamberlain to the empress, enriched with splendid presents, and treated with the most flattering attention. In the mean time Gregorevitsch, who had been appointed to treat with the Turkish plenipotentiaries relative to a peace, on hearing of this unexpected event, instantly returned to the capital from Fokshiani, but was arrested at the gates of Petersburgh, and stripped of all his employments. He, however, experienced the imperial bounty, and received, as a recompense for his submission, the sum of 100,000 rubles in hand, a pension of 150,000 more, a magnificent service of plate; and, to crown the whole, an estate, with 6000 peasants upon it, was made over to him.

Vassiltschikoff, during 22 months, enjoyed all the distinction belonging to the reigning favourite; but at the end of that period he also found occasion to lament the inconstancy of fortune. This young man had conducted himself with great prudence, for he had never abused his influence. He possessed none of that haughtiness so common to upstarts; and he did not appear

Catherine. pear eager to increase his own fortune, or to diminish that of his rivals. Such was his moderation, that, as his elevation excited no envy, so his disgrace was unaccompanied by exultation. His faults are still unknown; and most probably he had ceased to please. His retreat, however, was accompanied by every mark of respect; and, as he repaired to Moscow, the place of his destined exile, he received presents, on his journey, which might be styled imperial on account of their magnificence.

No sooner was this change made public than Orloff appeared once more on the scene, and was readmitted to all his former influence. Supposing Panin to be the cause of his late exile, he extorted a promise from his royal mistress to dismiss him from his employments. Her assent was given with reluctance; and the prayers of the grand duke, who was too generous to suffer his preceptor to fall a prey to the suspicions of a man he did not love, induced her to revoke her intentions.

In the mean time the manly air and elegant appearance of Potemkin made a great impression on an illustrious personage. This officer had been bred in the guards; and, perceiving on that memorable day when the empress, mounted on a fine charger and dressed in regimentals, exhibited herself at the head of the troops, that she had forgotten to place a plume in her hat, he snatched this decoration from his own, and presented it to the new sovereign. Neither this action, nor the grace with which it was performed, had escaped unnoticed; and the time was now arrived when his attachment was to receive an ample remuneration.

The post of favourite is almost peculiar to Russia, and was during many years considered an *official employment*. Ever since 1730 the nation had been governed by women, except during the short and unfortunate reign of Peter III. In fine, it seemed to be sanctioned, if not by a fundamental law of the empire, at least by prescription; as four empresses had successively consecrated it by their practice, and the age of the last Elizabeth made it be considered in some measure as a mere appendage to imperial grandeur.

Potemkin soon grew giddy with success, and his pride and presumption keeping pace with his elevation, he accordingly exposed himself to a number of disagreeable events. Boasting one day of the extent of his power in presence of Count Alexis Orloff, the brother of his predecessor, he received a blow which deprived him of an eye; and Prince Gregory Orloff having requested his dismission, he was forced to repair to Smolensk, at once the place of his nativity and exile. Such was his vexation, partly from the loss of his eye, and partly from his disgrace, that he actually entertained some idea of turning monk; but a submissive letter produced his recal; and from that moment he seemed to have dropped all thoughts of the cowl.

Ambition now appears to have taken complete possession of the bosom of Potemkin; and this was amply gratified, for his influence soon extended to every department of the state, and he himself, after procuring the dismission of Count Zachar Chernicheff, became vice-president at war, with a seat in the council. But his aspiring hopes were not yet gratified, for he entertained still higher expectations.

With a view to the accomplishment of these, he affected to be once more seized with a fit of religion, and kept Lent with great strictness, living upon roots and water during that holy season. He also wearied all the saints in the Greek calendar with his prayers; went daily to confession, and having selected on this occasion the same priest that afforded absolution to a great personage, he besought him to inform her, that his alarmed conscience could no longer permit him to indulge in an intercourse, which, by marriage alone, would cease to be criminal.

This project, however, failed of success; and, soon after the empress's return to Petersburgh (for it was at Moscow that it had been first conceived), a young man from the Ukraine, of the name of Zavadoffsky, was honoured with the imperial countenance, while the haughty Potemkin received the customary intimation, "that he must prepare to travel." Potemkin did not dare to disobey, but he evaded the order; for, setting out in great form, he proceeded a few miles towards the place indicated for his exile, but returned in the course of next day, and placed himself in the evening exactly opposite to the empress as she was about to sit down to whist. Every one expected to behold some signal mark of the imperial displeasure; but, on the contrary, Catherine, handing him a pack of cards, desired the ex-favourite to cut in, observing that he had always been a fortunate player. His posts, his honours, his influence, were all restored to him, and he now occupied a new situation about the person of her imperial majesty, for he became her friend.

In the mean time the bosom of the humble Zavadoffsky began to catch the flame of ambition; and, as he was jealous of the grandeur of Potemkin, he aimed a deadly blow at his consequence. But the minister at war, become wily in his turn, warded it off, and made it recoil on the head of his rival. Perceiving a handsome young Servian officer of hussars, of the name of Zoritch, who had repaired to Petersburgh in search of promotion, he presented him with a captain's commission, and in a few days he was perceived behind the chair of the empress. A large estate, the rank of major-general, and an immense sum of money, soon became the appanage of this fortunate youth; but the empress perceiving that he was ignorant, and being disgusted at his want of accomplishments, recommended, as he could speak no language but that of the Russian boors, that he should be sent abroad for improvement.

Fortune seems to have been in a playful mood when she elevated Rimsky Korzakoff to the post of chamberlain, and successor to the Servian. This man had actually been a serjeant in the guards; he was now proclaimed aid-de-camp general to the empress, and presented with the palace of Vassiltschikoff.

He proved to be a vain upstart, whose dress exhibited a profusion of diamonds, and whose conduct was such as could not fail to involve him in ruin. This speedily occurred; for, being detected in a secret correspondence with a lady, she was banished from court, and he was obliged to repair to Moscow.

The same day that beheld his disgrace witnessed the good fortune of Laskoi, a Pole by descent, and an officer of the body guards by profession. The education of this young man had been neglected; but this defect was in some measure remedied by the zeal and attachment of an illustrious personage, who superintended

Catherine. tended his improvement; and in a short time he became as remarkable for the superior elegance of his manners, as the graces of his person: but, while in the flower of youth, and the very height of his favour, he was attacked by a mortal disease, which cut him off after a short illness. He died in the arms of his mistress, who was inconsolable on the occasion, and refused to take any sustenance during three whole days. A mausoleum, the plan of which was sketched out by an English artist, attested the respect of the empress, who burst in tears on seeing it two years after. His fortune he had bequeathed to her imperial majesty, but she presented it, with her accustomed generosity, to the sister of this handsome youth.

The next person who aspired to the post of favourite was a young man educated in Scotland, and who had become a fellow of the Royal Society of London. This was Prince Dashkoff, son to the celebrated princess of the same name, who had participated in the memorable revolution that levelled Peter III. with the dust. A lieutenant of the name of Yermoloff anticipated him, however, in this post, to which he was raised by the interest of Potemkin; but, proving ungrateful to his benefactor, he was suddenly disgraced, being replaced by Momonoff, who attended her imperial majesty during her journey to the Crimea. He fell in love, however, with a lady of the court; and no sooner was the empress informed of this circumstance, than she insisted on his marrying her immediately; after which they were sent into exile at Moscow.

Plato Zuboff, an officer of the horse guards, supplied his place. This aspiring young man, not content with wealth and honours, affected public employments; and it is asserted that the idea of the second division of Poland originated with him. In a short time he became omnipotent at Petersburgh. He was decorated with the title of prince; received the post of grand master of the artillery; all the admirals, generals, and ministers of the empire, were to be seen at his levee, bending lowly before him, and, if we are to believe the author of a work of some reputation, paying their compliments, at the same time, in great form, to his favourite monkey.

Catherine hitherto had only afforded empty promises to the enemies of France: but, at the instigation of Zuboff, she now formed the design of giving effectual assistance to the confederated kings; and, as a proof of her intentions, issued orders for a squadron of men of war to join the English fleet, and commanded a levy of 60,000 troops. She at the same time prosecuted a war on the frontiers of Persia, where her army, under the command of a near relation of the grand master of the artillery, had experienced a most humiliating defeat; and she was now preparing to send fresh succours to his assistance.

Such were the projects that occupied the mind of Catherine, the overthrow of the French republic, and the subjugation of the distant Persians, when she was smitten by the hand of death. This fortunate princess had hitherto enjoyed an almost uninterrupted state of good health during the whole of her long reign. She was sometimes, indeed, subject to a colic, and her legs were now and then observed to swell; but neither of these symptoms were alarming.

On the morning of the 9th of November she rose at her usual hour, and breakfasted on coffee, according to custom. Some time after she retired to her closet; and her long absence affording cause of suspicion to her attendants, they entered the apartment, and found her lying speechless. Dr Rogerson, her physician, being sent for, he treated her disease as an apoplexy, and considerable relief seemed to ensue after the application of the lancet. But the empress never entirely recovered her senses; and did not utter a single word during the remainder of her life, which was prolonged till ten o'clock in the evening of November 10. 1797.

Thus, with her usual good fortune, after a very short illness, died Catherine II. empress of all the Russias. During her youth she had been extremely handsome, but she got fat as she increased in years; she, however, preserved a certain air of gracefulness, intermingled with dignity, until the last moment of her life.

Her majesty in person was not above the middle size; but, being well proportioned, and carrying her head high, she appeared tall. Her forehead was open, her nose aquiline, her mouth agreeable, and her chin, without being ugly, was rather long. Her hair, in which she took great delight, was auburn, and her eye-brows dark and thick. Her eyes, according to some, were blue, whilst others insist that they were of a brown hue. Upon the whole, her physiognomy was not deficient in expression; but she had such a command of her countenance, that no one could there discover the secrets of her heart.

Her imperial majesty was accustomed, on great occasions, to dress in a splendid manner, and to wear a profusion of jewels. Being particularly fond of diamonds, she possesed a prodigious number; and one in particular was the largest that ever had been seen in Europe. Catherine, however, was accustomed in general to affect the ancient Russian fashions, for the most part wearing green, out of compliment to the nation. Her hair was powdered but slightly. On the other hand, her face was covered with rouge; and as her imperial majesty, like the ladies in the French court, wore it in proportion to her rank, it is not to be wondered if it was of a high colour.

The strictest temperance was regularly preserved by Catherine, in a country, and at a court, where a little deviation would not have given occasion to much scandal. A slight breakfast, a moderate dinner, and two or three glasses of wine (for she never indulged in supper), constituted her usual diet.

It is far more easy to describe the empress than the woman. The acts of the former have now become history, but those of the latter must be left to the pen of genius, that can analyze the springs of human action.

It must be confessed that both she and the empire appear to have been frequently a prey to favouritism; and this part of her conduct, by being connected with the happiness of millions of her subjects, is highly censurable.

As a sovereign she stands conspicuous. She increased the extent of Russia, and added not only new countries, but new nations, to that mighty empire. As a conqueror, her victories were numerous and brilliant: she triumphed equally by sea and by land, and had she lived but ten years longer, might have realized the

the proud dream of her ambition, and beheld her grandson Constantine sitting on the throne of the Ottomans. Her merit as a legislator, too, is great; but she would have been far more worthy of our admiration, had she effected the generous idea of enfranchising all the peasantry of her immense dominions.

She was the only sovereign of Russia who ever exhibited a taste for letters. This was not all; she was an author herself, and did not disdain to compose little treatises for her grandchildren, whose education she superintended.

For music she also possessed an exquisite relish, and brought Gabrielli, and a number of singers of great note, from Italy, allowing them liberal salaries, and treating them with great attention. Throughout the whole of her long reign Catherine also evinced a marked predilection for painting. In the midst of a war with the Turks she purchased pictures in Holland, to the amount of 60,000 rubles, all of which were lost in consequence of a ship's being wrecked on the coast of Finland. This, however, rather served to stimulate her to fresh exertions, and her agents accordingly procured whatever was to be found in Italy worthy of notice. The Houghton collection from England was also transferred, by an act of her munificence, to the shores of the Baltic; and, while it added to her glory, disgraced this nation in the eyes of foreigners.

Her conduct to learned men was truly worthy of a woman of genius. She was proud of the correspondence and friendship of Voltaire; she invited Diderot to her court, and lived with him, while there, in habits of the utmost familiarity; to D'Alembert she looked up as to a superior being, and endeavoured, although in vain, to seduce him to reside at St Petersburgh; but he possessed a haughty soul, was devoted to liberty, and would not consent to degrade the mind of a freeman, by residing among a nation of slaves.

To the honour of Catherine, she was extremely attentive to the education of her people, and instituted a prodigious number of schools for their instruction. To remove their prejudices against inoculation, she herself submitted to the operation, and thus hazarded her life for her nation. Amidst the schemes of grandeur, the allurements of power, and the gratification of the passions, she found leisure to civilize and instruct her subjects: this added not a little to her glory, as it contributed to the benefit of so large a portion of the human race; but it will insensibly operate against a despotic government, by rendering the boors unfit for their chains, which they will some day break, perhaps, on the heads of the boyars, who at once enslave and oppress them.

No woman could so easily forgive; and in this point of view her conduct must be allowed to have possessed a great share of magnanimity. She generously pardoned old Munich and Godowitz, the one the counsellor, the other the favourite of Peter III. She even admitted the former of these into her confidence, and would have conferred honours and preferments on the latter; but he loved his late sovereign, and with a noble scorn spurned at the proffered friendship of his successor. To the mistress of Peter III. although her own rival, she granted her life, restored her fortune, and at length admitted her daughters to honourable situations at court.

No personage in our own times has attracted a greater share of censure and eulogium than Catherine; and no woman in any age ever exhibited more of the masculine greatness of one sex, and the feminine weakness of another. As a female, she appears at times the slave of passion, and the puppet of her courtiers; but while we behold her diminishing, in this point of view, into insignificance, we look again, and contemplate the *sovereign*, towering like an immense colossus, and with one foot placed on Cherson, and another at Kamtschatka, waving her iron sceptre over the subject nations, and regulating the destiny of a large portion of mankind.

The frailties, however, of the woman will soon be forgotten, while the glory that encircles the brows of the legislator and conqueror will long continue to dazzle the eyes of an admiring world. The present age, however, shudders at the untimely fate of Peter and of Iwan, and posterity will not easily pardon the degradation of Stanislaus, the partition of Poland, and the massacres of Ismailow and of Praga.

Catherine, St, Order of, in modern history, belongs to ladies of the first quality in the Russian court. It was instituted in 1714 by Catherine wife of Peter the Great, in memory of his signal escape from the Turks in 1711. The emblems of this order are a red cross, supported by a figure of St Catherine, and fastened to a scarlet string edged with silver, on which are inscribed the name of St Catherine, and the motto *Pro fide et patria*.

CATHERLOUGH, or Carlow, a town of Ireland in the county of Catherlough, and province of Leinster; seated on the river Barrow, 16 miles north-east of Kilkenny. W. Long. 7. 1. N. Lat. 52. 45.

Catherlough, or *Carlow*, a county of Ireland, about 28 miles in length, and eight in breadth; bounded on the east by Wicklow and Wexford, on the west by Queen's county, on the north by Kildare, and on the south and south-west by Wexford. It contains five baronies, 50 parishes, 13,000 houses, and 78,000 inhabitants. The county sends one member, and the town another to the imperial parliament. See Carlow, Supplement.

CATHETER, in *Surgery*, a fistulous instrument, usually made of silver, to be introduced into the bladder, in order to search for the stone, or discharge the urine when suppressed. See Surgery *Index*.

CATHETUS, in *Geometry*, a line or radius falling perpendicularly on another line or surface; thus the catheti of a right-angled triangle are the two sides that include the right angle.

Cathetus of Incidence, in *Catoptrics*, a right line drawn from a point of the object, perpendicular to the reflecting line.

Cathetus of Reflection, or *of the Eye*, a right line drawn from the eye perpendicular to the reflecting plane.

Cathetus of Obliquation, a right line drawn perpendicular to the speculum, in the point of incidence or reflection.

Cathetus, in *Architecture*, a perpendicular line supposed to pass through the middle of a cylindrical body, as a ballaster, column, &c.

CATHNESS. See Caithness.

CATHOLIC,

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CATHOLIC, in a general sense, denotes any thing that is universal or general.

Catholic Church. The rise of heresies induced the primitive Christian church to assume to itself the appellation of *catholic*, being a characteristic to distinguish itself from all sects, who, though they had party names, sometimes sheltered themselves under the name of Christians.

The Romish church distinguishes itself now by the name of *Catholic*, in opposition to all those who have separated from her communion, and whom she considers as heretics and schismatics, and herself only as the true and Christian church. In the strict sense of the word, there is no Catholic church in being, that is, no universal Christian communion.

Catholic King, is a title which has been long hereditary to the king of Spain. Mariana pretends, that Reccarede first received this title after he had destroyed Arianism in his kingdom, and that it is found in the council of Toledo for the year 589. Vasce ascribes the original of it to Alphonsus in 738. Some allege that it has been used only since the time of Ferdinand and Isabella. Colombiere says, it was given them on occasion of the expulsion of the Moors. The Bollandists pretend it had been borne by their predecessors the Visigoth kings of Spain; and that Alexander VI. only renewed it to Ferdinand and Isabella. Others say that Philip de Valois first bore the title; which was given him after his death by the ecclesiastics, on account of his favouring their interests.

In some epistles of the ancient popes, the title *catholic* is given to the kings of France and of Jerusalem, as well as to several patriarchs and primates.

CATHOLICON, in *Pharmacy*, a kind of soft purgative electuary, so called as being supposed an universal purger of all humours.

CATILINE, Lucius, a Roman of a noble family, who, having spent his whole fortune in debauchery, formed the design of oppressing his country, destroying the senate, seizing the public treasury, setting Rome on fire, and usurping a sovereign power over his fellow-citizens. In order to succeed in this design, he drew some young noblemen into his plot; whom he prevailed upon, it is said, to drink human blood as a pledge of their union. His conspiracy, however, was discovered by the vigilance of Cicero, who was then consul. Upon which, retiring from Rome, he put himself at the head of an army, with several of the conspirators, and fought with incredible valour against Petreius, lieutenant to Antony, who was colleague with Cicero in the consulship; but was defeated and killed in battle. See (*History of*) Rome.—Sallust has given an excellent history of this conspiracy.

CATO, Marcus Portius, the censor, one of the greatest men among the ancients, was born at Tusculum in the year of Rome 519, about the 232d before Christ. He began to bear arms at 17; and, on all occasions showed, extraordinary courage. He was a man of great sobriety, and reckoned no bodily exercise unworthy of him. He had but one horse for himself and his baggage, and he looked after and dressed it himself. At his return from his campaigns, he betook himself to plough his ground; not that he was without slaves to do it, but it was his inclination. He dressed also like his slaves, sat down at the same table with them, and partook of the same fare. He did not in the meanwhile neglect to cultivate his mind, especially in regard to the art of speaking; and he employed his talents, which were very great, in generously pleading causes in the neighbouring cities without fee or reward. Valerius Flaccus, who had a country seat near Cato, conceiving an esteem for him, persuaded him to come to Rome; where Cato, by his own merits, and the influence of so powerful a patron, was soon taken notice of, and promoted. He was first of all elected tribune of the soldiers for the province of Sicily; he was next made questor in Africa under Scipio. Having in this last office reproved him for his profuseness to his soldiers, the general answered, that "he did not want so exact a questor, but would make war at what expence he pleased; nor was he to give an account to the Roman people of the money he spent, but of his enterprises, and the execution of them." Cato, provoked at this answer, left Sicily, and returned to Rome.

Afterwards Cato was made prætor, when he fulfilled the duties of his office with the strictest justice. He conquered Sardinia, governed with admirable moderation, and was created consul. Being tribune in the war of Syria, he gave distinguished proofs of his valour against Antiochus the Great; and at his return stood candidate for the office of censor. But the nobles, who not only envied him as a *new* man, but dreaded his severity, set up against him seven powerful competitors. Valerius Flaccus, who had introduced him into public life, and had been his colleague in the consulship, was a ninth candidate, and these two united their interests. On this occasion Cato, far from employing soft words to the people, or giving hopes of gentleness or complaisance in the execution of his office, loudly declared from the rostra, with a threatening look and voice, "That the times required firm and vigorous magistrates to put a stop to that growing luxury which menaced the republic with ruin; censors who would cut up the evil by the roots, and restore the rigour of ancient discipline." It is to the honour of the people of Rome, that, notwithstanding these terrible intimations, they preferred him to all his competitors, who courted them by promises of a mild and easy administration; the comitia also appointed his friend Valerius to be his colleague, without whom he had declared that he could not hope to compass the reformations he had in view. Cato's merit, upon the whole, was superior to that of any of the great men who stood against him. He was temperate, brave, and indefatigable; frugal of the public money, and not to be corrupted. There is scarce any talent requisite for public or private life which he had not received from nature, or acquired by industry. He was a great soldier, an able statesman, an eloquent orator, a learned historian, and very knowing in rural affairs. Yet, with all these accomplishments, he had very great faults. His ambition being poisoned with envy, disturbed both his own peace and that of the whole city as long as he lived. Though he would not take bribes, he was unmerciful and unconscionable in amassing wealth by all such means as the law did not punish.

The first act of Cato in his new office, was naming his colleague to be prince of the senate; after which the censors struck out of the list of the senators the

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Cato. names of seven persons; among whom was Lucius the brother of T. Flaminius. Lucius, when consul, and commanding in Gaul, had with his own hand murdered a Boian of distinction, a deserter to the Romans; and he had committed this murder purely to gratify the curiosity of his pathic, a young Carthaginian, who longing to see somebody die a violent death, had reproached the general for bringing him away from Rome just when there was going to be a fight of gladiators. Titus Flaminius, full of indignation at the dishonour done to his brother, brought the affair before the people; and insisted upon Cato's giving the reason of his proceeding. The censor related the story; and when Lucius denied the fact, put him to his oath. The accused, refusing to swear, was deemed guilty; and Cato's censure was approved. But no part of the censor's conduct seemed so cruel to the nobles and their wives as the taxes he laid upon luxury in all its branches, dress, household furniture, women's toilets, chariots, slaves, and equipage. These articles were all taxed at three per cent. of the real value. The people, however, in general, were pleased with his regulations; insomuch that they ordered a statue to be erected to his honour in the Temple of Health, with an inscription that mentioned nothing of his victories or triumphs, but imported only, that by his wise ordinances in his censorship he had reformed the manners of the republic. Plutarch relates, that before this, upon some of Cato's friends expressing their surprise, that when many persons without merit or reputation had statues, he had none; he answered, "I had much rather it should be asked why the people have not erected a statue to Cato, than why they have." Cato was the occasion of the third Punic war. Being dispatched to Africa to terminate a difference between the Carthaginians and the king of Numidia, on his return to Rome he reported that Carthage was grown excessively rich and populous, and he warmly exhorted the senate to destroy a city and republic, during the existence of which Rome could never be safe. Having brought from Africa some very large figs, he showed them to the conscript fathers in one of the lappets of his gown. "The country (says he) where this fine fruit grows is but a three days voyage from Rome." We are told, that from this time he never spoke in the senate upon any subject, without concluding with these words, "I am also of opinion, that Carthage ought to be destroyed." He judged, that for a people debauched by prosperity, nothing was more to be feared than a rival state, always powerful, and now from its misfortunes grown wise and circumspect. He held it necessary to remove all dangers that could be apprehended from *without*, when the republic had *within* so many distempers threatening her destruction.

From the censor, dignified and severe, the reader will not perhaps be displeased to turn his view upon Cato sociable and relaxed. For we should have a false notion of him, if we imagined that nothing but a sad austerity prevailed in his speech and behaviour. On the contrary, he was extremely free; and often with his friends at table intermixed the conversation with lively discourses and witty sayings. Of these Plutarch has collected a pretty large number; we shall relate but one, and make use of Balzac's paraphrase, and the preface with which he introduces it. "The very censors, though sadness seemed to be one of the functions of their office, did not altogether lay aside raillery. They were not always bent upon severity; and the first Cato, that troublesome and intolerable honest man, ceased sometimes to be troublesome and intolerable. He had some glimpses of mirth, and some intervals of good humour. He dropped now and then some words that were not unpleasant, and you may judge of the rest by this. He had married a very handsome wife; and history tells us that she was extremely afraid of the thunder, and loved her husband well. These two passions prompted her to the same thing; she always pitched upon her husband as a sanctuary against thunder, and threw herself into his arms at the first noise she fancied she heard in the sky. Cato, who was well pleased with the storm, and very willing to be caressed, could not conceal his joy. He revealed that domestic secret to his friends; and told them one day, speaking of his wife, "that she had found out a way to make him love bad weather; and that he never was so happy as when Jupiter was angry." It is worth observing, that this was during his censorship; when he degraded the senator Manlius, who would probably have been consul the year after, only for giving a kiss to his wife in the day-time, and in the presence of his daughter.

Oeuvres diverses, p. 49.

Cato died in the year of Rome 604, aged 85. He wrote several works. 1. A Roman History. 2. Concerning the art of war. 3. Of Rhetoric. 4. A treatise of Husbandry. Of these, the last only is extant.

CATO, *Marcus Portius*, commonly called Cato *Minor*, or Cato of *Utica*, was great-grandson of Cato *the Censor*. It is said, that from his infancy he discovered by his speech, by his countenance, and even his childish sports and recreations, an inflexibility of mind; for he would force himself to go through with whatever he had undertaken, though the task was ill-suited to his strength. He was rough towards those that flattered him, and quite untractable when threatened; was rarely seen to laugh, or even to smile; was not easily provoked to anger; but if once incensed, hard to be pacified. Sylla having had a friendship for the father of Cato, sent often for him and his brother, and talked familiarly with them. Cato, who was then about 14 years of age, seeing the heads of great men brought there, and observing the sighs of those that were present, asked his preceptor, "Why does nobody kill this man?" Because, said the other, he is more feared than he is hated. The boy replied, "Why then did you not give me a sword when you brought me hither, that I might have stabbed him, and freed my country from this slavery?"

He learned the principles of the Stoic philosophy, which so well suited his character, under Antipater of Tyre, and applied himself diligently to the study of it. Eloquence he likewise studied, as a necessary means to defend the cause of justice, and he made a very considerable proficiency in that science. To increase his bodily strength, he inured himself to suffer the extremes of heat and cold; and used to make journeys on foot and bare-headed in all seasons. When he was sick, patience and abstinence were his only remedies: he shut himself up, and would see nobody till he was well. Though remarkably sober in the beginning of his

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Cato. his life, making it a rule to drink but once after supper, and then retire, he insensibly contracted a habit of drinking more freely, and of sitting at table till morning. His friends endeavoured to excuse this, by saying that the affairs of the public engrossed his attention all the day; and that, being ambitious of knowledge, he passed the night in the conversation of philosophers. Cæsar wrote, that Cato was once found dead drunk at the corner of a street, early in the morning, by a great number of people who were going to the levee of some great man; and that when, by uncovering his face, they perceived who it was, they blushed for shame: "You would have thought (added Cæsar), that Cato had found them drunk, not they him." Pliny observes, that by this reflection Cæsar praises his enemy at the same time that he blames him. And Seneca, his extravagant panegyrist, ventures to assert, that it is easier to prove drunkenness to be a virtue, than Cato to be vicious. He affected singularity; and in things indifferent, to act directly contrary to the taste and fashions of the age. Magnanimity and constancy are generally ascribed to him; and Seneca would fain make that haughtiness and contempt for others, which, in Cato, accompanied those virtues, a matter of praise. Cato, says Seneca, having received a blow in the face, neither took revenge nor was angry; he did not even *pardon the affront*, but *denied that he had received it*. His virtue raised him so high, that injury could not reach him. He is reputed to have been chaste in his youth. His first love was Lepida; but when the marriage was upon the point of being concluded, Metellus Scipio, to whom she had been promised, interfered, and the preference was given to him. This affront extremely exasperated our Stoic. He was for going to law with Scipio; and when his friends had diverted him from that design, by showing him the ridicule of it, he revenged himself by making verses upon his rival. When this first flame subsided, he married Attilia the daughter of Serranus, had two children by her, and afterwards divorced her for her very indiscreet conduct.

He served as a volunteer under Gallus in the war of Spartacus; and when military rewards were offered him by the commander, he refused them, because he thought he had no right to them. Some years after, he went a legionary tribune into Macedonia under the prætor Rubrius: in which station he appeared, in his dress and during a march, more like a private soldier than an officer: but the dignity of his manners, the elevation of his sentiments, and the superiority of his views, set him far above those who bore the titles of generals and proconsuls. It is said, that Cato's design in all his behaviour was to engage the soldiers to the love of virtue; whose affections he engaged thereby to himself, without his having that in his intention. "For the sincere love of virtue (adds Plutarch) implies an affection for the virtuous. Those who praise the worthy without loving them, pay homage to their glory; but are neither admirers nor imitators of their virtues." When the time of his service expired, and he was leaving the army, the soldiers were all in tears; so effectually had he gained their hearts by his condescending manners and sharing in their labours. After his return home, he was chosen to the questorship; and had scarce entered on his charge, when he made a great reformation in the questor's office, and particularly with regard to the registers. These registers, whose places were for life, and through whose hands passed incessantly all the public accounts, being to act under young magistrates inexperienced in business, assumed an air of importance; and, instead of asking orders from the questors, pretended to direct and govern as if they themselves were the questors. Cato reduced them to their proper sphere.

One thing by which Cato extremely pleased the people, was his making the assassins to whom Sylla had given considerable rewards out of the treasury for murdering the proscribed, disgorge their gains. Plutarch tells us, that Cato was so exact in discharging the duties of a senator, as to be always the first who came to the house, and the last who left it; and that he never quitted Rome during those days when the senate was to sit. Nor did he fail to be present at every assembly of the people, that he might awe those who, by an ill-judged facility, bestowed the public money in largesses, and frequently, through mere favour, granted remission of debts due to the state. At first his austerity and stiffness displeased his colleagues; but afterwards they were glad to have his name to oppose to all the unjust solicitations, against which they would have found it difficult to defend themselves. Cato very readily took upon him the task of refusing.

Cato, to keep out a very bad man, put in for the tribunate. He sided with Cicero against Catiline, and opposed Cæsar on that occasion. His enemies sent him to recover Cyprus, which Ptolemy had forfeited, thinking to hurt his reputation by so difficult an undertaking; yet none could find fault with his conduct.

Cato laboured to bring about an agreement between Cæsar and Pompey; but seeing it in vain, he sided with the latter. When Pompey was slain he fled to Utica; and being pursued by Cæsar, advised his friends to be gone, and throw themselves on Cæsar's clemency. His son, however, remained with him; and Statilius, a young man, remarkable for his hatred to Cæsar.

The evening before the execution of the purpose he had formed with regard to himself, after bathing, he supped with his friends and the magistrates of the city. They sat late at table, and the conversation was lively. The discourse falling upon this maxim of the Stoics, that "the wise man alone is free, and that the vicious are slaves;" Demetrius, who was a Peripatetic, undertook to confute it from the maxims of his school. Cato, in answer, treated the matter very amply; and with so much earnestness and vehemence of voice, that he betrayed himself, and confirmed the suspicion of his friends that he designed to kill himself. When he had done speaking, a melancholy silence ensued; and Cato perceiving it, turned the discourse to the present situation of affairs, expressing his concern for those who had been obliged to put to sea, as well as for those who had determined to make their escape by land, and had a dry and sandy desert to pass. After supper, the company being dismissed, he walked for some time with a few friends, and gave his orders to the officers of the guard: and going into his chamber, he embraced his son and his friends with more than usual.

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Cato.

usual tenderness, which farther confirmed the suspicions of the resolution he had taken. Then laying himself down on his bed, he took up Plato's Dialogue on the Immortality of the Soul. Having read for some time, he looked up, and missing his sword, which his son had removed while he was at supper, he called a slave, and asked who had taken it away; and receiving no pertinent answer, he resumed his reading. Some time after, he asked again for his sword; and, without showing any impatience, ordered it to be brought to him: but having read out the book, and finding nobody had brought him his sword, he called for all his servants, fell into a rage, and struck one of them on the mouth with so much violence that he very much hurt his own hand, crying out in a passionate manner, "What! do my own son and family conspire to betray me, and deliver me up naked and unarmed to the enemy?" Immediately his son and friends rushed into the room; and began to lament, and to beseech him to change his resolution. Cato raising himself, and looking fiercely at them, "How long is it," said he, "since I have lost my senses, and my son is become my keeper? Brave and generous son, why do you not bind your father's hands, that when Cæsar comes, he may find me unable to defend myself? Do you imagine that without a sword I cannot end my life? Cannot I destroy myself, by holding my breath for some moments, or by striking my head against the wall?" His son answered with his tears, and retired. Apollonides and Demetrius remained with him; and to them he addressed himself in the following words: "Is it to watch over me that ye sit silent here? Do you pretend to force a man of my years to live? or can you bring any reason to prove, that it is not base and unworthy of Cato to beg his safety of an enemy? or why do you not persuade me to unlearn what I have been taught, that, rejecting all the opinions I have hitherto defended, I may now, by Cæsar's means, grow wiser, and be yet more obliged to him than for life alone? Not that I have determined any thing concerning myself; but I would have it in my power to perform what I shall think fit to resolve upon: and I shall not fail to ask your counsel, when I have occasion to act up to the principles which your philosophy teaches. Go tell my son, that he should not compel his father to what he cannot persuade him." They withdrew, and the sword was brought by a young slave. Cato drew it, and finding the point to be sharp; "Now, (said he) I am my own master:" And, laying it down, he took up his book again, which it is reported he read twice over. After this he slept so soundly that he was heard to snore by those who were near him. About midnight he called two of his freedmen, Cleanthes his physician, and Butas, whom he chiefly employed in the management of his affairs. The last he sent to the port, to see whether all the Romans were gone; to the physician he gave his hand to be dressed, which was swelled by the blow he had given his slave. This being an intimation that he intended to live, gave great joy to his family. Butas soon returned, and brought word that they were all gone except Crassus, who had staid upon some business, but was just ready to depart. He added, that the wind was high and the sea rough. These words drew a sigh from Cato. He sent Butas again to the port, to know whether there might not be some one, who, in the hurry of embarkation, had forgot some necessary provisions, and had been obliged to put back to Utica. It was now break of day, and Cato slept yet a little more, till Butas returned to tell him, that all was perfectly quiet. He then ordered him to shut his door; and he flung himself upon his bed, as if he meant to finish his night's rest; but immediately he took his sword, and stabbed himself a little below his chest; yet not being able to use his hand so well by reason of the swelling, the blow did not kill him. It threw him into a convulsion, in which he fell from his bed, and overturned a table near it. The noise gave the alarm; and his son and the rest of the family, entering the room, found him weltering in his blood, and his bowels half out of his body. The surgeon, upon examination, found that his bowels were not cut; and was preparing to replace them and bind up the wound, when Cato, recovering his senses, thrust the surgeon from him, and tearing out his bowels, immediately expired, in the 48th year of his age.

By this rash act, independent of all moral or religious considerations, he carried his patriotism to the highest degree of political phrensy; for Cato, dead, could be of no use to his country; but had he preserved his life, his counsel might have moderated Cæsar's ambition, and (as Montesquieu observes) have given a different turn to public affairs.

Cato, Catoche.

CATOCHE, or Catochus, a disease by which the patient is rendered in an instant as immoveable as a statue, without either sense or motion, and continues in the same posture he was in at the moment of his being seized. See Medicine *Index*.

CATOPTRICS.

CATOPTRICS is that part of optics which explains the properties of reflected light, and particularly that which is reflected from mirrors.

As this and the other branches of Optics will be fully treated under the collective word, we shall, in the present article, 1st, Just give a summary of the principles of the branch, in a few plain aphorisms, with some preliminary definitions; and, 2dly, Insert a set of entertaining experiments founded upon them.

Sect. I. *Definitions.*

1. Every polished body that reflects the rays of light is called a mirror, whether its surface be plane, spherical, conical, cylindric, or of any other form whatever. 1 Definitions.

2. Of mirrors there are three principally used in optical experiments: The plane mirror, GHI, (fig. 1.); Plate CXXXVI.

1.); the spherical convex mirror, GHI, (fig. 2.); and the spherical concave mirror, GHI, (fig. 3.)

3. The point K, (fig. 2, 3.) round which the reflecting surface of a spherical mirror is described, is called its centre. The line KH, drawn from its centre perpendicular to its two surfaces, is the axis of the mirror; and the point H, to which that line is drawn, is its vortex.

4. The distance between the lines AG and BG, (fig. 1.) is called the angle of incidence, and the distance between BG and CG is the angle of reflection.

Sect. II. *Aphorisms.*

2 I. In a plane mirror.

1. The image DF, (fig. 1.) will appear as far behind the mirror as the object AC is before it.

2. The image will appear of the same size, and in the same position as the object.

3. Every such mirror will reflect the image of an object of twice its own length and breadth.

4. If the object be an opaque body, and its rays fall on the mirror nearly in direct lines, there will be only one image visible, which will be reflected by the inner surface of the glass. But,

5. If the object be a luminous body, and its rays fall very obliquely on the mirror, there will appear to an eye, placed in a proper position, several images; the first of which, reflected from the outer surface of the glass, will not be so bright as the second, reflected from the inner surface. The following images, that are produced by the repeated reflections of the rays between the two surfaces of the glass, will be in proportion less vivid, to the eighth or tenth, which will be scarce visible.

3 II. In a spherical convex mirror.

1. The image DF, (fig. 2.), will always appear behind it.

2. The image will be in the same position as the object.

3. It will be less than the object.

4. It will be curved, but not, as the mirror, spherical.

5. Parallel rays falling on this mirror will have the focus or image at half the distance of the centre K from the mirror.

6. In converging rays, the distance of the object must be equal to half the distance of the centre, to make the image appear behind the mirror.

7. Diverging rays will have their image at less than half the distance of the centre. If the object be placed in the centre of the mirror, its image will appear at one eighth of that distance behind it.

4 III. In a spherical concave mirror.

1. That point where the image appears of the same dimensions as the object, is the centre of that mirror.

2. Parallel rays will have their focus at one half the distance of the centre.

3. Converging rays will form an image before the mirror.

4. In diverging rays, if the object be at less than one-half the distance of the centre, the image will be behind the mirror, erect, curved, and magnified, as DEF, (fig. 3.); but if the distance of the object be greater, the image will be before the mirror, inverted and diminished, as DEF, (fig. 4.)

5. The sun's rays falling on a concave mirror, and being parallel, will be collected in a focus at half the distance of its centre, where their heat will be augmented in proportion of the surface of the mirror to that of the focal spot.

6. If a luminous body be placed in the focus of a concave mirror, its rays being reflected in parallel lines, will strongly enlighten a space of the same dimension with the mirror, at a great distance. If the luminous object be placed nearer than the focus, its rays will diverge, and consequently enlighten a larger space. It is on this principle that reverberators are constructed.

IV. In all plane and spherical mirrors the angle of incidence is equal to the angle of reflection.

Sect. III. *Entertaining Experiments.*

I. Of all our senses the sight is certainly subject to the greatest illusion. The various writers on optics have described a great number of instances in which it deceives us, and have constantly endeavoured to investigate the causes, to explain their effects, and to reconcile appearance with reality. We every day discover new phenomena, and doubtless many more are reserved for posterity. It frequently happens, moreover, that a discovery which at first seemed of little consequence has led to matters of the highest importance. 5 I. Catoptrical illusions.

Take a glass bottle A (fig. 14.) and fill it with water to the point B; leave the upper part BC empty, and cork it in the common manner. Place this bottle opposite a concave mirror, and beyond its focus, that it may appear reversed, and before the mirror, (see Sect. II. aph. 3. 4. of a spher. concave mirror,) place yourself still further distant from the bottle, and it will appear to you in the situation *a*, *b*, *c*, (fig. 15.)

Now it is remarkable in this apparent bottle, that the water, which, according to all the laws of catoptrics, and all the experiments made on other objects, should appear at *a b*, appears on the contrary at *b c*, and consequently the part *a b* appears empty.

If the bottle be inverted and placed before the mirror (as in fig. 16.), its image will appear in its natural erect position; and the water, which is in reality at BC, will appear at *a b*.

If while the bottle is inverted it be uncorked, and the water run gently out, it will appear, that while the part BC is emptying, that of *a b* in the image is filling; and what is likewise very remarkable, as soon as the bottle is empty the illusion ceases, the image also appearing entirely empty. If the bottle likewise be quite full there is no illusion.

If while the bottle is held inverted, and partly empty, some drops of water fall from the bottom A towards BC, it seems in the image as if there were formed at the bottom of that part *a b*, bubbles of air that rose from *a* to *b*; which is the part that seems full of water. All these phenomena constantly appear.

The remarkable circumstances in this experiment are, first, not only to see an object where it is not, but also where the image is not; and secondly, that of two objects which are really in its same place, as the surface at one place, and the other at another; and to see the bottle in the place of its image, and the water where neither it nor its image are.

II. Construct a box AB, of about a foot long, eight inches

6 II. Appearance of a boundless vista, fig. 5.

inches wide, and six high; or what other dimensions you shall think fit, provided it does not greatly vary from these proportions.

On the inside of this box, and against each of its opposite ends A and B, place a mirror of the same size. Take off the quicksilver from the mirror that you place at B, for about an inch and a half at the part C, where you are to make a hole in the box of the same size, by which you may easily view its inside. Cover the top of the box with a frame, in which must be placed a transparent glass, covered with gauze, on the side next the inner part of the box. Let there be two grooves at the parts E and F to receive the two painted scenes hereafter mentioned. On two pieces of cut pasteboard let there be skilfully painted on both sides (see fig. 6. and 7.) any subject you think proper; as woods, gardens, bowers, colonnades, &c. and on two other pasteboards, the same subjects on one side only; observing that there ought to be on one of them some object relative to the subject placed at A, that the mirror placed at D may not reflect the hole at C on the opposite side.

Place the two boards painted on both sides in the grooves E and F; and those that are painted on one side only against the opposite mirrors C and D; and then cover the box with its transparent top. This box should be placed in a strong light to have a good effect.

When the eye is placed at C, and views the objects on the inside of the box, of which some, as we have said, are painted on both sides, they are successively reflected from one mirror to the other; and if, for example, the painting consists of trees, they will appear like a very long vista, of which the eye cannot discern the end: for each of the mirrors repeating the objects, continually more faintly, contribute greatly to augment the illusion.

7 III. Of a fortification of immense extent, fig. 8.

III. Take a square box ABCD, of about six inches long, and twelve high; cover the inside of it with four plane mirrors, which must be placed perpendicular to the bottom of the box CHFD.

Place certain objects in relief on the bottom of this box; suppose, for example, a piece of fortification, (as fig. 9.) with tents, soldiers, &c. or any other subject that you judge will produce an agreeable effect by its disposition when repeatedly reflected by the mirrors.

On the top of this box place a frame of glass, in form of the bottom part of a pyramid, whose base AGEB is equal to the size of the box: its top ILN must form a square of six inches, and should not be more than four or five inches higher than the box. Cover the four sides of this frame with a gauze, that the inside may not be visible but at the top ILN, which should be covered with a transparent glass.

When you look into this box through the glass LN, the mirrors that are diametrically opposite each other, mutually reflecting the figures enclosed, the eye beholds a boundless extent, completely covered with these objects; and if they are properly disposed, the illusion will occasion no small surprise, and afford great entertainment.

Note, The nearer the opening ILN is to the top of the box, the greater will be the apparent extent of the subject. The same will happen if the four mirrors placed on the sides of the box be more elevated. The objects, by either of these dispositions, will appear to be repeated nine, twenty-five, forty-nine times, &c. by taking always the square of the odd numbers of the arithmetical progression 3, 5, 7, 9, &c. as is very easy to conceive, if we remember that the subject enclosed in the box is always in the centre of a square, composed of several others, equal to that which forms the bottom of the box.

Other pieces of the same kind (that is, viewed from above) may be contrived, in which mirrors may be placed perpendicular on a triangular, pentagon, or hexagon (that is, a three, five, or six-sided) plane. All these different dispositions, properly directed, as well with regard to the choice as position of the objects, will constantly produce very remarkable and pleasing illusions.

If instead of placing the mirrors perpendicular, they were to incline equally, so as to form part of a reversed pyramid, the subject placed in the box would then have the appearance of a very extensive globular or many-sided figure.

IV. On the hexagonal or six-sided plane ABCDEF draw six semidiameters GA, GB, GC, GD, GE, GF; and on each of these place perpendicularly two plane mirrors, which must join exactly at the centre G, and which placed back to back must be as thin as possible. Decorate the exterior boundary of this piece (which is at the extremity of the angles of the hexagon) with six columns, that at the same time serve to support the mirrors, by grooves formed on their inner sides. (See the profile H). Add to these columns their entablatures, and cover the edifice in such a manner as you shall think proper. 8 IV. Surprising multiplication of objects, fig. 10.

In each one of these six triangular spaces, contained between two mirrors, place little figures of pasteboard, in relief, representing such objects as when seen in a hexagonal form will produce an agreeable effect. To these add small figures of enamel; and take particular care to conceal, by some object that has relation to the subject, the place where the mirrors join, which, as we have said before, all meet in the common centre G.

When you look into any one of the six openings of this palace, the objects there contained being repeated six times, will seem entirely to fill up the whole of the building. This illusion will appear very remarkable; especially if the objects made choice of are properly adapted to the effect that is to be produced by the mirrors.

Note, If you place between two of these mirrors part of a fortification, as a curtain and two demi-bastions, you will see an entire citadel, with six bastions. Or if you place part of a ball-room, ornamented with chandeliers and figures in enamel, all those objects being here multiplied, will afford a very pleasing prospect.

V. Within the case ABCD, place your mirrors, O, P, Q, R, so disposed that they may each of them make an angle of forty-five degrees, that is, that they may be half way inclined from the perpendicular, as in the figure. In each of the two extremities AB, make a circular overture, in one of which fix the tube GL, 9 V. Opaque bodies seemingly rendered transparent, fig. 11.

GL, in the other the tube MF, and observe that in each of these is to be inserted another tube, as H and I (A).

Furnish the first of these tubes with an object-glass at G, and a concave eye-glass at F. You are to observe, that in regulating the focus of these glasses, with regard to the length of the tube, you are to suppose it equal to the line G, or visual pointed ray, which, entering at the aperture G, is reflected by the four mirrors, and goes out at the other aperture F, where the ocular glass is placed. Put any glass you will into the two ends of the moveable tubes H and I; and, lastly, place the machine on a stand E, moveable at the point S, that it may be elevated or depressed at pleasure.

When the eye is placed at F, and you look through the tube, the rays of light that proceed from the object T, passing through the glass G, are successevely reflected by the mirrors O, P, Q, and R, to the eye at F, and there paint the object T in its proper situation; and these rays appear to proceed directly from that object.

The two moveable tubes H and I, at the extremities of each of which a glass is placed, serve only the more to disguise the illusion, for they have no communication with the interior part of the machine. This instrument being moveable on the stand E, may be directed to any object; and if furnished with proper glasses will answer the purpose of a common perspective.

The two moveable tubes H and I being brought together, the machine is directed toward any object, and desiring a person to look at the end F, you ask him if he sees distinctly that object. You then separate the two moveable tubes, and leaving a space between them sufficient to place your hand, or any other solid body; you tell him that the machine has the power of making objects visible through the most opaque body; and as a proof you desire him then to look at the same object, when, to his great surprise, he will see it as distinct as when there was no solid body placed between the tubes.

Note, This experiment is the more extraordinary, as it is very difficult to conceive how the effect is produced. The two arms of the case appearing to be made to support the perspective glass; and to whatever object it is directed, the effect is still the same.

10 VI. VII. The magician's mirror, fig. 12. VI. In the partition AB, make two apertures, CD, and EF, of a foot high, and ten inches wide, and about a foot distant from each other. Let them be at the common height of a man's head; and in each of them place a transparent glass, surrounded with a frame, like a common mirror.

Behind this partition place two mirrors H and I, inclined to it in an angle of forty-five degrees; that is, half way between a line drawn perpendicular to the ground and its surface; let them be both 18 inches square: let all the space between them be inclosed by boards or pasteboard painted black, and well closed, that no light may enter: let there be also two curtains to cover them, which may be drawn aside at pleasure.

When a person looks into one of these supposed mirrors, instead of seeing his own face, he will perceive the object that is in front of the other; so that if two persons present themselves at the same time before these mirrors, instead of each one seeing himself, they will reciprocally see each other.

Note, There should be a sconce with a candle placed on each side of the two glasses in the wainscot, to enlighten the faces of the persons who look in them, otherwise this experiment will have no remarkable effect.

This experiment may be considerably improved by placing the two glasses in the partition in adjoining rooms, and a number of persons being previously placed in one room, when a stranger enters the other, you may tell him his face is dirty; and desire him to look in the glass, which he will naturally do; and on seeing a strange face he will draw back; but returning to it, and seeing another, another, and another, like the phantom kings in Macbeth, what his surprise will be is more easy to conceive than express. After this a real mirror may be privately let down on the back of the glass; and if he can be prevailed to look in it once more, he will then, to his further astonishment, see his own face; and may be told, perhaps persuaded, that all he thought he saw before was the mere effect of imagination.

How many tricks, less artful than this, have passed in former times for sorcery, and pass at this time in some countries for apparitions!

Note, When a man looks in a mirror that is placed perpendicular to another, his face will appear entirely deformed. If the mirror be a little inclined, so as to make an angle of 80 degrees (that is, one-ninth part from the perpendicular), he will then see all the parts of his face, except the nose and forehead. If it be inclined to 60 degrees (that is, one-third part), he will appear with three noses and six eyes: in short, the apparent deformity will vary at each degree of inclination: and when the glass comes to 45 degrees (that is, half way down), the face will vanish. If, instead of placing the two mirrors in this situation, they are so disposed that their junction may be vertical, their different inclinations will produce other effects; as the situation of the object relative to these mirrors is quite different. The effects of these mirrors, though remarkable enough, occasions but little surprise, as there is no method of concealing the cause by which they are produced.

VII. Make a box of wood, of a cubical figure, ABCD, of about 15 inches every way. Let it be fixed to the pedestal P, at the usual height of a man's head. In each side of this box, let there be an opening 11 Fig. 13.

(A) These four tubes must terminate in the substance of the case, and not enter the inside, that they may not hinder the effect of the mirrors. The fourfold reflection of the rays of light from the mirrors, darkens in some degree the brightness of the object; some light is also lost by the magnifying power of the perspective. If, therefore, instead of the object-glass at G, and concave eye-glass at F, plain glasses were substituted, the magnifying power of the perspective will be taken away, and the object appear brighter.

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ing of an oval form, of ten inches high, and seven wide.

In this box place two mirrors A, D, with their backs against each other; let them cross the box in a diagonal line, and in a vertical position. Decorate the openings in the sides of this box with four oval frames and transparent glasses, and cover each of them with a curtain, so contrived that they may all draw up together.

Place four persons in front of the four sides, and at equal distances from the box, and then draw up the curtains that they may see themselves in the mirrors; when each of them, instead of his own figure, will see that of the person who is next to him, and who, at the same time, will seem to him to be placed on the opposite side. Their confusion will be the greater, as it will be very difficult for them to discover the mirrors concealed in the box. The reason of this phenomenon is evident; for though the rays of light may be turned aside by a mirror, yet as we have before said, they always appear to proceed in right lines.

12 VIII. The perspective mirror, fig. 17.

VIII. Provide a box ABCD of about two feet long, 15 inches wide, and 12 inches high. At the end AC place a concave mirror, the focus of whose parallel rays is at 18 inches from the reflecting surface. At IL place a pasteboard blacked, in which a hole is cut sufficiently large to see on the mirror H the object placed at BEFD.

Cover the top of the box, from A to I, close, that the mirror H may be entirely darkened. The other part IB must be covered with a glass, under which is placed a gauze.

Make an aperture at G, near the top of the side ER; beneath which, on the inside, place, in succession, paintings of different subjects, as vistas, landscapes, &c. so, that they may be in front of the mirror H. Let the box be so placed that the object may be strongly illuminated by the sun, or by wax lights placed under the enclosed part of the box AI.

By this simple construction the objects placed at GD will be thrown into their natural perspective; and if the subjects be properly chosen, the appearance will be altogether as pleasing as in optical machines of a much more complicated form.

Note, A glass mirror should be always here used, as those of metal do not represent the objects with equal vivacity, and are besides subject to tarnish. It is also necessary that the box be sufficiently large, that you may not be obliged to use a mirror whose focus is too short; for in that case, the right lines near the border of the picture will appear bent in the mirror, which will have a disagreeable effect, and cannot be avoided.

13 IX. To set fire to a combustible body by the reflection of two concave mirrors, fig. 18.

IX. The rays of a luminous body placed in the focus of a concave mirror being reflected in parallel lines, if a second mirror be placed diametrically opposite the first, it will, by collecting those rays in its focus, set fire to a combustible body.

Place two concave mirrors, A and B, at about 12 or 15 feet distance from each other, and let the axis of each of them be in the same line. In the focus C of one of them place a live coal, and in the focus D of the other some gunpowder. With a pair of double bellows, which make a continual blast, keep constantly blowing the coal, and notwithstanding the distance between them, the powder will presently take fire.

It is not necessary that these mirrors be of metal or brass, those made of wood or pasteboard gilded will produce the explosion, which has sometimes taken effect at the distance of 50 feet, when mirrors of 18 inches, or two feet diameter, have been used.

This experiment succeeds with more difficulty at great distances; which may proceed from the moisture in a large quantity of air. It would doubtless take effect more readily, if a tin tube, of an equal diameter with the mirrors, were to be placed between them.

X. Behind the partition AB, place, in a position something oblique, the concave mirror EF, which must be at least ten inches in diameter, and its distance from the partition equal to three fourths of the distance of its centre.

14 The real apparition, fig. 19.

In the partition make an opening of seven or eight inches, either square or circular: it must face the mirror, and be of the same height with it. Behind this partition place a strong light, so disposed that it may not be seen at the opening, and may illumine an object placed at C, without throwing any light on the mirror.

Beneath the aperture in the partition place the object C, that you intend shall appear on the outside of the partition, in an inverted position; and which we will suppose to be a flower. Before the partition, and beneath the aperture, place a little flowerpot D, the top of which should be even with the bottom of the aperture, that the eye, placed at G, may see the flower in the same position as if its stalk came out of the pot.

Take care to paint the space between the back part of the partition and the mirror black, to prevent any reflections of light from being thrown on the mirror; in a word, so dispose the whole that it may be as little enlightened as possible.

When a person is placed at the point G, he will perceive the flower that is behind the partition, at the top of the pot at D: But on putting out his hand to pluck it, he will find that he attempts to grasp a shadow.

If in the opening of the partition a large double convex lens of a short focus be placed, or, which is not quite so well, a bottle of clear water, the image of the flower reflected thereon will appear much more vivid and distinct.

Observation.

The phenomena that may be produced by means of concave mirrors are highly curious and astonishing. By their aid, spectres of various kinds may be exhibited. Suppose, for example, a person with a drawn sword places himself before a large concave mirror, but farther from it than its focus; he will then see an inverted image of himself in the air, between him and the mirror, of a less size than himself. If he steadily present the sword towards the centre of the mirror, an image of the sword will come out therefrom towards the sword in his hand, point to point, as it were to fence with him: and by his pushing the sword nearer, the image will appear to come nearer him, and almost to touch his breast, having a striking effect upon him. If the mirror be turned 45 degrees, or one-eighth, round,

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Fig. 1.

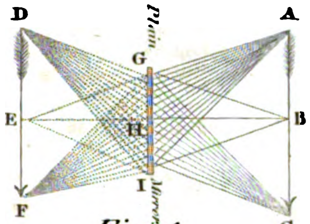


Fig. 2.

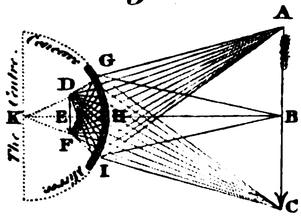


Fig. 3.

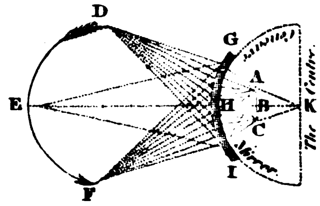


Fig. 8.

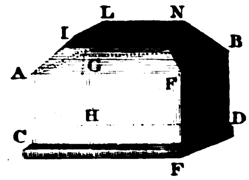


Fig. 4

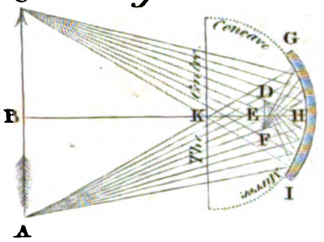


Fig. 7.

Fig. 6.

Fig. 9.

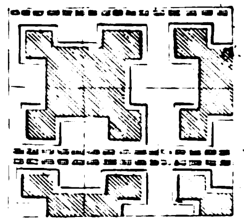


Fig. 10.

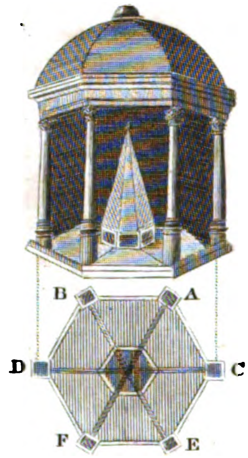


Fig. 5.

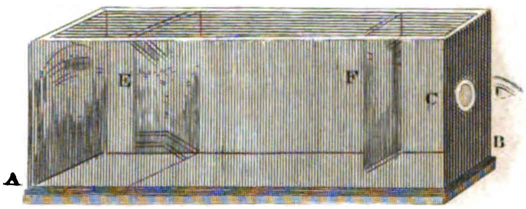


Fig. 11.

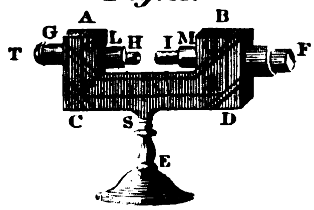


Fig. 12.

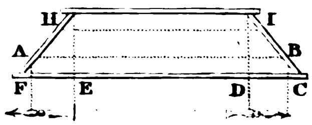


Fig. 13.

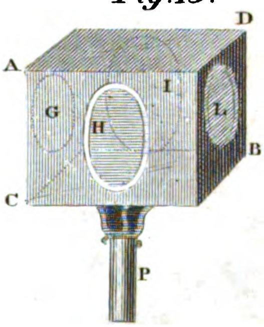


Fig. 14.

Fig. 15.

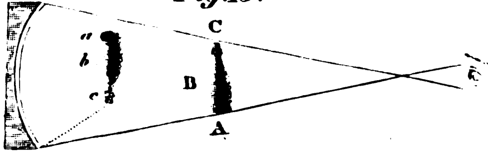


Fig. 17.

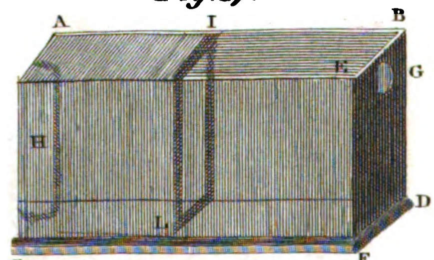


Fig. 16.

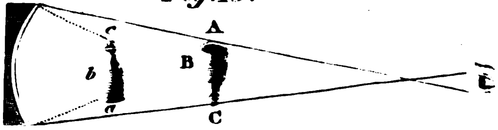
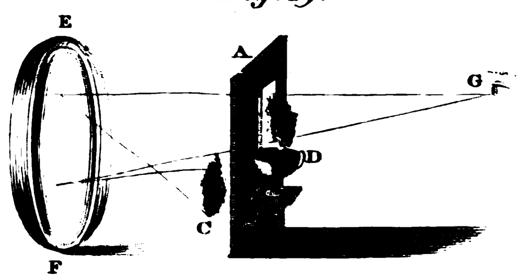


Fig. 19.



Cat head

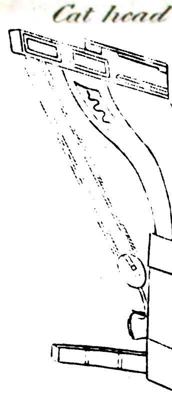
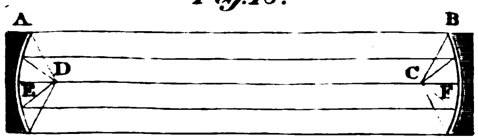


Fig. 18.



E. Mitchell sculp.t

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round, the reflected image will go out perpendicular to the direction of the sword presented, and apparently come to another person placed in the direction of the motion of the image. If that person is unacquainted with the experiment, and does not see the original sword, he will be much surprised and alarmed. This experiment may be another way diversified, by telling any person, that at such an hour, and in such a place, he should see the apparition of an absent or deceased friend (of whose portrait you are in possession). In order to produce this phantom, instead of the hole in the partition AB in the last figure, there must be a door which opens into an apartment to which there is a considerable descent. Under that door you are to place the portrait, which must be inverted and strongly illuminated, that it may be lively reflected by the mirror, which must be large and well polished. Then having introduced the incredulous spectator at another door, and placed him in the proper point of view, you suddenly throw open the door at AB, when, to his great astonishment, he will immediately see the apparition of his friend.

It will be objected, perhaps, that this is not a perfect apparition, because it is only visible at one point of view, and by one person. But it should be remembered, that it was an established maxim in the last centuries, that a spectre might be visible to one person and not to others. So Shakespeare makes both Hamlet and Macbeth see apparitions that were not visible to others present at the same time. It is not unlikely, moreover, that this maxim took its rise from certain apparitions of this kind that were raised by the monks, to serve some purposes they called religious; as they alone were in possession of what little learning there then was in the world.

Opticians sometimes grind a glass mirror concave in one direction only, as it is said longitudinally; it is in fact a concave portion of a cylinder, the breadth of which may be considered that of the mirror. A person looking at his face in this mirror, in the direction of its concavity, will see it curiously distorted in a very lengthened appearance; and by turning the cylindrical mirror a quarter round, his visage will appear distorted another way, by an apparent increase in width only. Another curious and singular property attends this sort of mirror: If in a very near situation before it, you put your finger on the right hand side of your nose, it will appear the same in the mirror; but if in a distant situation, somewhat beyond the centre of concavity, you again look at your face in the mirror, your finger will appear to be removed to the other or left hand side of your nose. This, though something extraordinary, will in its cause appear very evident from a small consideration of the properties of sperical concave mirrors.

CATOPTROMANCY, Κατοπτρομαντεια, a kind of divination among the ancients; so called, because consisting in the application of a mirror. The word is formed from κατοπτρον, *speculum*, "mirror," and μαντεια, *divinatio*, "divination." Pausanias says, it was in use among the Achaians; where those who were sick, and in danger of death, let down a mirror, or looking glass fastened by a thread, into a fountain before the temple of Ceres; then looking in the glass, if they saw a ghastly disfigured face, they took it as a sure sign of death: on the contrary, if the flesh appeared fresh and healthy, it was a token of recovery. Sometimes glasses were used without water, and the images of things future represented in them. See GASTROMANCY.

CATROU, FRANCIS, a famous Jesuit, born at Paris in 1659. He was engaged for 12 years in the *Journal de Trevoux*, and applied himself at the same time to other works, which distinguished him among the learned. He wrote a general History of the Mogul empire, and a Roman history, in which he was assisted by Father Rouille, a brother Jesuit. Catrou died in 1737; and this last history was continued by Rouille, who died in 1740.

CATTERHUN, a remarkable Caledonian post a few miles north of the town of Brechin in the county of Angus in Scotland. Mr Pennant describes it as of uncommon strength. "It is (says he) of an oval form, made of a stupendous dike of loose white stones, whose convexity, from the base within to that without, is 122 feet. On the outside a hollow, made by the disposition of the stones, surrounds the whole. Round the base is a deep ditch, and below that about 100 yards, are vestiges of another, that went round the hill. The area within the stony mound is flat: the axis, or length of the oval, is 436 feet, the transverse diameter 200. Near the east side is the foundation of a rectangular building; and on most parts are the foundations of others small and circular: all which had once their superstructures, the shelter of the possessors of the post: there is also a hollow, now almost filled with stones, the well of the place." There is another fortification, but of inferior strength, in the neighbourhood. It is called the *Brown Catterthun*, from the colour of the ramparts, which are composed only of earth. It is of a circular form, and consists of various concentric dikes. On one side of this rises a small rill, which, running down the hill, has formed a deep gully. From the side of the fortress is another rampart, which extends parallel to the rill, and then reverts, forming an additional post or retreat. The meaning of the word *Catter-thun*, is *Camp-town;* and Mr Pennant thinks these might probably be the posts occupied by the Caledonians before their engagement at the foot of the Grampian mountains with the celebrated Agricola. See (*History of*) SCOTLAND.

CATTI, a people of Germany, very widely spread, on the east reaching to the river Sala, on the north to Westphalia; occupying, besides Hesse, the Wetterau, and part of the tract on the Rhine, and on the banks of

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of the river Lohne. The Hercynian forest began and ended in their country.

CATTIVELLAUNI, anciently a people of Britain, seated in the country which is now divided into the counties of Hertford, Bedford, and Bucks. The name of this ancient British people is written in several different ways by Greek and Roman authors, being sometimes called Catti, Cassii, Catticulcani, Cattidudani, Catticludani, &c. That they were of Belgic origin cannot be doubted; and it is not improbable that they derived their name of Catti from the Belgic word Katten, which signifies illustrious or noble, and that the addition of Vellauni, which means on the banks of rivers, might be given them after their arrival in Britain, as descriptive of the situation of their country. However this may be, the Cattivellauni formed one of the most brave and warlike of the ancient British nations when Cæsar invaded Britain, and long after. Cassibelanus, their prince, was made commander in chief of the confederated Britons, not only on account of his own personal qualities, but also because he was at the head of one of their bravest and most powerful tribes. In the interval between the departure of Cæsar and the next invasion under Claudius, the Cattivellauni had reduced several of the neighbouring states under their obedience; and they again took the lead in opposition to the Romans at their second invasion, under their brave but unfortunate prince, Caractacus. The country of the Cattivellauni was much frequented and improved by the Romans, after it came under their obedience. Verulamium, their capital, which stood near where St Alban's now stands, became a place of great consideration, was honoured with the name and privileges of a municipium or free city, and had magistrates after the model of the city of Rome. This place was taken and almost destroyed by the insurgents under Boadicea; but it was afterwards rebuilt, restored to its former splendour, and surrounded with a strong wall, some vestiges of which are still remaining. Durocobrivæ and Magiavintum, in the second iter of Antoninus, were probably Dunstable and Fenny Stratford, at which places there appear to have been Roman stations. The Salenæ of Ptolemy, a town in the country of the Cattivellauni, was perhaps situated at Salndy in Bedfordshire, where several Roman antiquities have been found. There were, besides these, several other Roman forts, stations, and towns in this country, which it would be tedious to enumerate. The territories of the Cattivellauni made a part of the Roman province called Britannia Prima.

CATTLE, a collective word, which signifies the four-footed animals, which serve either for tilling the ground, or for food to man. They are distinguished into large or black cattle, and into small cattle: of the former are horses, bulls, oxen, cows, and even calves and heifers: amongst the latter are rams, ewes, sheep, lambs, goats, kids, &c. Cattle are the chief stock of a farm: they who deal in cattle are styled graziers.

CATULLUS, Caius Valerius, a Latin poet, born at Verona, in the year of Rome 666. The harmony of his numbers acquired him the esteem and friendship of Cicero, and other great men of his time. Many of his poems, however, abound with gross obscenities. He wrote satirical verses against Cæsar, under the name of Marmuro. He spent his whole life in a state of poverty; and died in the flower of his age and the height of his reputation. Joseph Scaliger, Passerat, Muret, and Isaac Vossius, have written learned notes on this poet.

CATZ, James, a great civilian, politician, and Dutch poet, was born at Browershaven, in Zealand, in the year 1577. After having made several voyages, he fixed at Middleburg; and acquired by his pleadings such reputation, that the city of Dort chose him for its pensionary; as did also, some time after, that of Middleburg. In 1634, he was nominated pensionary of Holland and West Friesland; and in 1648, he was elected keeper of the seal of the same state, and stadtholder of the fiefs: but some time after, he resigned these employments, to enjoy the repose which his advanced age demanded. As the post of grand pensionary had been fatal to almost all those who had enjoyed it, from the beginning of the republic till that time, Catz delivered up his charge on his knees, before the whole assembly of the states, weeping for joy, and thanking God for having preserved him from the inconveniences that seemed attached to the duties of that office. But though he was resolved to spend the rest of his days in repose, the love of his country engaged him to comply with the desires of the states, who importuned him to go on an embassy to England, in the delicate conjuncture in which the republic found itself during the protectorate of Cromwell. At his return, he retired to his fine country seat at Sorgvliet, where he lived in tranquillity till the year 1660, in which he died. He wrote a great number of poems in Dutch; most of which are on moral subjects, and so esteemed, that they have been often printed in all the different sizes; and, next to the Bible, there is no work so highly valued by the Dutch.

CATZENELLIBOGEN, a town of Germany, in the duchy of Nassau, with a strong castle. It is capital of a county of the same name. E. Long. 7. 38. N. Lat. 50. 20.

CAVA, in *Anatomy*, the name of a vein, the largest in the body, terminating in the right ventricle of the heart. See Anatomy *Index*.

Cava, a considerable and populous town of Italy, in the kingdom of Naples, and in the Hither Principato, with a bishop's see. It is situated at the foot of Mount Metelian, in E. Long. 15. 5. N. Lat. 40. 40.

CAVAILLAN, a town of France, in the department of Vaucluse, and formerly a bishop's see. It is situated on the river Durance, in a fertile and pleasant country, and 20 miles south-east of Avignon. Population 7000. E. Long. 4. 17. N. Lat. 43. 52.

CAVALCADE, a formal pompous march or procession of horsemen, equipages, &c. by way of parade or ceremony, to grace a triumph, public entry, or the like.

CAVALCADOUR, or Cavalcadeur, anciently denoted a riding master; but at present is disused in that sense, and only employed to denote a sort of equerries or officers who have the direction of princes stables. The French say, *ecuyer cavalcadeur* of the king, the duke of Orleans, &c. Menage writes it *cavalcadour*, and derives it from the Spanish *cavalgador*, a horseman.

CAVALCANTE, Guido, a nobleman of Florence in

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in the 13th century, who having followed the party of the Guelphs, experienced the changeableness of fortune. He showed great strength of mind in his misfortunes, and never neglected to improve his talents. He wrote a treatise in Italian concerning style, and some verses which are esteemed. His poem on the love of this world has been commented on by several learned men.

CAVALIER, a horseman, or person mounted on horseback: especially if he be armed withal, and have a military appearance.

Anciently the word was restrained to a knight, or *miles*. The French still use *Chevalier* in the same sense.

CAVALIER, considered as a faction. See BRITAIN, No. 109.

CAVALIER, in fortification, an elevation of earth of different shapes, situated ordinarily in the gorge of a bastion, bordered with a parapet, and cut into more or less embrasures, according to the capacity of the cavalier. Cavaliers are a double defence for the faces of the opposite bastion: they defend the ditch, break the besiegers galleries, command the traverses in dry moats, scour the salient angle of the counterscarp, where the besiegers have their counter batteries, and enfilade the enemy's trenches, or oblige them to multiply their parallels: they are likewise very serviceable in defending the breach and the retrenchments of the besieged.

CAVALIER, in the manege, one that understands horses, and is practised in the art of riding them.

CAVALIERI, BONAVENTURE, an eminent mathematician in the 17th century, a native of Milan, and a friar of the order of the Jesuati of St Jerome, was professor of the mathematics at Bologna, where he published several mathematical books, particularly the "Method of Indivisibles." He was a scholar of Galileo. His *Directorium generale Uranometricum* contains great variety of most useful practices in trigonometry and astronomy. His trigonometrical tables in that work are excellent.

CAVALLO, TIBERIUS, an eminent natural philosopher. See SUPPLEMENT.

CAVALRY, a body of soldiers that charge on horseback. The word comes from the French, *cavalerie*, and that from the corrupt Latin, *caballus*, a horse.

The Roman cavalry consisted wholly of those called *equites*, or knights, who were a distinct order in the distribution of citizens.—The Grecian cavalry were divided into *cataphractæ* and *non cataphractæ*, *i. e.* into heavy and light armed.—Of all the Greeks, the Thessalians excelled most in cavalry. The Lacedemonians, inhabiting a mountainous country, were but meanly furnished with cavalry, till, carrying their arms into other countries, they found great occasion for horse to support and cover their foot. The Athenian cavalry, for a considerable time, consisted only of 96 horsemen: after expelling the Persians out of Greece, they increased the number to 300; and afterwards to 1200, which was the highest pitch of the Athenian cavalry.

The chief use of the cavalry is to make frequent excursions to disturb the enemy, intercept his convoys, and destroy the country: in battle to support and cover the foot, and to break through and disorder the enemy: also to secure the retreat of the foot. Formerly, the manner of fighting of the cavalry was, after firing their pistols or carabines, to wheel off, to give opportunity for loading again. Gustavus Adolphus is said to have first taught the cavalry to charge through, to march straight up to the enemy, with the sword drawn in the bridle hand, and each man having fired his piece, at the proper distance, to betake himself to his sword, and charge the enemy as was found most advantageous.

CAVAN, a town of Ireland, and capital of a county of the same name, in the province of Ulster, situated in W. Long. 6. 32. N. Lat. 54. 0.

CAVAN, a county of Ireland, 47 miles in length and 23 in breadth; is bounded on the east by Monaghan, and on the south by Longford, West-Meath, and East-Meath. It has but two towns of any note, viz. Cavan and Kilmore. It contains 33 parishes, and in 1801 was computed to have 18,000 houses and 90,000 inhabitants. The county sends two members to the imperial parliament. It has nine market towns. See CAVAN, SUPPLEMENT.

CAVANILLES, ANTONIO JOSEPH, an eminent Spanish botanist. See SUPPLEMENT.

CAUBUL, an extensive country in Asia. See SUPPLEMENT.

CAUCASUS, the name of a very high mountain of Asia, being one of that great ridge which runs between the Black and Caspian seas. Sir John Chardin describes this as the highest mountain, and the most difficult to pass, of any he had seen. It has frightful precipices, and in many places the roads are cut out of the solid rock. At the time he passed it, the mountain was entirely covered with snow; so that, in many places, his guides behoved to clear the way with shovels. The mountain is 36 leagues over, and the summit of it eight leagues in breadth. The top is perpetually covered with snow; and our traveller relates, that the two last days he seemed to be in the clouds, and was not able to see 20 paces before him. Excepting the very top, however, all the parts of Mount Caucasus are extremely fruitful; abounding in honey, corn, fruits, hogs, and large cattle. The vines twine about the trees, and rise so high, that the inhabitants cannot gather the fruit from the uppermost branches. There are many streams of excellent water, and a vast number of villages. The inhabitants are for the most part Christians of the Georgian church. They have fine complexions, and the women are very beautiful.—In the winter they wear snow shoes in the form of rackets, which prevent their sinking in the snow, and enable them to run upon it with great swiftness.

CAUDEBEC, a rich, populous, and trading town, in Normandy, and capital of the territory of Caux. It is seated at the foot of a mountain near the river Seine, in E. Long. 0. 46. N. Lat. 40. 30.

CAUDEX, by Malpighi and other botanists, is used to signify the stem or trunk of a tree; by Linnæus, the stock or body of the root, part of which ascends, part descends. The ascending part raises itself gradually above ground, serving frequently for a trunk, and corresponds in some measure to the *caudex* of former writers; the descending part strikes gradually downward into the ground, and puts forth radicles or small fibres, which are the principal and essential part of every root. The descending caudex

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dex therefore corresponds to the radix of other botanists. Agreeably to this idea, Linnæus considers trees and shrubs as roots above ground: an opinion which is confirmed by a well known fact, that trees, when inverted, put forth leaves from the descending caudex, and radicles or roots from the ascending. For the varieties in the descending caudex, see the article RADIX.

CAUDIUM, in *Ancient Geography*, a town of Samnium, on the Via Appia, between Calatia and Beneventum: *Caudinus*, the epithet. The *Caudinæ Furcæ, Furcatæ*, were memorable by the disgrace of the Romans; being spears disposed in the form of a gallows, under which prisoners of war were made to pass, and gave name to a defile or narrow pass near *Caudium* (Livy); where the Samnites obliged the Roman army and the two consuls to lay down their arms, and pass under the gallows, or yoke, as a token of subjection.

CAVE, any large subterraneous hollow. These were undoubtedly the primitive habitations, before men began to build edifices above ground. The primitive method of burial was also to reposite the bodies in caves, which seems to have been the origin of catacombs. They long continued the proper habitations of shepherds. Among the Romans, *caves* (*antra*) used to be consecrated to nymphs, who were worshipped in caves, as other gods were in temples. The Persians also worshipped their god Mithras in a natural cave consecrated for the purpose by Zoroaster. The cave of the nymph Egeria is still shown at Rome. Kircher, after Gaffarellus, enumerates divers species of caves; as divine, natural, &c.—Of natural caves some are possessed of a medicinal virtue, as the Grotto de Serpente; others are poisonous or mephitical: some are replete with metalline exhalations, and others with waters. Divine caves were those said to affect the human mind and passions in various ways, and even to inspire with a knowledge of future events. Such were the sacred caverns at Delphi which inspired the Pythia; the Sibyl's cave at Cumæ, still shown near the lake Avernus; the cave of Trophonius, &c.

CAVE, *Dr William*, a learned English divine, born in 1637, educated in St John's College, Cambridge; and successively minister of Hasely in Oxfordshire, Allhallows the Great in London, and of Islington. He became chaplain to Charles II. and in 1684 was installed a canon of Windsor. He compiled *the Lives of the Primitive Fathers in the three first Centuries of the Church*, which is esteemed a very useful work, and *Historia Literaria*, &c. in which he gives an exact account of all who had written for or against Christianity from the time of Christ to the 14th century: which works produced a very warm dispute between Dr Cave and M. le Clerc, who was then writing his *Bibliotheque Universelle* in Holland, and who charged the doctor with partiality. Dr Cave died in 1713.

CAVE, *Edward*, printer, celebrated as the projector of the *Gentleman's MAGAZINE*,—the first publication of the species, and since

The fruitful mother of a thousand more,

was born in 1691. His father being disappointed of some small family expectations, was reduced to follow the trade of a shoemaker at Rugby in Warwickshire. The free school of this place, in which his son had, by the rules of its foundation, a right to be instructed, was then in high reputation, under the Rev. Mr Holyock, to whose care most of the neighbouring families, even of the highest rank, intrusted their sons. He had judgment to discover, and for some time generosity to encourage, the genius of young Cave; and was so well pleased with his quick progress in the school, that he declared his resolution to breed him for the university, and recommend him as a servitor to some of his scholars of high rank. But prosperity which depends upon the caprice of others is of short duration. Cave's superiority in literature exalted him to an invidious familiarity with boys who were far above him in rank and expectations; and, as in unequal associations it always happens, whatever unlucky prank was played was imputed to Cave. When any mischief, great or small, was done, though perhaps others boasted of the stratagem when it was successful, yet upon detection or miscarriage, the fault was sure to fall to poor Cave. The harsh treatment he experienced from this source, and which he bore for a while, made him at last leave the school, and the hope of a literary education, to seek some other means of gaining a livelihood.

He was first placed with a collector of the excise; but the insolence of his mistress, who employed him in servile drudgery, quickly disgusted him, and he went up to London in quest of more suitable employment. He was recommended to a timber merchant at the Bankside; and while he was there on liking, is said to have given hopes of great mercantile abilities; but this place he soon left, and was bound apprentice to Mr Collins, a printer of some reputation, and deputy alderman. This was a trade for which men were formerly qualified by a literary education, and which was pleasing to Cave, because it furnished some employment for his scholastic attainments. Here, therefore, he resolved to settle, though his master and mistress lived in perpetual discord, and their house was therefore no comfortable habitation. From the inconveniences of these domestic tumults he was soon released, having in only two years attained so much skill in his art, and gained so much the confidence of his master, that he was sent without any superintendant to conduct a printing house at Norwich, and publish a weekly paper. In this undertaking he met with some opposition, which produced a public controversy, and procured young Cave the reputation of a writer.

His master died before his apprenticeship was expired, and he was not able to bear the perverseness of his mistress; he therefore quitted her house upon a stipulated allowance, and married a young widow, with whom he lived at Bow. When his apprenticeship was over, he worked as a journeyman at the printing-house of Mr Barbar, a man much distinguished and employed by the Tories, whose principles had at that time so much prevalence with Cave, that he was for some years a writer in Mist's Journal. He afterwards obtained by his wife's interest a small place in the post-office; but still continued, at his intervals of attendance, to exercise his trade, or to employ himself with some typographical business. He corrected the *Gradus ad Parnassum*; and was liberally rewarded by the Company

Company of Stationers. He wrote an Account of the Criminals, which had for some time a considerable sale; and published many little pamphlets that accident brought into his hands, of which it would be very difficult to recover the memory. By the correspondence which his place in the post-office facilitated, he procured a country newspaper, and sold their intelligence to a journalist in London for a guinea a-week. He was afterwards raised to the office of the clerk of the franks, in which he acted with great spirit and firmness; and often stopped franks which were given by members of parliament to their friends, because he thought such extension of a peculiar right illegal. This raised many complaints; and the influence that was exerted against him procured his ejectment from office. He had now, however, collected a sum sufficient for the purchase of a small printing office, and began the Gentleman's Magazine; an undertaking to which he owed the affluence in which he passed the last 20 years of his life, and the large fortune which he left behind him. When he formed the project, he was far from expecting the success which he found; and others had so little prospect of its consequence, that though he had for several years talked of his plan among printers and booksellers, none of them thought it worth the trial. That they were not (says Dr Johnson) restrained by their virtue from the execution of another man's design, was sufficiently apparent as soon as that design began to be gainful; for, in a few years, a multitude of magazines arose, and perished; only the London Magazine, supported by a powerful association of booksellers, and circulated with all the art and all the cunning of trade, exempted itself from the general fate of Cave's invaders, and obtained, though not an equal, yet a considerable sale.

Cave now began to aspire to popularity; and being a greater lover of poetry than any other art, he sometimes offered subjects for poems, and proposed prizes for the best performers. The first prize was 50l. for which, being but newly acquainted with wealth, and thinking the influence of 50l. extremely great, he expected the first authors of the kingdom to appear as competitors, and offered the allotment of the prize to the universities. But, when the time came, no name was seen among the writers that had been ever seen before; and the universities and several private men rejected the province of assigning the prize. The determination was then left to Dr Cromwell Mortimer and Dr Birch; and by the latter the award was made, which may be seen in Gent. Mag. vol. vi. p. 59.

Mr Cave continued to improve his Magazine, and had the satisfaction of seeing its success proportionate to his diligence, till in 1751 his wife died of an asthma. He seemed not at first much affected by her death, but in a few days lost his sleep and his appetite, which he never recovered. After having lingered about two years, with many vicissitudes of amendment and relapse, he fell by drinking acid liquors into a diarrhœa, and afterwards into a kind of lethargic insensibility; and died Jan. 10. 1754, having just concluded the 23d annual collection.

CAVEARE. See CAVIARE.

CAVEAT, in *Law*, a kind of process in the spiritual courts, to stop the proving of a will, the granting titles of administration, &c. to the prejudice of another. It is also used to stop the institution of a clerk to a benefice.

CAVEATING, in fencing, is the shifting the sword from one side of that of your adversary to the other.

CAVEDO, in commerce, a Portuguese long measure, equal to $27\frac{354}{1000}$ English inches.

CAVENDISH, THOMAS, of Suffolk, the second Englishman that sailed round the globe, was descended from a noble family in Devonshire. Having dissipated his fortune, he resolved to repair it at the expence of the Spaniards. He sailed from Plymouth with two small ships in July 1586; passed through the straits of Magellan; took many rich prizes along the coasts of Chili and Peru; and near California, possessed himself of the St Ann, an Acapulco ship, with a cargo of immense value. He completed the circumnavigation of the globe, returning home round the Cape of Good Hope, and reached Plymouth again in September 1588. On his arrival, it is said that his soldiers and sailors were clothed in silk, his sails were damask, and his top-mast was covered with cloth of gold. His acquired riches did not last long: he reduced himself, in 1591, to the expedient of another voyage; which was far from being so successful as the former; he went no farther than the straits of Magellan, where the weather obliging him to return, he died of grief on the coast of Brasil.

CAVENDISH, *Sir William*, descended of an ancient and honourable family, was born about the year 1505, the second son of Thomas Cavendish of Cavendish in Suffolk, clerk of the pipe in the reign of Henry VIII. Having had a liberal education, he was taken into the family of the great Cardinal Wolsey, whom he served in the capacity of gentleman-usher of the chamber, when that superb prelate maintained the dignity of a prince. In 1527, he attended his master on his splendid embassy to France, returned with him to England, and was one of the few who continued faithful to him in his disgrace. Mr Cavendish was with him when he died, and delayed going to court till he had performed the last duty of a faithful servant by seeing his body decently interred. The king was so far from disapproving of his conduct, that he immediately took him into his household, made him treasurer of his chamber, a privy counsellor, and afterwards conferred on him the order of knighthood. He was also appointed one of the commissioners for taking the surrender of religious houses. In 1540, he was nominated one of the auditors of the court of augmentations, and soon after obtained a grant of several considerable lordships in Hertfordshire. In the reign of Edward VI. his estates were much increased by royal grants in seven different counties; and he appears to have continued in high favour at court during the reign of Queen Mary. He died in the year 1557. He was the founder of Chatsworth, and ancestor of the dukes of Devonshire. He wrote "The life and death of Cardinal Wolsey; printed at London in 1607; reprinted in 1706, under the title of "Memoirs of the great favourite Cardinal Wolsey."

CAVENDISH, *William*, Duke of Newcastle, grandson of Sir William Cavendish, was born in 1592. In 1610, he was made knight of the Bath; in 1620, raised to the dignity of a peer, by the title of Baron Ogle,

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Cavendish. Ogle, and Viscount Mansfield; and in the third year of King Charles I. created earl of Newcastle upon Tyne, and Baron Cavendish of Bolesover. He was after this made governor to the prince of Wales, afterwards Charles II. When the first troubles broke out in Scotland, and the king's treasury was but indifferently provided, he contributed ten thousand pounds, and also raised a troop of horse, consisting of about two hundred knights and gentlemen, who served at their own charge, were commanded by the earl, and honoured with the title of *the prince's troop*. He had after this the command of the northern counties; and was constituted general and commander in chief of all the forces that might be raised north of Trent, and of several counties south of that river. He afterwards raised an army of eight thousand horse, foot, and dragoons; with which he took some towns, and gained several important victories. On this he was advanced to the dignity of marquis of Newcastle; but his majesty's affairs being totally ruined by the rashness of Prince Rupert, he, with a few of the principal officers of the army, went abroad, and staid for some time at Paris; where, notwithstanding the vast estate he had when the civil war broke out, his circumstances were now so bad, that himself and wife were reduced to the necessity of pawning their clothes for a dinner. He afterwards removed to Antwerp, that he might be nearer his own country: and there, though under great difficulties, resided for several years; but, notwithstanding his distresses, he was treated, during an exile of eighteen years, with extraordinary marks of distinction. On his return to England at the Restoration, he was advanced to the dignity of earl of Ogle, and duke of Newcastle. He spent his time in a country retirement, and was the patron of men of merit. His grace died in 1670, aged 84. He wrote a treatise on horsemanship, which is esteemed: and some comedies, which are not.

Mr Granger observes, that he was master of many accomplishments, and was much better qualified for a court than a camp; that he understood horsemanship, music, and poetry; but was a better horseman than musician, and a better musician than poet.

Cavendish, *Margaret*, duchess of Newcastle, famous for her voluminous productions, was born about the latter end of the reign of James I. and was the youngest sister of Lord Lucas of Colchester. She married the duke of Newcastle abroad in 1645; and on their return after the Restoration, spent the remainder of her life in writing plays, poems, with the life of her husband, to the amount of about a dozen of folios. "What gives the best idea of her unbounded passion for scribbling (says Mr Walpole), was her seldom revising the copies of her works, lest, as she said, it should disturb her following conceptions." She died in 1673.

Cavendish, *William*, the first duke of Devonshire, and one of the most distinguished patriots in the British annals, was born in 1640. In 1677, being then member for Derby, he vigorously opposed the venal measures of the court; and, the following year, was one of the committee appointed to draw up articles of impeachment against the lord treasurer Danby. In 1679, being re-elected to serve for Derby in a new parliament, Charles II. thought fit to make him a privy counsellor; but he soon withdrew from the board, with his friend Lord Russel, when he found that Popish interest prevailed. He carried up the articles of impeachment to the house of lords, against Lord-chief-justice Scroggs, for his arbitrary and illegal proceedings in the court of king's bench; and when the king declared his resolution not to sign the bill for excluding the duke of York (afterwards James II.) he moved the house of a commons, that a bill might be brought in for the association of all his majesty's Protestant subjects. He also openly named the king's evil counsellors, and voted for an address to remove them from his presence and councils for ever. He nobly appeared at Lord Russel's trial, in defence of that great man, at a time when it was scarce more criminal to be an accomplice than a witness for him. The same fortitude, activity, and love of his country, animated this illustrious patriot to oppose the arbitrary proceedings of James II.; and when he saw there was no other method of saving the nation from impending slavery, he was the foremost in the association for inviting over the prince of Orange, and the first nobleman who appeared in arms to receive him at his landing. He was created duke of Devonshire in 1694, by William and Mary. His last public service was in the union with Scotland, for concluding of which he was appointed a commissioner by Queen Anne. He died in 1707, and ordered the following inscription to be put on his monument.

Willielmus dux Devon,
Bonorum Principum Fidelis subditus,
Inimicus et Invisus Tyrannis.
William duke of Devonshire,
Of good Princes the faithful Subject,
The Enemy and Aversion of Tyrants.

Besides being thus estimable for public virtues, his grace was distinguished by his literary accomplishments. He had a poetical genius, which showed itself particularly in two pieces written with equal spirit, dignity, and delicacy: these are, an Ode on the Death of Queen Mary; and an allusion to the archbishop of Cambray's Supplement to Homer. He had great knowledge in the languages, was a true judge in history, and a critic in poetry; he had a fine hand in music, an elegant taste in painting, and in architecture had a skill equal to any person of the age in which he lived. His predecessor, Sir John Cavendish, was the person who killed the famous Wat Tyler in 1381.

Cavendish, *Henry*, an eminent chemist and natural philosopher. See Supplement.

Cavendish ‖ Caviare.

CAVETTO, in *Architecture*, a hollow member, or round concave moulding, containing a quadrant of a circle, used as an ornament.

CAVEZON, in the manege, a sort of nose band, either of iron, leather, or wood, sometimes flat, and at other times hollow or twisted, clapt upon the nose of a horse to wring it, and so forward the suppling and breaking of the horse.

CAVIARE, a kind of food lately introduced into Britain. It is made of the hard roes of sturgeon *, formed into small cakes, about an inch thick, and three or four inches broad. The method of making it is, by taking out of the spawn all the nerves or strings, then washing it in white wine or vinegar, and spreading

* See *Acipenser*.

ing it on a table. It is then salted and pressed in a fine bag; after which it is cased up in a vessel with a hole at the bottom, that if any moisture is left it may run out. This kind of food is in great request among the Muscovites, on account of their three lents, which they keep with a superstitious exactness; wherefore the Italians settled at Moscow drive a very great trade in this commodity throughout that empire, there being a prodigious quantity of sturgeon taken at the mouth of the Wolga and other rivers which fall into the Caspian sea. A pretty large quantity of the commodity is also consumed in Italy and France. They get the caviare from Archangel, but commonly buy it at second hand of the English and Dutch.—According to Savary, the best caviare brought from Muscovy is prepared from the belluga, a fish eight or ten feet long, caught in the Caspian sea, which is much preferable to that made of the spawn of a sturgeon. A kind of caviare, or rather sausage, is also made from the spawn of some other fishes; particularly a sort of mullet caught in the Mediterranean. See Mugil and Botargo.

CAVIDOS. See Cabidos.

CAVIL (*cavillatio*), is defined by some a fallacious kind of reason, carrying some resemblance of truth, which a person, knowing its falsehood, advances in dispute for the sake of victory. The art of framing sophisms or fallacies is called by Boethius *cavillatoria*.

CAUK, or Cawk. See Barytes, Chemistry and Mineralogy *Index*.

CAUKING, or *Caulking of a Ship*, is driving a quantity of oakum, or old ropes untwisted and drawn asunder, into the seams of the planks, or into the intervals where the planks are joined together in the ship's decks or sides, in order to prevent the entrance of water. After the oakum is driven very hard into these seams, it is covered with hot melted pitch or rosin, to keep the water from rotting it.

Among the ancients, the first who made use of pitch in caulking, were the inhabitants of Phæacia, afterwards called Corsica. Wax and rosin appear to have been commonly used previous to that period; and the Poles at this time use a sort of unctuous clay for the same purpose on their navigable rivers.

Caulking Irons, are iron chissels for that purpose. Some of these irons are broad, some round, and others grooved. After the seams are stopped with oakum, it is done over with a mixture of tallow, pitch, and tar, as low as the ship draws water.

CAUL, in *Anatomy*, a membrane in the abdomen, covering the greatest part of the guts; called, from its structure, *Reticulum*, but most frequently *Omentum*. See Anatomy *Index*.

Caul is likewise a little membrane, found on some children, encompassing the head when born.

Drelincourt takes the *caul* to be only a fragment of the membranes of the fœtus; which ordinarily break at the birth of the child. Lampridius tells us, that the midwives sold this *caul* at a good price to the advocates and pleaders of his time; it being an opinion, that while they had this about them, they should carry with them a force of persuasion which no judge could withstand; the canons forbid the use of it, because some witches and sorcerers, it seems, had abused it.

CAULIFLOWERS, in *Gardening*, a much esteemed species of cabbage. See Brassica.

CAURIS, in *Natural History*, a name given by some to the genus of shells called, by the generality of writers, *porcellana* and *conchæ venereæ*. It is from a false pronunciation of this word *cauris* that these shells are called *cowries*. See *Porcelain Shell*, Conchology *Index*.

CAURSINES (*Caursini*), were Italians that came into England about the year 1235, terming themselves *the pope's merchants*, but driving no other trade than letting out money; and having great banks in England, they differed little from Jews, save (as history says) they were rather more merciless to their debtors. Some will have them called *Coursines*, quasi *Causa Ursini*, bearish, or cruel in their causes; others *Caorsini* or *Corsini*, as coming from the isle of Corsica; but Cowel says, they have their name from *Caorsium*, *Caorsi*, a town in Lombardy, where they first practised their arts of usury and extortion; from whence spreading themselves, they carried their infamous trade through most parts of Europe, and were a common plague to every nation where they came. The then bishop of London excommunicated them; and King Henry III. banished them from the kingdom in the year 1240. But, being the pope's solicitors and money changers, they were permitted to return in the year 1250; though in a very short time they were again driven out of the kingdom on account of their intolerable exactions.

CAUSA matrimonii prælocuti, in common law, a writ that lies where a woman gives lands to a man in fee to the intent he shall marry her, and he refuses to do it in a reasonable time, being thereupon required by the woman; and in such case, for not performing the condition, the entry of the woman into the lands again has been adjudged lawful.

The husband and wife may sue this writ against another who ought to have married her.

CAUSALITY, among metaphysicians, the action or power of a cause in producing its effect.

CAUSALTY, among miners, denotes the lighter, sulphureous, earthy parts of ores, carried off in the operation of washing. This, in the mines, they throw in heaps upon banks, which in six or seven years they find it worth their while to work over again.

CAUSE, that from whence any thing proceeds, or by virtue of which any thing is done; it stands opposed to effect. We get the ideas of cause and effect from our observation of the vicissitude of things, while we perceive some qualities or substances begin to exist, and that they receive their existence from the due application and operation of other beings. That which produces, is the cause; and that which is produced, the effect; thus, fluidity in wax is the effect of a certain degree of heat, which we observe to be constantly produced by the application of such heat.

Aristotle, and the schoolmen after him, distinguished four kinds of causes; the efficient, the material, the formal, and the final. This, like many of Aristotle's distinctions, is only a distinction of the various meanings of an ambiguous word; for the efficient, the matter, the form, and the end, have nothing common in their nature, by which they may be accounted species of the same *genus*; but the Greek word, which we translate

Reid on the Active Powers of Man.

translate *cause*, had these four different meanings in Aristotle's days, and we have added other meanings. We do not indeed call the matter or the form of a thing its cause; but we have final causes, instrumental causes, occasional causes, and many others. Thus the word cause has been so hackneyed, and made to have so many different meanings in the writings of philosophers, and in the discourse of the vulgar, that its original and proper meaning is lost in the crowd.

With regard to the phenomena of nature, the important end of knowing their causes, besides gratifying our curiosity, is, that we may know when to expect them, or how to bring them about. This is very often of real importance in life; and this purpose is served, by knowing what, by the course of nature, goes before them and is connected with them; and this, therefore, we call the *cause* of such a phenomenon.

If a magnet be brought near to a mariner's compass, the needle, which was before at rest, immediately begins to move, and bends its course towards the magnet, or perhaps the contrary way. If an unlearned sailor is asked the cause of this motion of the needle, he is at no loss for an answer. He tells you it is the magnet; and the proof is clear; for, remove the magnet, and the effect ceases; bring it near, and the effect is again produced. It is, therefore, evident to sense, that the magnet is the cause of this effect.

A Cartesian philosopher enters deeper into the cause of this phenomenon. He observes, that the magnet does not touch the needle, and therefore can give it no impulse. He pities the ignorance of the sailor. The effect is produced, says he, by magnetic effluvia, or subtle matter, which passes from the magnet to the needle, and forces it from its place. He can even shew you, in a figure, where these magnetic effluvia issue from the magnet, what round they take, and what way they return home again. And thus he thinks he comprehends perfectly how, and by what cause, the motion of the needle is produced.

A Newtonian philosopher inquires what proof can be offered for the existence of magnetic effluvia, and can find none. He therefore holds it as a fiction, a hypothesis; and he has learned that hypothesis ought to have no place in the philosophy of nature. He confesses his ignorance of the real cause of this motion, and thinks that his business as a philosopher is only to find from experiment the laws by which it is regulated in all cases.

These three persons differ much in their sentiments with regard to the real cause of this phenomenon; and the man who knows most is he who is sensible that he knows nothing of the matter. Yet all the three speak the same language, and acknowledge that the cause of this motion is the attractive or repulsive power of the magnet.

What has been said of this, may be applied to every phenomenon that falls within the compass of natural philosophy. We deceive ourselves, if we conceive that we can point out the real efficient cause of any one of them.

The grandest discovery ever made in natural philosophy, was that of the law of gravitation, which opens such a view of our planetary system, that it looks like something divine. But the author of this discovery was perfectly aware that he discovered no real cause, but only the law or rule according to which the unknown cause operates.

Natural philosophers, who think accurately, have a precise meaning to the terms they use in the science; and when they pretend to shew the cause of any phenomenon of nature, they mean by the cause, a law of nature of which that phenomenon is a necessary consequence.

The whole object of natural philosophy, as Newton expressly teaches, is reducible to these two heads: first, by just induction from experiment and observation, to discover the laws of nature; and then to apply those laws to the solution of the phenomena of nature. This was all that this great philosopher attempted, and all that was thought attainable. And this indeed he attained in a great measure, with regard to the motions of our planetary system, and with regard to the rays of light.

But supposing that all the phenomena which fall within the reach of our senses were accounted for from general laws of nature justly deduced from experience; that is, supposing natural philosophy brought to its utmost perfection: it does not discover the efficient cause of any one phenomenon in nature.

The laws of nature are the rules according to which the effects are produced; but there must be a cause which operates according to these rules. The rules of navigation never navigated a ship. The rules of architecture never built a house.

Natural philosophers, by great attention to the course of nature, have discovered many of her laws, and have very happily applied them to account for many phenomena: but they have never discovered the efficient cause of any one phenomenon; nor do those who have distinct notions of the principles of the science make any such pretence.

Upon the theatre of nature we see innumerable effects which require an agent endowed with active power: but the agent is behind the scene. Whether it be the Supreme cause alone, or a subordinate cause or causes; and if subordinate causes be employed by the Almighty, what their nature, their number, and their different offices may be, are things hid, for wise reasons, without doubt, from the human eye.

Cause, among civilians, the same with action. See Action.

Cause, among physicians. The cause of a disease is defined by Galen to be that during the presence of which we are ill, and which being removed, the disorder immediately ceases. The doctrine of the causes of diseases is called Etiology.

Physicians divide causes into procatarctic, antecedent, and continent.

Procatarctic Cause (αιτια προκαταρκτικη), called also *primitive* and *incipient cause*, is either an occasion which of its own nature does not beget a disease, but happening on a body inclined to diseases, breeds a fever, gout, &c. (such as are watching, fasting, and the like); or an evident and manifest cause, which immediately produces the disease, as being sufficient thereto, such as is a sword in respect of a wound.

Antecedent Cause, (αιτια προηγουμενη), a latent disposition of the body, from whence some disease may arise: such as a plethora in respect of a fever, a cacochymia in respect of a scurvy.

Continent, *Conjunct*, or *Proximate* CAUSE, that principle in the body which immediately adheres to the disease, and which being present, the disease is also present: or, which being removed, the disease is taken away: such is the stone in a nephritic patient.

CAUSEWAY, or CAUSEY, a massive construction of stones, stakes, and fascines; or an elevation of fat viscous earth, well beaten: serving either as a road in wet marshy places, or as a mole to retain the waters of a pond, or prevent a river from overflowing the lower grounds. See ROAD.—The word comes from the French *chaussee*, anciently wrote *chaulsée;* and that from the Latin *calceata*, or *calcata;* according to Somner and Spelman, *à calcando*. Bergier rather takes the word to have had its rise *à peditum calceis, quibus teruntur*. Some derive it from the Latin *calx*, or French *chaux*, as supposing it primarily to denote a way paved with chalk stones.

CAUSEWAY, (*calcetum* or *calcea*), more usually denotes a common hard raised way, maintained and repaired with stones and rubbish.

Devil's CAUSEWAY, a famous work of this kind, which ranges through the county of Northumberland, commonly supposed to be Roman, though Mr Horsley suspects it to be of later times.

Giant's CAUSEWAY, is a denomination given to a huge pile of stony columns in the district of Coleraine in Ireland. See GIANT's *Causeway*.

CAUSSIN, NICHOLAS, surnamed the Just, a French Jesuit, was born at Troyes in Champagne, in the year 1580; and entered into the Jesuits order when he was 26 years of age. He taught rhetoric in several of their colleges, and afterwards began to preach, by which he gained very great reputation. He increased this reputation by publishing books, and in time was preferred to be confessor to the king. But he did not discharge this office to the satisfaction of Cardinal Richelieu, though he discharged it to the satisfaction of every honest man; and therefore it is not to be wondered at that he came at length to be removed. He died in the Jesuits convent at Paris in 1651. None of his works did him more honour than that which he entitled *La Cour Sainte*. It has been printed a great many times; and translated into Latin, Italian, Spanish, Portuguese, German, and English. He published several other books both in Latin and French.

CAUSTICITY, a quality belonging to several substances, by the acrimony of which the parts of living animals may be corroded and destroyed. Bodies which have this quality, when taken internally, are true poisons. The causticity of some of these, as of arsenic, is so deadly, that even their external use is proscribed by prudent physicians. Several others, as nitrous acid, lapis infernalis or lunar caustic, common caustic, butter of antimony, are daily and successfully used to consume fungous flesh, to open issues, &c. They succeed very well when properly employed and skilfully managed.

The causticity of bodies depends entirely on the state of the saline, and chiefly of the acid matters they contain. When these acids happen to be at the same time much concentrated, and slightly attached to the matters with which they are combined, they are then capable of acting, and are corrosive or caustic. Thus fixed and volatile alkalies, although they are themselves caustic, become much more so by being treated with quicklime; because this substance deprives them of all their fixed air, or carbonic acid, to which they owe their mildness. By this treatment, then, the saline principle is more disengaged, and rendered more capable of action. Also all combinations of metallic matters with acids form salts more or less corrosive, because these acids are deprived of all their superabundant water, and are besides but imperfectly saturated with the metallic matters. Nevertheless, some other circumstance is necessary to constitute the causticity of these saline metalline matters. For the same quantity of marine acid, which, when pure and diluted with a certain quantity of water, would be productive of no harm, shall, however, produce all the effects of a corrosive poison, when it is united with mercury in *corrosive sublimate*, although the sublimate shall be dissolved in so much water that its causticity cannot be attributed to the concentration of its acid. This effect is, by some chemists, attributed to the great weight of the metallic matters, with which the acid is united; and this opinion is very probable, seeing its causticity is nothing but its dissolving power, or its disposition to combine with other bodies; and this disposition is nothing else than attraction.

On this subject Dr Black observes, that the compounds produced by the union of the metals with acids are in general corrosive. Many of them applied to the skin destroy it almost as fast as the mineral acids; and some of the most powerful potential cauteries are made in this way. Some are reckoned more acrid than the pure acids themselves; and they have more powerful effects when taken internally, or at least seem to have. Thus we can take 10 or 12 drops of a fossil acid, diluted with water, without being disturbed by it; but the same quantity of acid previously combined with silver, quicksilver, copper, or regulus of antimony, will throw the body into violent disorders, or even prove a poison, if taken all at once.

This increased activity was, by the mechanical philosophers, supposed to arise from the weight of the metallic particles. They imagined that the acid was composed of minute particles of the shape of needles or wedges; by which means they were capable of entering the pores of other bodies, separating their atoms from each other, and thus dissolving them. To these acid spiculæ the metallic particles gave more force; and the momentum of each particular needle or wedge was increased in proportion to its increase of gravity by the additional weight of the metallic particle. But this theory is entirely fanciful, and does not correspond with facts. The activity of the compound is not in proportion to the weight of the metal; nor are the compounds always possessed of any great degree of acrimony: neither is it true that any of them have a greater power of destroying animal substances than the pure acids have.

There is a material difference between the powers called *stimuli* and *corrosives*. Let a person apply to any part of the skin a small quantity of lunar caustic, and likewise a drop of strong nitrous acid, and he will find that the acid acts with more violence than the caustic; and the disorders that are occasioned by the compounds of metals and acids do not proceed from a *causticity* in them, but from the metal affecting and proving a stimulus to the nerves: and that this is the case,

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ease, appears from their affecting some particular nerves of the body. Thus the compounds of antimony and mercury with the vegetable acids, do not show the smallest degree of acrimony; but, taken internally, they produce violent convulsive motions over the whole body, which are occasioned by the metallic matter having a power of producing this effect; and the acid is only the means of bringing it into a dissolved state, and making it capable of acting on the nervous system. In general, however, the compounds of metallic substances with acids may be considered as milder than the acids in a separate state; but the acid is not so much neutralized as in other compounds, for it is less powerfully attracted by the metal; so that alkaline salts, absorbent earths, or even heat alone, will decompound them; and some of the inflammable substances, as spirit of wine, aromatic oils, &c. will attract the acid, and precipitate the metal in its metallic form: and the metals can be employed to precipitate one another in their metallic form; so that the cohesion of these compounds is much weaker than those formed of the same acids with alkaline salts or earths.

CAUSTICS, is an appellation given to substances of so hot and fiery a nature, that, being applied, they consume, and as it were burn, the texture of the parts, like hot iron.

Caustics are generally divided into four sorts; the common stronger caustic, the common milder caustic, the antimonial caustic, and the lunar caustic. See Pharmacy and Chemistry *Index*.

Caustic Curve, in the higher geometry, a curve formed by the concourse or coincidence of the rays of light reflected from some other curve.

CAUSUS, or Burning Fever, a species of continual fever, accompanied with a remarkable inflammation of the blood.

CAUTERIZATION, the act of burning or searing some morbid part, by the application of fire either actual or potential. In some places they cauterize with burning tow, in others with cotton or moxa, in others with live coals; some use Spanish wax, others pyramidal pieces of linen, others gold or silver; Severinus recommends flame blown through a pipe; but what is usually preferred among us is a hot iron.

Cauterizing irons are of various figures; some flat, others round, some curved, &c. of all which we find draughts in Albucasis, Scultetus, Ferrara, and others. Sometimes a cautery is applied through a capsula, to prevent any terror from the sight of it. This method was invented by Placentius, and is described by Scultetus. In the use of all cauteries, care is to be taken to defend the neighbouring parts, either by a lamina, defensive plaster, or lint moistened in oxycrate. Sometimes the hot iron is transmitted through a copper cannula, for the greater safety of the adjoining parts. The degrees and manners of cauterizing are varied according to the nature of the disease and the part affected.

CAUTERY, in *Surgery*, a medicine for burning, eating, or corroding any solid part of the body.

Cauteries are distinguished into two classes: actual and potential: by actual cauteries are understood red hot instruments, usually of iron; and by potential cauteries are understood certain kinds of corroding medicines. See Pharmacy.

CAUTION, in the *Civil* and *Scots Law*, denotes much the same with what, in the law of England, is called Bail.

CAUTIONER, in *Scots Law*, that person who becomes bound for another to the performance of any deed or obligation. As to the different kinds and effects of cautionry, see Law, Part III. No. clxxv. 19.

CAWK. See Cauk.

CAXA, a little coin made of lead mixed with some scoria of copper, struck in China, but current chiefly at Bantam in the island of Java, and some of the neighbouring islands. See (the *Table* subjoined to) Money.

CAXAMALCA, the name of a town and district of Peru in South America, where there was a most sumptuous palace belonging to the Incas, and a magnificent temple dedicated to the sun.

CAXTON, William, a mercer of London, eminent by the works he published, and for being *reputed* the first who introduced and practised the art of printing in England; as to which, see *(the History of)* Printing.

CAYENNE, a rich town and island of South America, and capital of the French settlements there, is bounded on the north by the Dutch colonies of Surinam, and situated in W. Long. 53. 10. N. Lat. 50.

This settlement was begun in 1646. A report had prevailed for some time before, that in the interior parts of Guiana, there was a country known by the name of *El Dorada*, which contained immense riches in gold and precious stones; more than ever Cortez and Pizarro had found in Mexico and Peru; and this fable had fired the imagination of every nation in Europe. It is supposed that this was the country in quest of which Sir Walter Raleigh went on his last voyage; and as the French were not behind their neighbours in their endeavours to find out so desirable a country, some attempts for this purpose were likewise made by that nation much about the same time; which at last coming to nothing, the adventurers took up their residence on the island of Cayenne. In 1643, some merchants of Rouen united their stock, with a design to support the new colony; but, committing their affairs to one Poncet de Bretigny, a man of a ferocious disposition, he declared war both against the colonists and savages, in consequence of which he was soon massacred. This catastrophe entirely extinguished the ardour of these associates; and in 1651, a new company was established. This promised to be much more considerable than the former; and they set out with such a capital as enabled them to collect 700 or 800 colonists in the city of Paris itself. These embarked on the Seine, in order to sail down to Havre de Grace; but unfortunately the abbé de Marivault, a man of great virtue, and the principal promoter of the undertaking, was drowned as he was stepping into his boat. Another gentleman, who was to have acted as general, was assassinated on his passage, and 12 of the principal adventurers who had promised to put the colony into a flourishing situation, not only were the principal perpetrators of this fact, but uniformly behaved in the same atrocious manner. At last they hanged one of their own number; two died; three were banished to a

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a desert island; and the rest abandoned themselves to every kind of excess. The commandant of the citadel deserted to the Dutch with part of his garrison. The savages, roused by numberless provocations, fell upon the remainder: so that the few who were left thought themselves happy in escaping to the Leeward islands in a boat and two canoes, abandoning the fort, ammunition, arms, and merchandise, fifteen months after they had landed on the island.

In 1663, a new company was formed, whose capital amounted only to 8750l. By the assistance of the ministry they expelled the Dutch who had taken possession of the island, and settled themselves much more comfortably than their predecessors. In 1667 the island was taken by the English, and in 1676 by the Dutch, but afterwards restored to the French: and since that time it has never been attacked. Soon after some pirates, laden with the spoils they had gathered in the South seas, came and fixed their residence at Cayenne; resolving to employ the treasures they had acquired in the cultivation of the lands. In 1688, Ducasse, an able seaman, arrived with some ships from France, and proposed to them the plundering of Surinam. This was agreed to. The expedition, however, proved unfortunate. Many of the assailants were killed, and all the rest taken prisoners and sent to the Caribbee islands. Cayenne surrendered to the British in 1809, but was restored to France at the peace of Paris in 1814.

The island of Cayenne is about 16 leagues in circumference, and is only parted from the continent by two rivers. By a particular formation, uncommon in islands, the land is higher near the water side, and low in the middle. Hence the island is so full of morasses, that all communication between the different parts of it is impossible, without taking a great circuit. There are some small tracts of an excellent soil to be found here and there; but the generality is dry, sandy, and soon exhausted. The only town in the colony is defended by a covert way, a large ditch, a very good mud rampart, and five bastions. In the middle of the town is a pretty considerable eminence, of which a redoubt has been made that is called the *fort*. The entrance into the harbour is through a narrow channel; and ships can only get in at high water, through the rocks and reefs that are scattered about this pass.

The first produce of Cayenne was the arnotto; from the culture of which the colonists proceeded to that of cotton, indigo, and lastly sugar. It was the first of all the French colonies that attempted to cultivate coffee. The coffee tree was brought from Surinam in 1721 by some deserters from Cayenne, who purchased their pardon by so doing. Ten or twelve years after they planted cacao. In the year 1752 there were exported from Cayenne 260,541 pounds of arnotto, 80,363 pounds of sugar, 17,919 pounds of cotton, 26,881 pounds of coffee, 91,016 pounds of cacao, 618 trees for timber, and 104 planks.

CAYLUS, Count de, Marquis de Sternay, Baron de Bronsac, was born at Paris in 1692. He was the eldest of the two sons of John Count de Caylus, lieutenant general of the armies of the king of France, and of the marchioness de Villette. The count and countess, his father and mother, were very careful of the education of their son. The former instructed him in the profession of arms, and in bodily exercises; the latter watched over and fostered the virtues of his mind, and this delicate task she discharged with singular success. The countess was the niece of Madame de Maintenon, and was remarkable both for the solidity of her understanding and the charms of her wit. She was the author of that agreeable book entitled "The Recollections of Madame de Caylus," of which Voltaire lately published an elegant edition. The amiable qualities of the mother appeared in the son; but they appeared with a bold and military air. In his natural temper he was gay and sprightly, had a taste for pleasure, a strong passion for independence, and an invincible aversion to the servitude of a court. Such were the instructors of the count de Caylus. He was only twelve years of age when his father died at Brussels in 1704. After finishing his exercises, he entered into the corps of the *Musquetoires;* and in his first campaign in the year 1709, he distinguished himself by his valour in such a manner, that Louis XIV. commended him before all the court, and rewarded him with an ensigncy in the *Gendarmerie*. In 1711 he commanded a regiment of dragoons, which was called by his own name; and he signalized himself at the head of it in Catalonia. In 1713, he was at the siege of Fribourg, where he was exposed to imminent danger in the bloody attack of the covered way. The peace of Rastadt having left him in a state of inactivity ill suited to his natural temper, his vivacity soon carried him to travel into Italy: and his curiosity was greatly excited by the wonders of that country, where antiquity is still fruitful, and produces so many objects to improve taste and to excite admiration. The eyes of the count were not yet learned; but he was struck with the sight of so many beauties, and soon became acquainted with them. After a year's absence, he returned to Paris with so strong a passion for travelling and for antiquities, as induced him to quit the army.

He had no sooner quitted the service of Louis, than he sought for an opportunity to set out for the Levant. When he arrived at Smyrna, he visited the ruins of Ephesus. From the Levant he was recalled in February 1717 by the tenderness of his mother. From that time he left not France, but to make two excursions to London. The Academy of Painting and Sculpture adopted him an honorary member in the year 1731; and the count, who loved to realize titles, spared neither his labour, nor his credit, nor his fortune, to instruct, assist, and animate the artists. He wrote the lives of the most celebrated painters and engravers that have done honour to this illustrious academy; and, in order to extend the limits of the art, which seemed to him to move in too narrow a circle, he collected, in three different works, new subjects for the painter, which he had met with in the works of the ancients.

Such was his passion for antiquity, that he wished to have had it in his power to bring the whole of it to life again. He saw with regret, that the works of the ancient painters, which have been discovered in our times, are effaced and destroyed almost as soon as they are drawn from the subterraneous mansions where they were buried. A fortunate accident furnished

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nished him with the means of showing us the composition and the colouring of the pictures of ancient Rome. The coloured drawings which the famous Pietro Sante Bartoli had taken there from antique pictures, fell into his hands. He had them engraved; and, before he enriched the king of France's cabinet with them, he gave an edition of them at his own expence. It is perhaps the most extraordinary book of antiquities that ever will appear. The whole is painted with a purity and precision that are inimitable; we see the liveliness and the freshness of the colouring that charmed the Cæsars. There were only 30 copies published; and there is no reason to expect that there will hereafter be any more.

Count de Caylus was engaged at the same time in an enterprise still more favourable to Roman grandeur, and more interesting to the French nation. Colbert had framed the design of engraving the Roman antiquities that are still to be seen in the southern provinces of France. By his orders Mignard the architect had made drawings of them, which Count de Caylus had the good fortune to recover. He resolved to finish the work begun by Colbert, and to dedicate it to that great minister; and so much had he this enterprise at heart, that he was employed in it during his last illness, and warmly recommended it to M. Mariette.

In 1742, Count Caylus was admitted honorary member of the Academy of Belles Lettres; and then it was that he seemed to have found the place for which nature designed him. The study of literature now became his ruling passion; he consecrated to it his time and his fortune; he even renounced his pleasures to give himself wholly up to that of making some discovery in the field of antiquity. But amidst the fruits of his research and invention, nothing seemed more flattering to him than his discovery of encaustic painting. A description of Pliny's, but too concise a one to give him a clear view of the matter, suggested the idea of it. He availed himself of the friendship and skill of M. Magault, a physician in Paris, and an excellent chemist; and by repeated experiments found out the secret of incorporating wax with divers tints and colours, and of making it obedient to the pencil. Pliny has made mention of two kinds of encaustic painting practised by the ancients; one of which was performed with wax, and the other upon ivory, with hot punches of iron. It was the former that Count Caylus had the merit of reviving: and M. Muntz afterwards made many experiments to carry it to perfection.

In the hands of Count Caylus, literature and the arts lent each other a mutual aid. But it would be endless to give an account of all his works. He published above 40 dissertations in the Memoirs of the Academy of Belles Lettres. The artists he was particularly attentive to; and to prevent their falling into mistakes from an ignorance of costume, which the ablest of them have sometimes done, he founded a prize of 500 livres, the object of which is to explain, by means of authors and monuments, the usages of ancient nations. In order that he might enjoy with the whole world the treasures he had collected, he caused them to be engraved, and gave a learned description of them in a work which he embellished with 800 copperplates.

The strength of his constitution seemed to give him hopes of a long life; but a humour settling in one of his legs, which entirely destroyed his health, he expired on the 5th of September 1765, and by his death his family is extinct. The tomb erected to the honour of Count Caylus is to be seen in the chapel of St Germain l'Auxerrois, and deserves to be remarked. It is perfectly the tomb of an antiquary. This monument was an ancient sepulchral antique, of the most beautiful porphyry, with ornaments in the Egyptian taste. From the moment he procured it, he had destined it to grace the place of his interment. While he awaited the fatal hour, he placed it in his garden, where he used to look upon it with a tranquil but thoughtful eye, and pointed it out to the inspection of his friends.

The character of Count Caylus is to be traced in the different occupations which divided his cares and his life. In society, he had all the frankness of a soldier, and a politeness which had nothing in it of deceit or circumvention. Born independent, he applied to studies which suited his taste. His heart was yet better than his abilities. In his walks he used frequently to try the honesty of the poor, by sending them with a piece of money to get change for him. In these cases he enjoyed their confusion at not finding him; and then presenting himself, used to commend their honesty, and give them double the sum. He said frequently to his friends, "I have this day lost a crown; but I was sorry that I had not an opportunity of giving a second. The beggar ought not to want integrity."

CAYSTER, or CAYSTRUS, in *Ancient Geography*, a river of Ionia, whose mouth Ptolemy places between Colophon and Ephesus; commended by the poets for its swans, which it had in great numbers. Its source was in the Montes Cilbiani, (Pliny). *Caÿstrius Campus* was a part of the territory of Ephesus. *Campi Caÿstriani* of Lydia were plains lying in the middle between the inland parts and Mount Tmolus.

CAZEROM, or CAZERON, a city of Asia, in Persia, situated in E. Long. 70. N. Lat. 29. 15.

CAZIC, or CAZIQUE, a title given by the Spaniards to the petty kings, princes, and chiefs, of the several countries of America, excepting those of Peru, which are called *curatas*. The French call them *casiques*, a denomination which they always give to the Tartarian hordes.—The cazics, in some places, do the office of physicians, and in others of priests, as well as of captains. The dignity of cazic among the Chiites, a people of South America, does not descend to children, but must be acquired by valour and merit. One of the prerogatives attached to it is, that the cazic may have three wives, while the other people are allowed only one. Mexico comprehended a great number of provinces and islands, which were governed by lords called *caziques*, dependent on and tributary to the emperor. Thirty of these vassals are said to have been so powerful, that they were able, each of them, to bring an army of 100,000 men into the field.

CAZIMIR, a handsome town of Poland, in the palatinate of Lublin, situated on a hill covered with trees, in E. Long. 3. 10. N. Lat. 51. 5.

CEA. See CEOS.

CEANOTHUS. NEW-JERSEY TEA. See BOTANY *Index*.

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CEBES, of Thebes, a Socratic philosopher, author of the admired *Table of Cebes;* or, "Dialogues on the Birth, Life, and Death of Mankind." He flourished about 405 years before Christ.—The above piece is mentioned by some of the ancient writers, by Lucian, D. Laertius, Tertullian, and Suidas: but of Cebes himself we have no account, save that he is once mentioned by Plato, and once by Xenophon. The former says of him, in his "Phædo," that he was a sagacious investigator of truth, and never assented without the most convincing reasons: the latter, in his "Memorabilia," ranks him among the few intimates of Socrates, who excelled the rest in the innocency of their lives. Cebes's *Tabula* is usually printed with Epictetus's *Manuale.*

CECIL, William, Lord Burleigh, treasurer of England in the reign of Queen Elizabeth, was the son of Richard Cecil, Esq. master of the robes to King Henry VIII. He was born in the house of his grandfather, David Cecil, Esq. at Bourn in Lincolnshire, in the year 1520; and received the rudiments of his education in the grammar-school at Grantham. From thence he was removed to Stamford; and about the year 1535, was entered of St John's College, Cambridge. Here he began his studies with a degree of enthusiastic application very uncommon in young gentlemen of family. At the age of 16 he read a sophistry lecture, and at 19 a voluntary Greek lecture, which was the more extraordinary as being at a time when the Greek language was by no means universally understood. In 1541 he went to London, and became a member of the society of Gray's Inn, with an intention to study the law; but he had not been long in that situation before an accident introduced him to King Henry, and gave a new bias to his pursuits. O'Neil, a famous Irish chief, coming to court, had brought with him two Irish chaplains, violent bigots to the Romish faith; with these Mr Cecil, visiting his father, happened to have a warm dispute in Latin, in which he displayed uncommon abilities. The king, being informed of it, ordered the young man into his presence, and was so pleased with his conversation, that he commanded his father to find a place for him. He accordingly requested the reversion of the *custos brevium*, which Mr Cecil afterwards possessed. About this time he married the sister of Sir John Cheke, by whom he was recommended to the earl of Hertford, afterwards duke of Somerset, and protector.

Soon after King Edward's accession, Mr Cecil came into the possession of the office of *custos brevium*, worth about 240l. a-year. His first lady dying in 1543, he married the daughter of Sir Anthony Cook, director of the king's studies. In 1547, he was appointed by the protector master of requests; and soon after attended his noble patron on his expedition against the Scots, and was present at the battle of Musselburgh. In this battle, which was fought on the 10th of September 1547, Mr Cecil's life was miraculously preserved by a friend, who on pushing him out of the level of a cannon, had his arm shattered to pieces. The sight and judgment of his friend must have been as extraordinary as his friendship, to perceive the precise direction of a cannon shot; unless we suppose, that the ball was almost quite spent; in which case the thing is not impossible. The story is told in his life by a domestic. In the year 1548, Mr Cecil was made secretary of state; but in the following year, the duke of Northumberland's faction prevailing, he suffered in the disgrace of the protector Somerset, and was sent prisoner to the Tower. After three months confinement he was released; in 1551 restored to his office; and soon after knighted, and sworn of the privy council. In 1553, he was made chancellor of the order of the Garter, with an annual fee of 100 merks.

On the death of Edward VI. Mr Cecil prudently refused to have any concern in Northumberland's attempt in favour of the unfortunate Lady Jane Gray: and when Queen Mary succeeded to the throne, he was graciously received at court; but not choosing to change his religion, was dismissed from his employments. During this reign, he was twice elected knight of the shire for the county of Lincoln; and often spoke in the house of commons with great freedom and firmness, in opposition to the ministry. Nevertheless, though a Protestant and a *patriot* (that is, a courtier out of place), he had the address to steer through a very dangerous sea without a shipwreck.

Queen Elizabeth's accession in the year 1558 immediately dispelled the cloud which had obscured his fortunes and ministerial capacity. During the horrid reign of her sister, he had constantly corresponded with the princess Elizabeth. On the very day of her accession, he presented her with a paper containing twelve articles necessary for her immediate dispatch; and, in a few days after, was sworn of the privy council, and made secretary of state. His first advice to the queen was, to call a parliament; and the first business he proposed after it was assembled was the establishment of a national church. A plan of reformation was accordingly drawn up under his immediate inspection, and the legal establishment of the church of England was the consequence. Sir William Cecil's next important concern, was to restore the value of the coin, which had in the preceding reigns been considerably debased. In 1561, he was appointed master of the wards; and, in 1571, created baron of Burleigh, as a reward for his services, particularly in having lately stifled a formidable rebellion in the north. The following year he was honoured with the Garter, and raised to the office of lord high treasurer of England. From this period we find him the *primum mobile* of every material transaction during the glorious reign of Queen Elizabeth. Notwithstanding the temporary influence of other favourites, Lord Burleigh was, in fact, her prime minister, and the person on whom she chiefly confided in matters of real importance. Having filled the highest and most important offices of the state for 40 years, and guided the helm of government during the most glorious period of English history, he departed this life on the 4th of August 1598, in the 78th year of his age. His body was removed to Stamford, and there deposited in the family vault, where a magnificent tomb was erected to his memory.—Notwithstanding his long enjoyment of such lucrative employments, he left only an estate of 4000l. per annum, 14,000l. in money, and effects worth about 11,000l. He lived, indeed, in a manner suitable to his high rank and importance.

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portance. He had four places of residence, viz. his lodgings at court, his house in the Strand, his seat at Burleigh Park, near Stamford, and his seat at Theobald's. The last of these was his favourite place of retirement, where he frequently entertained the queen at a vast expence.

Lord Burleigh was doubtless a man of singular abilities and prudence, amiable in his private character, and one of the most able, upright, and indefatigable ministers ever recorded in the annals of this kingdom. His principal works are, 1. *La Complainte de l'ame pecheresse*, or the Complaint of a sinful Soul, in French verse, in the king's library. 2. Materials for Patten's *Diarium exped. Scoticæ*, London, 1541, 12mo. 3. Slanders and lies maliciously, grossly, and impudently vomited out, in certain traiterous books and pamphlets, against two counsellors, Sir Francis Bacon and Sir William Cecil. 4. A speech in parliament, 1562, Strype's Mem. vol. iv. p. 107. 5. Precepts or directions for the well ordering of a man's life, 1637, Harl. Cat. vol. ii. p. 755. 6. Meditations on the death of his lady, Ballard's Mem. p. 184. 7. Meditations on the state of England during the reign of Queen Elizabeth, manuscript. 8. The execution of justice in England for the maintenance of public and Christian peace, &c. Lond. 1581, 1583, Somer's tracts, 4th Collect. vol. i. p. 5. 9. Advice to Queen Elizabeth in matters of religion and state, ib. p. 101, 106. 10. A great number of letters. See Peck's *Desiderata Curiosa*, Howard's collections, &c. 11. Several pedigrees, some of which are preserved in the archbishop of Canterbury's library at Lambeth, No. 299,747.

CECILIA, St, the patroness of music, has been honoured as a martyr ever since the fifth century. Her story, as delivered by the notaries of the Roman church, and from thence transcribed into the Golden Legend and other books of the like kind, says, that she was a Roman lady, born of noble parents about the year 295: That, notwithstanding she had been converted to Christianity, her parents married her to a young Pagan nobleman named Valerianus; who going to bed to her on the wedding night, *as the custom is*, says the book, was given to understand by his spouse, that she was nightly visited by an angel, and that he must forbear to approach her, otherwise the angel would destroy him. Valerianus, somewhat troubled at these words, desired that he might see his rival the angel; but his spouse told him that was impossible, unless he would consent to be baptized and become a Christian. This he consented to; after which, returning to his wife, he found her in her closet at prayer, and by her side, in the shape of a beautiful young man, an angel clothed with brightness. After some conversation with the angel, Valerianus told him that he had a brother named Tiburtius, whom he greatly wished to see a partaker of the grace which he himself had received. The angel told him that his desire was granted, and that they should be both crowned with martyrdom in a short time. Upon this the angel vanished, and was not long in showing himself as good as his word; Tiburtius was converted, and both he and his brother Valerianus were beheaded. Cecilia was offered her life upon condition that she would sacrifice to the deities of the Romans; but she refused; upon which she was thrown into a cauldron of boiling water, and scalded to death. Others say, that she was stifled in a dry bath, *i. e.* an enclosure from whence the air was excluded, having a slow fire underneath it; which kind of death was sometimes inflicted by the Romans upon women of quality who were criminals. Upon the spot where her house stood, is a church, said to have been built by Pope Urban I. who administered baptism to her husband and his brother: it is the church of St Cecilia at Trastevere; within is a most curious painting of the saint, as also a stately monument with a cumbent statue of her with her face downwards. There is a tradition of St Cecilia, that she excelled in music; and that the angel who was thus enamoured of her, was drawn from the celestial regions by the charms of her melody; this has been deemed authority sufficient to making her the patroness of music and musicians. The legend of St Cecilia has given frequent occasion to painters and sculptors to exercise their genius in representations of her, playing on the organ, and sometimes on the harp. Raphael has painted her singing with a regal in her hands; and Domenichino and Mignard, singing and playing on the harp.

CECROPS, the founder and first king of Athens, about the time of Moses the lawgiver of the Hebrews. He was the first who established civil government, religious rites, and marriage among the Greeks; and died after a reign of 50 years. See Attica, N° 4.

CEDAR. See Juniperus and Pinus, Botany *Index*.

The species of cedar famous for its duration, is that popularly called the cedar of Lebanon (*Pinus cedrus*), by the ancients *cedrus magna*, or the great cedar; also *cedrelate*, κεδρελατη. See Pinus, Botany *Index*.

CEDRENUS, George, a Grecian monk, lived in the 11th age, and wrote, "Annals, or an abridged History, from the beginning of the World to the Reign of Isaac Comnenus, emperor of Constantinople, who succeeded Michael IV. in 1057." This work is no more than an extract from several historians. There is an edition of it, printed at Paris in 1647, with the Latin version of Xylander, and the notes of Father Goar, a Dominican.

CEDRUS, the Cedar tree, Mahogany, &c. See Juniperus, Pinus, and Swietenia, Botany *Index*.

CEILING, in *Architecture*, the top or roof of a lower room; or a covering of plaster over laths nailed on the bottom of the joists that bear the floor of the upper room; or where there is no upper room, on joists for the purpose; hence called *ceiling joists*. The word *ceiling* answers pretty accurately to the Latin *lacunar*, "every thing over head."

Plastered ceilings are much used in Britain, more than any other country: nor are they without their advantages, as they make the room lightsome; are good in case of fire; stop the passage of the dust; lessen the noise over head; and, in summer, make the air cooler.

Ceiling, in sea language, denotes the inside planks of a ship.

CEIMELIA, from κειμαι, "to be laid up," in antiquity, denotes choice or precious pieces of furniture or ornaments, reserved or laid up for extraordinary

nary occasions and uses; in which sense, sacred garments, vessels, and the like, are reputed of the ceimelia of a church. Medals, antique stones, figures, manuscripts, records, &c. are the ceimelia of men of letters.

CEIMELIARCHIUM, the repository or place where ceimelia are preserved.

CEIMELIOPHYLAX, (from κειμηλιον and φυλαττω, *I keep*), the keeper or curator of a collection of ceimelia; sometimes also denominated *ceimeliarcha*. The ceimeliarcha, or ceimeliophylax, was an officer in the ancient churches or monasteries, answering to what was otherwise denominated *chartophylax* and *custos archivorum*.

CELÆNÆ, in *Ancient Geography*, the capital of Phrygia Magna, situated on a cognominal mountain, at the common sources of the Mæander and Marsyas. The king of Persia had a strong palace beneath the citadel, by the springs of the Marsyas, which rose in the market-place, not less in size than the Mæander, and flowed through the city. Cyrus the Younger had also a palace there, but by the springs of the Mæander, which river passed likewise through the city. He had, moreover, an extensive paradise or park, full of wild beasts, which he hunted on horseback for exercise or amusement; and watered by the Mæander, which ran through the middle. Xerxes was said to have built these palaces and the citadel after his return from his expedition into Greece.

Antiochus Soter removed the inhabitants of Celænæ into a city which he named, from his mother, Apamea; and which became afterwards a mart inferior only to Ephesus. See APAMEA.

CELANDINE. See CHELIDONIUM, BOTANY *Index*.

CELANO, a town of Italy, in the kingdom of Naples, in Farther Abruzzo. It is seated a mile from the lake Celano, anciently called FUCINUS. E. Long 13. 39. N. Lat. 41. 56.

CELARENT, among logicians, a mode of syllogism, wherein the major and conclusion are universal negative propositions, and the minor an universal affirmative.

E. gr. cE None whose understanding is limited can be omniscient.
lA Every man's understanding is limited.
rEnt Therefore no man is omniscient.

CELASTRUS. See BOTANY *Index*.

In Senegal the negroes use the powder of the root of this plant as a specific against gonorrhœas, which it is said to cure in eight or sometimes in three days. An infusion of the bark of a species of staff tree, which grows in the isle of France, is said to possess the same virtues.

CELEBES, an island in the Indian sea, situated under the equator, and called by some *Macassar*. It extends 2° north, and 6° south latitude, and between 119° and 125° east longitude. It is of a very irregular figure, consisting of three long peninsulas. The air is hot and moist, and subject to great rains during the north-west winds, which blow from November to March, at which time the country is overflowed, and for this reason they build their houses on piles of wood ten feet high. The most healthful time is during the northern

monsoons, which seldom fail blowing regularly in one part of the year. The chief vegetables are rice and cocoas; but they have ebony, sanders, &c. Their fruits and flowers are much the same as in the neighbouring parts of the Indies. They have pepper, sugar, betel, areca, the finest cotton, and opium. The natives have bright olive complexions, and the women have shining black hair. They are thought to be very handsome by the Dutch and Chinese, who often purchase them for bed-fellows. The men are industrious, robust, and make excellent soldiers. Their arms are sabres, and trunks, from whence they blow poisoned darts, which are pointed with the tooth of a sea-fish. Some likewise use poisoned daggers. They were the last of the Indian nations that were enslaved by the Dutch, which could not be effected till after a long war. They teach their children to read and write, and their characters have some resemblance of the Arabic. Their religion being Mahometan, the men indulge themselves in many wives and concubines. The employment of the women is spinning, cookery, and making their own and their husbands clothes. The men wear jewels in their ears, and the women gold chains about their necks. The inhabitants in general go half-naked, without any thing on their head, legs, or feet, and some have nothing but a cloth about their middle. The streets of the town Macassar are spacious, and planted with trees on every side. It stands by the side of the only large river they have in the island. The Dutch have a fort here, mounted with 40 guns, and garrisoned with 700 men; having gradually possessed themselves of a great part of the country. They were, however, dispossessed by the British during the late wars, but received back the colony at the peace in 1814. It is said that the population has diminished since the Dutch conquest.

The religion of these islands was formerly idolatry. They worshipped the sun and moon. They sacrificed to them in the public squares, having no materials which they thought valuable enough to be employed in raising temples. About two centuries ago, some Christians and Mahometans having brought their opinions to Celebes, the principal king of the country took a dislike to the national worship. Having convened a general assembly, he ascended an eminence, when, spreading out his hands towards heaven, he told the Deity, that he would acknowledge for truth that doctrine whose ministers should first arrive in his dominions, and, as the winds and waves were at his command, the Almighty would have himself to blame if he embraced a falsehood. The assembly broke up, determined to wait the orders of heaven, and to obey the first missionaries that should arrive. The Mahometans were the most active, and their religion accordingly prevailed. See CELEBES, SUPPLEMENT.

CELERES, in Roman antiquity, a regiment of body-guards belonging to the Roman kings, established by Romulus, and composed of 300 young men, chosen out of the most illustrious Roman families, and approved by the suffrages of the curiæ of the people, each of which furnished ten. The name comes from *celer*, "quick, ready;" and was given them because of their promptness to obey the king.

The celeres always attended near the king's person, to guard him, to be ready to carry his orders, and to execute

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execute them. In war they made the van-guard in the engagement, which they always began first; in retreats they made the rear-guard.

Though the celeres were a body of horse, yet they usually dismounted, and fought on foot; their commander was called tribune, or prefect of the celeres. They were divided into three troops of 100 each, commanded by a captain called centurio: their tribune was the second person in the kingdom.

Plutarch says, Numa broke the celeres. If this be true, they were soon re-established; for we find them under most of the succeeding kings: witness the great Brutus, who expelled the Tarquins, and who was the tribune of the celeres.

CELERI, in *Botany*, the English name of a variety of the APIUM GRAVEOLENS.

The seed of celeri should be sown at two or three different times, the better to continue it for use through the whole season without running up to seed. The first sowing should be in the beginning of March, upon a gentle hot-bed; the second may be at the end of the same month, which ought to be in an open spot of light earth, where it may have the benefit of the sun; the third time of sowing should be in the latter end of April, or beginning of May, on a moist soil; and if exposed to the morning sun only, it will be so much the better, but it should not be under the drip of trees. The middle of May, some of the plants of the first sowing will be fit to transplant for blanching.

The manner of transplanting it is as follows: after having cleared the ground of weeds, you must dig a trench by a line about 10 inches wide, and 8 or 9 inches deep, loosening the earth in the bottom, and laying it level; and the earth that comes out of the trench should be equally laid on each side the trench, to be ready to draw in again to earth the celeri as it advances in height. These trenches should be made at three feet distance from each other; then plant your plants in the middle of the trench, at about four or five inches distance, in one straight row, having before trimmed the plants, and cut off the tops of the long leaves: and as they are planted, you must observe to close the earth well to their roots with your feet, and to water them plentifully until they have taken new root. As these plants advance in height, you must observe to draw the earth on each side close to them, being careful not to bury their hearts, nor ever to do it but in dry weather; otherwise the plants will rot. When your plants have advanced a considerable height above the trenches, and all the earth, which was laid on the sides thereof, hath been employed in earthing them up, you must then make use of a spade to dig up the earth between the trenches, which must also be made use of for the same purpose, continuing from time to time to earth it up until it is fit for use. The last crop should be planted in a drier soil, to prevent its being rotted with too much wet in the winter. You will do well to cover your ridges of celeri with some pease-haulm, or some such light covering, when the frost is very hard, which will admit the air to the plants; for if they are covered too close they will be very subject to rot: by this means you will preserve your celeri till spring: but you must remember to take off the covering whenever the weather will permit, otherwise it will be apt to cause the celeri to pipe and run to seed. The celeri, when full blanched, will not continue good above three weeks or a month before it will rot or pipe; therefore, in order to continue it good, you should have at least six or seven different seasons of planting, proportioned to the consumption.

The other sort of celeri, which is commonly called *celeriac*, is to be managed in the same manner; excepting that this should be planted on the level ground, or in very shallow drills: for this plant seldom grows above eight or ten inches high, so requires but little earthing up; the great excellency of this being in the size of the root, which is often as large as ordinary turnips.

The best method to save the seed of celeri, is to make choice of some long good roots of the upright celeri, which have not been too much blanched, and plant them out, at about a foot asunder, in a moist soil, early in the spring; and when they run up to seed, keep them supported with stakes, to prevent their being broken down with the wind: and in July, when the seed begins to be formed, if the season should prove very dry, it will be proper to give some water to the plant, which will greatly help its producing good seeds. In August these seeds will be ripe, at which time it should be cut up, in a dry time, and spread upon cloths in the sun to dry; then beat out the seeds, and preserve it in bags for use.

CELERI, Wild, (Apium antarcticum), was found in considerable quantities by Sir Joseph Banks and Dr Solander on the coast of Terra del Fuego. It is like the garden celeri in the colour and disposition of the flowers, but the leaves are of a deeper green. The taste is between that of celeri and parsley. It is a very useful ingredient in the soup for seamen, because of its antiscorbutic quality.

CELERITY, in *Mechanics*, the swiftness of any body in motion. It is also defined to be an affection of motion, by which any moveable body runs through a given space in a given time.

CELESTINS, a religious order, so called from their founder Peter de Meuron, afterwards raised to the pontificate under the name of Celestin V. This Peter, who was born at Isernia, a little town in the kingdom of Naples, in the year 1215, of but mean parents, retired, while very young, to a solitary mountain, in order to dedicate himself wholly to prayer and mortification. The fame of his piety brought several, out of curiosity, to see him; some of whom charmed with his virtues, renounced the world to accompany him in his solitude. With these he formed a kind of community in the year 1254: which was approved by Pope Urban IV. in 1264, and erected into a distinct order, called the *hermits of St Damien*. Peter de Meuron governed this order till 1286, when his love of solitude and retirement induced him to quit the charge. In July 1294, the great reputation of his sanctity raised him, though much against his will, to the pontificate. He then took the name of Celestin V. and his order that of *Celestins* from him. By his bull he approved their constitutions, and confirmed all their monasteries to the number of 20. But he sat too short time in the chair of St Peter to do many great things for his order; for having governed the church five

months

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months and a few days, and considering the great burden he had taken upon him, to which he thought himself unequal, he solemnly renounced the pontificate in a consistory held at Naples.

After his death, which happened in 1296, his order made great progress, not only in Italy but in France likewise; whither the then general Peter of Tivoli sent 12 religious, at the request of King Philip the Fair, who gave them two monasteries; one in the forest of Orleans, and the other in the forest of Compeigne at Mount Chartres. This order likewise passed into several provinces of Germany. They have about 96 convents in Italy, and 21 in France, under the title of priories.

The Celestins rise two hours after midnight to say matins. They eat no flesh at any time, except when they are sick. They fast every Wednesday and Friday, from Easter to the feast of the exaltation of the holy cross; and, from that feast to Easter, every day. As to their habit, it consists of a white gown, a capuche, and a black scapulary. In the choir, and when they go out of the monastery, they wear a black cowl with the capuche: their shirts are of serge.

CELETES, or CELETÆ (from κελης, *a race-horse*) in antiquity, denote single or saddle-horses, by way of contradistinction from those yoked or harnessed together, called *bigarii*, *quadrigarii*, &c. The same denomination is also given to the cavaliers or riders on horseback: and hence some deduce celeres, the name of Romulus's guard.

CELEUSMA, or CELEUMA, in antiquity, the shout or cry of the seamen, whereby they animated each other in their work of rowing. The word is formed from κελευειν, *to call, to give the signal.*

CELEUSMA, was also a kind of song or formula, rehearsed or played by the master, or others, to direct the strokes and movements of the mariners, as well as to encourage them to labour. See CELEUSTES.

CELEUSTES, *in Ancient Navigation*, the boatswain or officer appointed to give the rowers the signal, when they were to pull, and when to stop. He is also denominated *epopeus*, and by the Romans, *portisculus;* sometimes simply *hortator.*

CELIBACY, the state of unmarried persons. Scaliger derives the word from the Greek κοιτη, "bed," and λειπω, *linquo*, "I leave:" others say it is formed from *cœli beatitudo*, q. d. *the blessedness of heaven.*

The ancient Romans used all means imaginable to discourage celibacy. Nothing was more usual than for the censors to impose a fine on bachelors. Dionysius Halicarnassensis mentions an ancient constitution whereby all persons of full age were obliged to marry. But the first law of that kind, of which we have any certainty, is that under Augustus, called *lex Julia de maritandis ordinibus.* It was afterwards denominated *Papia Poppæa*, and more usually *Julia Papia*, in regard of some new sanctions and amendments made to it under the consuls Papius and Poppæus. By this law, divers prerogatives were given to persons who had many children; penalties imposed on those who lived a single life, as that they should be incapable of receiving legacies, and not exceeding a certain proportion.

CELIBATE, the same with celibacy; but it is chiefly used in speaking of the single life of the Popish clergy, or the obligation they are under to abstain from marriage. In this sense we say the law of *celibate.* Monks and religious take a vow of celibate; and what is more, of chastity.

The church of Rome imposes an universal celibacy on all its clergy, from the pope to the lowest deacon and subdeacon. The advocates for this usage pretend that a vow of perpetual celibacy was required in the ancient church as a condition of ordination, even from the earliest apostolic ages. But the contrary is evident, from numerous examples of bishops and archbishops, who lived in a state of matrimony, without any prejudice to their ordination or their function. It is generally agreed that most of the apostles were married. Some say all of them, except St Paul and St John. Others say St Paul himself was married, because he writes to his *yoke-fellow*, whom they interpret his wife. Be this as it will, in the next ages after the apostles, we have accounts of divers married bishops, presbyters, and deacons, without any reproof or mark of dishonour set on them; *e. g.* Valens, presbyter of Philippi, mentioned by Polycarp; and Chæremon, bishop of Nilus. Novatus was a married presbyter of Carthage, as we learn from Cyprian; who himself was also a married man, as Pagi confesses; and so was Cæcilius the presbyter who converted him; and Numidius, another presbyter of Carthage. The reply which the Romanists give to this is, that all married persons, when they came to be ordained, promised to live separate from their wives by consent, which answered the vow of celibacy in other persons. But this is not only said without proof, but against it. For Novatus presbyter of Carthage was certainly allowed to cohabit with his wife after ordination; as appears from the charge that Cyprian brings against him, that he had struck and abused his wife, and thereby caused her to miscarry. There seems indeed to have been, in some cases, a tendency towards the introduction of such a law by one or two zealots; but the motion was no sooner made than it was quashed by the authority of wiser men. Thus Eusebius observes, that Pinytus, bishop of Gnossus in Crete, was for laying the law of celibacy upon his brethren; but Dionysius bishop of Corinth wrote to him, that he should consider the weakness of men, and not impose that heavy burden on them. In the council of Nice, anno 325, the motion was renewed for a law to oblige the clergy to abstain from all conjugal society with their wives, whom they had married before their ordination; but Paphnutius, a famous Egyptian bishop, and one who himself never was married, vigorously declaimed against it, upon which it was unanimously rejected. So Socrates and Sozomen tell the story; to which all that Valesius, after Bellarmin, has to say, is, that he suspects the truth of it. The council in Trullo, held in 692, made a difference in this respect between bishops and presbyters; allowing presbyters, deacons, and all the inferior orders, to cohabit with their wives after ordination; and giving the Roman church a smart rebuke for the contrary prohibition, but at the same time laying an injunction upon bishops to live separate from their wives, and appointing the wives to betake themselves to a monastic life, or become deaconesses in the church. And thus was a total celibate established in the Greek church as to bishops, but not any

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any others. In the Latin church, the like establishment was also made, but by slow steps in many places. For, in Africa, even bishops themselves cohabited with their wives at the time of the council of Trullo. The celibacy of the clergy, however, appears of an ancient standing, if not of command and necessity, yet of counsel and choice. But as it is clearly neither of divine nor apostolical institution, it is at first hard to conceive from what motive the court of Rome persisted so very obstinately to impose this institution on the clergy. But we are to observe that this was a leading step to the execution of the project formed of making the clergy independent of princes, and rendering them a separate body to be governed by their own laws. In effect, while priests had children, it was very difficult to prevent their dependence on princes, whose favours have such an influence on private men; but having no family, they were more at liberty to adhere to the pope.

CELIDOGRAPHIA, the description of the spots which appear on the surfaces of the sun and planets. See ASTRONOMY.

CELL, (*Cella*) in ancient writers, denotes a place or apartment usually under ground, and vaulted, in which were stored up some sort of necessaries, as wine, honey, and the like; and according to which it was called *Cella Vinaria*, *Olearia*, *Mellaria*, &c. The word is formed from the Latin *celare*, to conceal.

CELLA was also used for the lodge or habitation of a common prostitute, as being anciently under ground, hence also denominated *fornix*.

Intravit calidum veteri centone lupanar,
Et cellam vacuam. Juv. Sat. vi. ver. 121.

On which place an ancient scholiast remarks, that the names of the whores were written on the doors of their several cells; by which we learn the meaning of *inscripta cella* in Martial, lib. xi. ep. 46.

CELLA was also applied to the bedchambers of domestics and servants; probably as being low and narrow.—Cicero, inveighing against the luxury of Antony, says the beds in the very cellæ of his servants were spread with pompous purple coverlets.

CELLA is also applied to the members or apartments of baths. Of these there were three principal, called *frigidaria*, *tepidaria*, and *caldaria*: to which may be added a fourth, called *cella assa*, and sometimes *sudatoria*.

CELLA likewise signified the *adyta*, or inmost and most retired parts of temples, wherein the images of the gods to whom the edifices were consecrated were preserved. In this sense we meet with *cella Jovis*, *cella Concordiæ*.

CELLA is also used for a lesser or subordinate sort of monastery dependent on a great one, by which it was erected, and continues still to be governed. The great abbeys in England had most of them *cells* in places distant from the mother abbey, to which they were accountable, and from which they received their superiors. The alien priories in England were cells to abbeys in Normandy, France, Italy, &c. The name *cell* was also given to rich and considerable monasteries not dependent on any other.

CELL signifies also a little apartment or chamber, such as those wherein the antient monks, solitaries, and hermits, lived in retirement. Some derive the word from the Hebrew כלא, i. e. "a prison, or place where any thing is shut up."

The same name is still retained in divers monasteries. The dormitory is frequently divided into so many cells or lodges. The Carthusians have each a separate house, which serves them as a cell. The hall wherein the Roman conclave is held, is divided by partitions into divers cells, for the several cardinals to lodge in.

CELL is also a name given to the little divisions in honeycombs, which are always regular hexagons. See BEE.

CELL, in *Botany*, is applied to the hollow place between the partitions in the pods, husks, and other seed-vessels of plants: according as there is one, two, three, &c. of these cells, the vessel is said to be unilocular, bilocular, trilocular, &c.

CELLS, in *Anatomy*, little bags, or bladders, where fluids or other matters are lodged; called *loculi*, *cellulæ*, &c. Thus the *cellulæ adiposæ* are the little cells where the fat is contained; *cellulæ* in the *colon*, are spaces wherein the excrements are detained till voided, &c.

CELLAR, (*Cellarium*), in ancient writers, denotes the same with cella, viz. a conservatory of eatables or drinkables.

Cellar differs from vault, as the latter is supposed to be deeper, the former being frequently little below the surface of the ground. In which sense, *cellarium* also differed from *penus*, as the former was only a storehouse for several days, the latter for a long time. Thus it is the bactroperatæ, a sort of ancient Cynics, are said by St Jerome to carry their cellar about with them.

Cellarium also denoted an allowance of bread, wine, oil, or other provision, furnished out of the cella, to the use of the governor of the province and his officers, &c. In which sense, the word amounts to much the same with *annona*.

CELLARS, in modern building, are the lowest rooms in a house, the ceilings of which usually lie level with the surface of the ground on which the house is built; or they are situated under the pavement before the house, especially in streets and squares.

Cellars, and other places vaulted under ground, were called by the Greeks *hypogæa*: the Italians still call them *fundi delli case*.

CELLARER, or CELLERER, (*Cellerarius* or *Cellarius*), an officer in monasteries, to whom belong the care and procurement of provisions for the convent. The denomination is said to be borrowed from the Roman law, where *cellarius* denotes an examiner of accounts and expences. Ulpian defines it thus: "Cellerarius, id est, ideo præpositus ut rationes salvæ sint."

The *cellerarius* was one of the four *obedientiarii*, or great officers of monasteries: under his ordering was the *pistrinum* or bakehouse, and the *braccinum* or brewhouse. In the richer houses there were particular lands set apart for the maintenance of his office, called in ancient writings *ad cibum monachorum*. The *cellerarius* was a great man in the convent. His whole office in ancient times had a respect to that origin: he was to see his lord's corn got in, and laid up in granaries; and his appointment consisted in a certain proportion thereof, usually fixed at a thirteenth part of

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of the whole, together with a forred gown. The office of cellarer then only differed in name from those of bailiff and minstrel; excepting that the cellarer had the receipt of his lord's rents throughout the whole extent of his jurisdiction.

CELLARER was also an officer in chapters, to whom belonged the care of the temporals, and particularly the distributing of bread, wine, and money, to canons, on account of their attendance in the choir. In some places he was called *cellarer*, in others *burser*, and in others *currier*.

CELLARIUS, CHRISTOPHER, was born in 1638, at Smalcade in Franconia, of which town his father was minister. He was successively rector of the colleges at Weymar, Zeits, and Mersbourg: and the king of Prussia having founded an university at Halle in 1693, he was prevailed on to be professor of eloquence and history there, where he composed the greatest part of his works. His great application to study hastened the infirmities of old age; for it is said, he would spend whole days and nights together at his books, without any attention to his health, or even the calls of nature. His works relate to grammar, geography, history, and the oriental languages; and the number of them is amazing. He died in 1707.

CELLINI, BENVENUTO, an eminent statuary, who was bred a jeweller and goldsmith, but seems to have had an extraordinary genius for the fine arts in general. He was cotemporary with Michael Angelo and Julio Romano, and was employed by popes, kings, and other princely patrons of sciences and arts, so highly cultivated in the days of Leo X. and Charles V. some of his productions being esteemed most exquisite. He lived to a very considerable old age; and his life, almost to the last, was a continued scene of adventure, persecution, and misfortune, truly wonderful. He wrote his own history, which was not, however, published till the year 1730, probably, on account of the excessive freedom with which he therein treated many distinguished personages of Italy and other countries. It was translated into English by Dr Nugent in 1771, to which the reader is referred, as it will not admit of an abridgment suitable to the design of this work.

CELLULAR, in a general sense, is applied to any thing consisting of single cells.

CELLULAR Membrane. See ANATOMY *Index*.

CELOSIA, COCK'S-COMB. See BOTANY *Index*.

CELSIA. See BOTANY *Index*.

CELSUS, AURELIUS CORNELIUS, a celebrated physician of the first century, who wrote eight books on medicine, in elegant Latin. He was the Hippocrates of the Latins: and Quintilian gives him a high eulogium. The great Boerhaave tells us, that Celsus is one of the best authors of antiquity for letting us into the true meaning and opinions of Hippocrates; and that, without him, the writings of this father in physic would be often unintelligible, often misunderstood by us. He shows us also how the ancients cured distempers by friction, bathing, &c. His eight books *de Medicina* have been several times printed. The Elzevir edition, in the year 1650, by Vander Linden, is the best, as being entirely corrected from his manuscripts.

CELSUS, an Epicurean philosopher, in the second century. He wrote a work against the Christians, entitled, *The True Discourse*: to which Origen, at the desire of Ambrose his friend, wrote a learned answer. To this philosopher Lucian dedicated his *Pseudomanies*.

CELTÆ, or CELTES, an ancient nation, by which most of the countries of Europe are thought to have been peopled. The compilers of the Universal History are of opinion that they were descended from Gomer the eldest son of Japhet, the son of Noah. They think that Gomer settled in the province of Phrygia in Asia; Ashkenaz his eldest son, or Togarmah his youngest, or both, in Armenia; and Riphath the second son in Cappadocia. When they spread themselves wider, they seem to have moved regularly in columns without interfering with or disturbing their neighbours. The descendants of Gomer, or the Celtæ, took the left hand, insensibly spreading themselves westward towards Poland, Hungary, Germany, France, and Spain; while the descendants of Magog, Gomer's brother, moving eastward, peopled Tartary.

In this large European tract, the Celtes began to appear a powerful nation under a regular monarchy, or rather under several considerable kingdoms. Mention is made of them indeed in so many parts of Europe, by ancient geographers and historians, that Ortellius took *Celtica* to be a general name for the continent of Europe, and made a map of it bearing this title. In those parts of Asia which they possessed, as well as in the different parts of Europe, the Celtes went by various names. In Lesser Asia they were known by the names of *Titans* and *Sacks*; in the northern parts of Europe, by those of *Cymmerians*, *Cymbrians*, &c.; and in the southern part they were called *Celtes*, *Gauls*, or *Galatians*.

With respect to the government of the Celtes we are entirely in the dark. All we know is, that the curates, and afterwards druids and bards, were the interpreters of their laws; judged all causes whether criminal or civil; and their sentence was reckoned so sacred, that whoever refused to abide by it was by them excluded from assisting at their sacred rites; after which no man dared to converse with him: so that this punishment was reckoned the most severe of all, even severer than death itself.

They neither reared temples nor statues to the Deity, but destroyed them wherever they could find them, planting in their stead large spacious groves; which, being open on the top and sides, were, in their opinion, more acceptable to the Divine Being, who is absolutely unconfined. In this their religion seems to have resembled that of the Persees and disciples of Zoroaster. The Celtes only differed from them in making the oak instead of fire the emblem of the Deity; in choosing that tree above all others to plant their groves with, and attributing several supernatural virtues both to its wood, leaves, fruit, and misletoe; all of which were made use of in their sacrifices and other parts of their worship. But after they had adopted the idolatrous superstition of the Romans and other nations, and the apotheosis of their heroes and princes, they came to worship them much in the same manner; as Jupiter under the name of *Taran*, which in the Celtic signifies thunder; Mercury, whom some authors call *Heus* or *Hesus*, probably from the Celtic *handh*, which signifies a dog, and might be the *Anubis latrans*.

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latrans of the Egyptians. But Mars was held in the greatest veneration by the warlike, and Mercury by the trading, part of the nation. The care of religion was immediately under the curates, since known by the name of druids and bards. These were, as Cæsar tells us, the performers of sacrifices and all religious rites, and expounders of religion to the people. They also instructed youth in all kinds of learning, such as philosophy, astronomy, astrology, &c. Their doctrines were taught only by word of mouth, esteeming them too sacred to be committed to writing. Other more common subjects, such as their hymns to their gods, the exploits of princes and generals in time of war, and especially before a battle, were couched in elegant verse, and recited, or rather sung, on all proper occasions; though even these were also kept from vulgar eyes, and either committed to memory, or, if to writing, the whole was a secret to all the laity. The latter indeed seems the most probable, if what Cæsar hints be true; namely, that those poetic records were increased in his time to such a bulk, that it took up a young bard near 20 years to learn them by heart. Diodorus tells us farther, that these poets used to accompany their songs with instrumental music, such as those of organs, harps, and the like; and that they were held in such veneration, that if in the time of an engagement between two armies one of these bards appeared, both sides immediately ceased fighting. The reason of this was, that they were universally believed to be prophets as well as poets; so that it was thought dangerous as well as injurious to disobey what they supposed came from their gods. These prophetic philosophers kept academies, which were resorted to, not only by a great number of their own youth, but also of those from other countries, insomuch that Aristotle says, their philosophy passed from thence into Greece, and not from Greece thither. Diodorus likewise quotes a passage from Hecateus, which is greatly in their praise; viz. that the druids had some kinds of instruments by which they could draw distant objects nearer, and make them appear larger and plainer; and by which they could discover even seas, mountains, and valleys, in the moon. But whatever might be their learning, it is certain, that in process of time they adopted several very barbarous customs, such as sacrificing human victims to their gods, as more acceptable to them than those of any other animals. And Diodorus tells us of another inhuman custom they used in their divinations, especially in great matters, which was done by killing some of their slaves, or some prisoners of war, if any they had, with a scymitar, to draw the augury from the running of his blood from his mangled limbs.

For the history, &c. of the different Celtic nations, see the article GAUL, &c.

CELTES, certain ancient instruments, of a wedge-like form, of which several have been discovered in different parts of Great Britain. Antiquarians have generally attributed them to the Celtæ; but not agreeing as to their use, distinguished them by the above unmeaning appellation. But Mr Whitaker makes it probable that they were British battle-axes. See *BATTLE-Axes*.

CELTIBERIA, in *Ancient Geography*, a country of the Hither Spain, along the right or south-west side of the river Iberus; though sometimes the greatest part of Spain was called by the name *Celtiberia*. The people were denominated *Celtiberi*, or the Celtæ seated on the Iberus. They were brave and very warlike; their cavalry in particular was excellent. They wore a black and rough cloak, the shag of which was like goats hair. Some of them had light bucklers like the Gauls: others hollow and round ones like those of other nations. They all wore boots made of hair, and iron helmets adorned with crests of a purple colour. They used swords which cut on both sides, and poniards of a foot long. Their arms were of an admirable temper, and are said to have been prepared in the following manner: they buried plates of iron under ground, where they let them remain till the rust had eaten the weakest part of the metal, and the rest was consequently hard and firm. Of this excellent iron they made their swords, which were so strong and well tempered, that there was neither buckler nor helmet that could resist their edge. The Celtiberians were very cruel towards their enemies and malefactors, but showed the greatest humanity to their guests. They not only cheerfully granted their hospitality to strangers who travelled in their country, but were desirous that they should seek protection under their roof.

CELTIS. See BOTANY *Index*.

CEMENT, in a general sense, any glutinous substance capable of uniting and keeping things together in close cohesion. In this sense the word *cement* comprehends mortar, solder, glue, &c. but has been generally restrained to the compositions used for holding together broken glasses, china, and earthen ware. For this purpose the juice of garlic is recommended as exceedingly proper, being both very strong, and if the operation is performed with care leaving little or no mark. Quicklime and the white of an egg mixed together and expeditiously used, are also very proper for this purpose. Dr Lewis recommends a mixture of quicklime and cheese in the following manner; "Sweet cheese shaved thin, and stirred with boiling-hot water, changes into a tenacious slime which does not mingle with the water. Worked with fresh particles of hot water, and then mixed upon a hot stone with a proper quantity of unslacked lime, to the consistence of a paste, it proves a strong and durable cement for wood, stone, earthen ware, and glass. When thoroughly dry, which will be in two or three days, it is not in the least acted upon by water. Cheese barely beat with quicklime, as directed by some of the chemists for luting cracked glasses, is not near so efficacious." A composition of the drying oil of linseed and white lead is also used for the same purposes, but is greatly inferior.

CEMENT, in building, is used to denote any kind of mortar of a stronger kind than ordinary. The cement commonly used is of two kinds; hot and cold. The hot cement is made of rosin, bees-wax, brick-dust, and chalk boiled together. The bricks to be cemented are heated, and rubbed one upon another, with cement between them. The cold cement is that above described for cementing china, &c. which is sometimes, though rarely, employed in building.

The ruins of the ancient Roman buildings are found to cohere so strongly, that most people have imagined the

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Cement. the ancients were acquainted with some kind of mortar, which, in comparison of ours, might justly be called *cement;* and that to our want of knowledge of the materials they used, is owing the great inferiority of modern buildings in their durability. In 1770, one M. Loriot, a Frenchman, pretended to have discovered the secret of the ancient cement, which, according to him, was no more than a mixture of powdered *quicklime* with lime which had been long slacked and kept under water. The slacked lime was first to be made up with sand, earth, brickdust, &c. into mortar, after the common method, and then about a third part of quicklime in powder was added to the mixture. This produced an almost instantaneous petrification, something like what is called the *setting* of alabaster, but in a much stronger degree; and was possessed of many wonderful qualities needless here to relate, seeing it has never been known to succeed with any other person who tried it. Mr Anderson, in his essays on agriculture, has discussed this subject at considerable length, and seemingly with great judgment. He is the only person we know who has given any rational theory of the uses of lime in building, and why it comes to be the proper basis of all cements. His account is in substance as follows:

Lime which has been slacked and mixed with sand becomes hard and consistent when dry, by a process similar to that which produces the natural *stalactites* in caverns. These are always formed by water dropping from the roof. By some unknown and inexplicable process of nature, this water has dissolved in it a small portion of calcareous matter in a *caustic* state. As long as the water continues covered from the air, it keeps the earth dissolved in it: it being the natural property of calcareous earths, when deprived of their fixed air, to dissolve in water. But when the small drop of water comes to be exposed to the air, the calcareous matter contained in it begins to attract the fixable part of the atmosphere. In proportion as it does so, it also begins to separate from the water, and to reassume its native form of limestone or marble. This process Mr Anderson calls a *crystallization:* and when the calcareous matter is perfectly *crystallized* in this manner, he affirms, that it is to all intents and purposes limestone or marble of the same consistence as before: and in this manner (says he), within the memory of man, have huge rocks of marble been formed near Matlock in Derbyshire." If lime in a caustic state is mixed with water, part of the lime will be dissolved, and will also begin to crystallize. The water which parted with the crystallized lime will then begin to act upon the remainder, which it could not dissolve before; and thus the process will continue, either till the lime be all reduced to an *effete*, or (as he calls it) *crystalline* state, or something hinders the action of the water upon it. It is this crystallization which is observed by the workmen when a heap of lime is mixed with water, and left for some time to macerate. A hard crust is formed upon the surface, which is ignorantly called *frosting*, though it takes place in summer as well as in winter. If therefore the hardness of the lime, or its becoming a cement, depends entirely on the formation of its crystals, it is evident that the perfection of the cement must depend on the perfection of the crystals, and the hardness of the matters which are entangled among them. The additional substances used in making of mortar, such as sand, brickdust, or the like, according to Mr Anderson, serve only for a purpose similar to what is answered by sticks put into a vessel full of any saline solution, namely, to afford the crystals an opportunity of fastening themselves upon it. If therefore the matter interposed between the crystals of the lime is of a friable, brittle nature, such as brickdust or chalk, the mortar will be of a weak and imperfect kind; but, when the particles are hard, angular, and very difficult to be broken, such as those of river or pit sand, the mortar turns out exceedingly good and strong. Sea sand is found to be an improper material for mortar, which Mr Anderson ascribes to its being less angular than the other kinds. That the crystallization may be the more perfect, he also recommends a large quantity of water, that the ingredients be perfectly mixed together, and that the drying be as slow as possible. An attention to these circumstances, he thinks, would make the buildings of the moderns equally durable with those of the ancients; and from what remains of the ancient Roman works, he thinks a very strong proof of his hypothesis might be adduced. The great thickness of their walls necessarily required a vast length of time to dry. The middle of them was composed of pebbles thrown in at random, and which have evidently had mortar so thin as to be *poured* in among them. By this means a great quantity of the lime would be dissolved, and the crystallization performed in the most perfect manner; and the indefatigable pains and perseverance for which the Romans were so remarkable in all their undertakings, leave no room to doubt that they would take care to have the ingredients mixed together as well as possible. The consequence of all this is, that the buildings formed in this manner are all as firm as if cut out of a solid rock; the mortar being equally hard, if not more so, than the stones themselves.

Notwithstanding the bad success of those who have attempted to repeat M. Loriot's experiments, however, Dr Black informs us, that a cement of this kind is certainly practicable. It is done, he says, by powdering the lime while hot from the kiln, and throwing it into a thin paste of sand and water; which, not slacking immediately, absorbs the water from the mortar by degrees, and forms a very hard mass. "It is plain, he adds, that the strength of this mortar depends on using the lime hot or fresh from the kiln."

By mixing together gypsum and quicklime, and then adding water, we may form a cement of tolerable hardness, and which apparently might be used to advantage in making troughs for holding water, or lining small canals for it to run in. Mr Wiegley says, that a good mortar or cement, which will not crack, may be obtained, by mixing three parts of a thin magma of slacked lime with one of powdered gypsum; but adds, that it is used only in a dry situation. A mixture of tarras with slacking lime acquires in time a stony hardness, and may be used for preventing water from entering. See Mortar and Stucco.

Cement, among engravers, jewellers, &c. is the same with the hot cement used in building*; and is used for keeping the metals to be engraven firm to the block, and also for filling up what is to be chisseled.

* See the foregoing article.

Cement, in *Chemistry*, is used to signify all those powders

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powders and pastes with which any body is surrounded in pots or crucibles, and which are capable by the help of fire of producing changes upon that body. They are made of various materials; and are used for different purposes, as for parting gold from silver, converting iron into steel, copper into brass; and by cementation more considerable changes can be effected upon bodies, than by applying to them liquids of any kind; because the active matters are then in a state of vapour, and assisted by a very considerable degree of heat.

Cement which quickly hardens in water. This is described in the posthumous works of Mr Hooke, and is recommended for gilding live craw fish, carps, &c. without injuring the fish. The cement for this purpose is prepared, by putting some Burgundy pitch into a new earthen pot, and warming the vessel till it receives so much of the pitch as will stick round it, then strewing some finely-powdered amber over the pitch when growing cold, adding a mixture of three pounds of linseed oil, and one of the oil of turpentine, covering the vessel and boiling them for an hour over a gentle fire, and grinding the mixture as it is wanted with as much pumice-stone in fine powder as will reduce it to the consistence of paint. The fish being wiped dry, the mixture is spread upon it; and the gold leaf being then laid on, the fish may be immediately put into water again, without any danger of the gold coming off, for the matter quickly grows hard in the water.

Cement Pots, are those earthen pots used in the cementation of metals.

CEMENTATION, the act of corroding or otherwise changing a metal by means of a Cement.

CEMETERY (Κοιμητηριον, from Κοιμαω, to "*sleep*"); a place set apart or consecrated for the burial of the dead.

Anciently none were buried in churches or church-yards; it was even unlawful to inter in cities, and the cemeteries were without the walls. Among the primitive Christians these were held in great veneration. It even appears from Eusebius and Tertullian, that, in the early ages, they assembled for divine worship in the cemeteries. Valerian seems to have confiscated the cemeteries and other places of divine worship, but they were restored again by Gallienus. As the martyrs were buried in these places, the Christians chose them for building churches on, when Constantine established their religion; and hence some derive the rule which still obtains in the church of Rome, never to consecrate an altar without putting under it the relicks of some saint. The practice of consecrating cemeteries is of some antiquity. The bishop walked round it in procession, with the crosier or pastoral staff in his hand, the holy water pot being carried before, out of which the aspersions were made.

CENCHRUS. See Botany *Index*.

CENEGILL, in the Saxon antiquities, an expiatory mulct, paid by one who had killed a man to the kindred of the deceased. The word is compounded of the Saxon *cinne*, i. e. *cognatio*, "relation," and *gild*, *solutio*, "payment."

CENOBITE. See Coenobite.

CENOTAPH, in antiquity, an empty tomb, erected by way of honour to the deceased. It is distinguished from a sepulchre, in which a coffin was deposited. Of these there were two sorts; one for those who had, and another for those who had not, been honoured with funeral rites in another place.

The sign whereby honorary sepulchres were distinguished from others, was commonly the wreck of a ship, to denote the decease of the person in some foreign country.

CENSER, in antiquity, a vase containing incense to be used in sacrifices. Censer is chiefly used in speaking of the Jewish worship. Among the Greeks and Romans it is more frequently called *thuribulum*, λιβανωτις, and *acerra*.

The Jewish censer was a small sort of chafing dish, covered with a dome, and suspended by a chain. Josephus tells us, that Solomon made 20,000 gold censers for the temple of Jerusalem, to offer perfumes in, and 50,000 others to carry fire in.

CENSIO, in antiquity, the act or office of the censor. See Census.

Censio included both the rating or valuing a man's estate, and the imposing mulcts and penalties.

Censio hastaria, a punishment inflicted on a Roman soldier for some offence, as laziness or luxury, whereby his *hasta* or spear was taken from him, and consequently his wages and hopes of preferment stopped.

CENSITUS, a person censed, or entered in the censual tables. See Census.

In an ancient monument found at Ancyra, containing the actions of the emperor Octavius, we read,

Quo lustro civium Romanorum
Censita sunt capita quadragies
Centum millia et sexaginta tria.

Censitus is also used in the civil law for a servile sort of tenant, who pays capitation to his lord for the lands he holds of him, and is entered as such in the lord's rent roll. In which sense, the word amounts to the same with *capite census*, or *capite censitus*. See *Capite Censi*.

CENSOR, (from *censere* to "think" or "judge"), one of the prime magistrates in ancient Rome.—Their business was to register the effects of the Roman citizens, to impose taxes in proportion to what each man possessed, and to take cognizance or inspection of the manners of the citizens. In consequence of this last part of their office, they had a power to censure vice or immorality, by inflicting some public mark of ignominy on the offender. They had even a power to create the *princeps senatus*, and to expel from the senate such as they deemed unworthy of that office. This power they sometimes exercised without sufficient grounds; and therefore a law was at length passed, that no senator should be degraded or disgraced in any manner until he had been formally accused and found guilty by both the censors. It was also a part of the censorian jurisdiction, to fill up the vacancies in the senate, upon any remarkable deficiency in their number; to let out to farm all the lands, revenues, and customs, of the republic; and to contract with artificers for the charge of building and repairing all the public works and edifices both in Rome and the colonies of Italy. In all parts of their office, however, they

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Censor ‖ Censure.

they were subject to the jurisdiction of the people; and an appeal always lay from the sentence of the censors to that of an assembly of the people.

The first two censors were created in the year of Rome 311, upon the senate's observing that the consuls were so much taken up with war as not to have time to look into other matters. The office continued to the time of the emperors, who assumed the censorial power, calling themselves *morum præfecti;* though Vespasian and his son took the title of censors. Decius attempted to restore the dignity to a particular magistrate. After this we hear no more of it, till Constantine's time, who made his brother censor, and he seems to have been the last that enjoyed the office.

The office of censor was so considerable, that for a long time none aspired to it till they had passed all the rest; so that it was thought aspiring that Crassus should be admitted censor, without having been either consul or prætor. At first the censors enjoyed their dignity for five years, but in 420 the dictator Mamercus made a law restraining it to a year and a half, which was afterwards observed very strictly. At first one of the censors was elected out of a patrician, and the other out of a plebeian family; and upon the death of either, the other was discharged from his office, and two new ones elected, but not till the next lustrum. In the year of Rome 622, both censors were chosen from among the plebeians; and after that time the office was shared between the senate and people. After their election in the Comitia Centuriata, the censors proceeded to the capitol, where they took an oath not to manage either by favour or disaffection, but to act equitably and impartially throughout the whole course of their administration.

The republic of Venice still has a censor of the manners of their people, whose office lasts six months.

Censors of Books, are a body of doctors or others established in divers countries to examine all books before they go to the press, and to see they contain nothing contrary to faith and good manners.

At Paris, before the late revolution, the faculty of theology claimed this privilege as granted to them by the pope; but, in 1624, new commissions of four doctors were created, by letters patent, the sole censors of all books, and answerable for every thing contained therein.

In England, we had formerly an officer of this kind, under the title of licenser of the press: but, since the Revolution, our press has been laid under no such restraint.

CENSORINUS, a celebrated writer in the third century, well known by his treatise *De die Natali.* This treatise, which was written about the year 238, Gerard Vossius calls a little book of gold; and declares it to be a most learned work of the highest use and importance to chronologers, since it connects and determines, with great exactness, some of the principal eras in pagan history. It was printed at Cambridge, with the notes of Lindenbrokius, in 1695.

CENSURE, a judgment which condemns some book, person, or action, or more particularly, a reprimand from a superior. Ecclesiastical censures are penalties, by which, for some remarkable misbehaviour, Christians are deprived of the communion of the church, or prohibited to exercise the sacerdotal office.

Census.

CENSUS, in Roman antiquity, an authentic declaration made before the censors, by the several subjects of the empire, of their respective names and places of abode. This declaration was registered by the censors; and contained an enumeration, in writing, of all the estates, lands, and inheritances they possessed; their quantity, quality, place, wives, children, domestics, tenants, slaves. In the provinces the census served not only to discover the substance of each person, but where, and in what manner and proportion, taxes might be best imposed. The census at Rome is commonly thought to have been held every five years; but Dr Middleton hath shown, that both census and lustrum were held irregularly and uncertainly at various intervals. The census was an excellent expedient for discovering the strength of the state; for by it they discovered the number of the citizens, how many were fit for war, and how many for offices of other kinds; how much each was able to pay of taxes, &c. It went through all ranks of people, though under different names: that of the common people was called *census;* that of the knights, *census, recensio, recognitio;* that of the senators, *lectio, relectio.*—Hence also *census* came to signify a person who had made such a declaration; in which sense it was opposed to *incensus*, a person who had not given in his estate or name to be registered.

The census, according to Salmasius, was peculiar to the city of Rome. That in the provinces was properly called *professio* and ἀπογραφη. But this distinction is not everywhere observed by the ancients themselves.

Census was also found for the book or register wherein the professions of the people were entered: In which sense, the census was frequently cited and appealed to as evidence in the courts of justice.

Census is also used to denote a man's whole substance or estate.

Census Senatorius, the patrimony of a senator, which was limited to a certain value; being at first rated at 800,000 sesterces, but afterwards, under Augustus, enlarged to 1,200,000.

Census Equester, the estate or patrimony of a knight, rated at 400,000 sesterces, which was required to qualify a person for that order, and without which no virtue or merit was available.

Census was also used for a person worth 100,000 sesterces, or who was entered as such in the censual tables, on his own declaration. In which sense, census amounts to the same with *classicus*, or a man of the first class; though Gellius limits the estate of those of this class to 125,000 asses. By the Voconian law, no census was allowed to give by his will above a fourth part of what he was worth to a woman.

Census was also used to denote a tax or tribute imposed on persons, and called also capitation. See *Capite Censi.*

Census Dominicatus, in writers of the lower age, denotes a rent due to the lord.

Census Duplicatus, a double rent or tax, paid by vassals to their lord on extraordinary or urgent occasions; as expeditions to the Holy Land, &c.

Census Ecclesiæ Romanæ, was an annual contribution voluntarily paid to the see of Rome by the several princes of Europe.

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CENT signifies properly a hundred, being an abridgement of the word *centum;* but is often used in commerce to express the profit or loss arising from the sale of any commodity: so that when they say there is 10 per cent. profit, or 10 per cent. loss, upon any merchandise that has been sold, it is to be understood that the seller has either gained or lost 10l. on every 100l. of the price at which he bought that merchandise; which is $\frac{1}{10}$ of profit, or $\frac{1}{10}$ of loss, upon the total of the sale.

CENTAUR, in *Astronomy*, a part or moiety of a southern constellation, in form half man half horse; usually joined with the wolf. The word comes from κενταυρος, formed of κεντω, *pungo;* and ταυρος, *bull;* q. d. *bull-pricker.* The stars of this constellation, in Ptolemy's Catalogue, are 36; in Tycho's 4; and in the Britannic Catalogue, with Sharp's Appendix, 35.

CENTAURS, in *Mythology*, a kind of fabulous monsters, half men and half horses.—The poets pretended that the Centaurs were the sons of Ixion and a cloud; the reason of which fancy is, that they retired to a castle called νεφελη, which signifies "a cloud."—This fable is differently interpreted: some will have the Centaurs to have been a body of shepherds and herdsmen, rich in cattle, who inhabited the mountains of Arcadia, and to whom is attributed the invention of bucolic poetry. Palæphætus, in his book of incredibles, relates, that under the reign of Ixion, king of Thessaly, a herd of bulls on Mount Thessaly run mad, and ravaged the whole country, rendering the mountains inaccessible; that some young men who had found the art of taming and mounting horses, undertook to clear the mountains of these animals, which they pursued on horseback, and thence obtained the appellation of *Centaurs.* This success rendering them insolent, they insulted the Lapithæ, a people of Thessaly: and because when attacked they fled with great rapidity, it was supposed they were half horses and half men.—The Centaurs in reality were a tribe of Lapithæ, who inhabited the city Pelethronium, adjoining to Mount Pelion, and first invented the art of breaking horses, as is intimated by Virgil.

CENTAUREA, Greater Centaury. See Botany *Index.* There are 61 species belonging to this genus. The root of one of them, called *glastifolia*, is an article in the materia medica. It has a rough, somewhat acrid taste, and abounds with a red viscid juice. Its rough taste has gained it some esteem as an astringent, its acrimony as an aperient, and its glutinous quality as a vulnerary; but the present practice takes very little notice of it in any intention. Another of the species is the cyanus or blue bottle, which grows commonly among corn. The expressed juice of this flower stains linen of a beautiful blue colour, but is not permanent. Mr Boyle says, that the juice of the inner petals, with a little alum, makes a beautiful permanent colour, equal to ultramarine.

Lesser Centaury. See Gentiana, Botany *Index.*

CENTELLA. See Botany *Index.*

CENTENARIUS, or Centenario, in the middle age, an officer who had the government or command, with the administration of justice, in a village. The centenarii as well as vicarii were under the jurisdiction and command of the court. We find them among the Franks, Germans, Lombards, Goths, &c.

Centenarius was also used for an officer who had the command of 100 men, most frequently called a Centurion.

Centenarius, in monasteries, was an officer who had the command of 100 monks.

CENTENINUM ovum, among naturalists, denotes a sort of hen's egg much smaller than ordinary, vulgarly called a *cock's egg;* from which it has been fabulously held that the cockatrice or basilisk is produced. The name is taken from an opinion, that these are the last eggs which hens lay, having laid 100 before; whence *centeninum*, q. d. the hundredth egg.—These eggs have no yolks, but in other respects differ not from common ones, having the albumen, chalazes, membranes, &c. in common with others. In the place of the yolk is found a little body like a serpent coiled up, which doubtless gave rise to the fable of the basilisk's origin from thence. Their origin is with probability ascribed by Harvey to this, that the yolks in the vitellary of the hen are exhausted before the albumina.

CENTER, or Centre, in a general sense, signifies a point equally distant from the extremities of a line, figure, or body. The word is formed from the Greek κεντρον, a *point.*

Center of an Arch. Under the article Bridge, the different forms of arches have been particularly considered.

Under this article, it comes very properly to be ascertained in what manner the arch-stones are supported till the arch is completed, and the most commodious and least expensive manner in which this can be accomplished. When the span is small, and upon a limited scale, as cellars, and vaults below ground, the foundation of the side walls is dug out, the earth rounded off betwixt, the arch thrown over upon it, and the earth is afterwards dug out and carried away. This must have been done on any account. By this method the wood and workmanship are saved; but it is only in particular instances that this can be done. When the arch to be cast is on land, and at no great height above the surface of the earth, a frame for supporting the arch-stones can be raised from the earth, and bound together, frequently, with a great profusion of wood, which on account of the smallness of the arch is not taken into account; but, when the span is great, or at a great height above the surface of the earth, the expence of a frame formed in the same manner would be enormous, and in many cases impracticable; but whether the arch be great or small, high or low, a proper economy ought to be observed; and the less the expence in wood and workmanship incurred, so much the more advantage to those concerned, and the purpose being obtained, so much more credit is due to the engineer.

It is again to be considered, on the other hand, that in order to save some expence, either in wood or workmanship, the frame or center, as we shall call it, is made too slight, and so unconnected in its parts, that the pressure of the arch-stones is greater than it can support. The whole work is brought down, and the saving on the one part produces a more serious loss on the other; so that both the workmen and proprietors agree, that it is better that the center be too strong than too weak; better have too much wood in it than too

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Center. too little. To assist the mechanic in this important affair, is the design of treating this article with particular attention; for which purpose we shall be at pains to acquire every assistance that can be collected, from the most experienced engineers, and from the researches and experiments of the most distinguished philosophers who have treated of such arts as may enable us to elucidate the subject, and make it worth the attention of engineers and mechanics who may have occasion to exert their genius in that line.

In the first place, it will be necessary to consider the weight to be supported: 2dly, The quantity of the materials to be used, that shall be of strength sufficient to support such a weight: 3dly, The most effective method to apply these materials, as supported by the most approved authorities, or practised by the ablest engineers. The weight to be supported is the arch-stones. Suppose an arch 20 feet span, (see figures for the arches, a new figure being unnecessary). It has been shown under the article BRIDGE, that the arch can be raised to 30 degrees and upwards, without the support of the center; after which it begins to rest upon the frame of which the center is composed, if the arch is a semicircle, or semiellipse; if a segment of a circle, it will press sooner upon the center, and the more so the flatter the arch is. 1st, Suppose a semicircle; then there is 120 degrees of the arch to be supported by the center, the diameter supposed is 20 feet. One hundred and twenty degrees will measure 20.94393 feet; but as it is advisable to give the advantage to the center, we call it 21 feet in an arch of 20 feet span. If the stone is of a durable and hard quality, perhaps an arch-stone of 12 or 14 inches might be of sufficient strength; yet it is not probable that any one would think of less than 18 inches for the thickness of the arch; for it will not have too heavy an appearance if it should be two feet thick. We shall calculate the weight at 18 inches square; the thickness of the stone is not here to be considered, as the weight of the whole is to be supported till the key-stone is driven: the specific gravity of good free stone is 2.532, the solid feet in an arch of 120 degrees; the span 20 feet is 21 feet, nearly as above. The stone 18 inches square by 21 feet gives 47.25 solid feet; the weight by the above specific gravity is 7477.3076 lb. avoirdupoise, about 66.753 cwt. being the weight that one rib of the center frame must sustain, without warping, or by the pressure on its haunches make it rise in the crown; neither must it sink under the pressure: in either case the consequences would be fatal, either in causing the arch to give way, upon striking out the center, or in weakening it in such a manner as to shorten its durability; being twisted in its shape, the equilibrium would be destroyed, and the consequence would be either to spring the key-stone, or, if that was prevented by the weight above it, the same weight would cause it to yield at about, or a little above, 30 degrees from the spring of the arch. From all which the necessity of the strength and firmness of the center frame is evident.

If the arch exceeds 20 feet, suppose 50, the weight will evidently become greater, and an additional strength necessary on that account; and likewise on account of its greater extent, the frame that would be sufficiently firm at 20 feet would be supple at 50. To prevent any error on this account, another calculation for 50 feet will become necessary. In the span of 50 the arch of 120 degrees measures 52.36 feet; suppose the arch-stone, 2½ feet deep by 2, is five superficial feet, multiplied by 52.36 is 261.8 solid feet, and at the above specific gravity gives 41429.7154748 lb. avoirdupoise, equal to 369.908 cwt. Here the weight is increased upon the center frame, in the proportion of 66.5 to 369.9, that is, more than five times, besides what allowance it will be necessary to make for the difference of the stiffness of the center frame; both which will be considered in their proper places. Center.

Let us now consider what will be the increase of weight, upon a span of 100 feet. The rise of the arch, before it presses on the center frame in a semicircle, being in the same proportion, the arch of 120 degrees in 100 feet span measures 104.719 feet; the arch-stone may be supposed abundantly strong of 4 feet length, for the depth of the arch, and 3 feet broad, which makes a superficies of 12 feet, and multiplied by 104.719 gives 1256.628 solid feet, the specific gravity, that is, the stone is supposed of the same durability gives 198.861.381 lb. avoirdupois, equal to 1775.548 cwt. about five times more weight than upon the arch of 50 feet span. If the arch is 130 feet span, 120 degrees measures 136.13556 feet. Suppose the arch-stone 5 feet, as in the arch-stones of the bridge over the Dee at Aberdeen, at least they are between 4½ and 5 feet. The Aberdeen granite is a very hard stone, and perhaps exceeds the specific gravity above. The arch-stone is here supposed to be 5 feet by 3, equal to 15 square feet, multiplied by 136.13556, gives 2042.0334 solid feet. According to the above specific gravity, the weight to be supported till the key-stone is drove, is 2885.2838 cwt. The weight of the key-stone in the whole of the above may be deducted.

As center-frames must likewise be used for iron bridges, we shall consider them, and take the span 236 feet, still supporting a semicircle.

It may be proper to take the weight that it would be if the arch were the segment of a circle, the span of the arch 236, the height above the spring of the arch or the versed sine of the arch, 34 feet, in which case the diameter of the circle would be 444 feet nearly; the arch-stones in this segment would press upon the center-frame, at about 18 feet from the spring of the arch. Suppose the arch-stone 5 feet by 4, equal to 20 superficial feet, the whole measure of the arch is 444.154 lineal feet, the solid content is 4131.84 feet, and weight 318.689 tons; but the weight of the iron was only 260 tons. It may not be improper here to observe, that in a stone bridge of that span, 5 feet of arch-stone would be too small to sustain the arch. It may perhaps be admitted, that it would be sufficient to support its own weight; and if so, the arch being smoothed above, a second arch of a five feet stone may be thrown over above it. These two together may form a stronger arch than a stone of ten feet depth would do. And thus a stone arch may be extended to any span, and made of abundant strength; and experience has shown its durability to withstand the weather. Thus the old London bridge has performed its faithful services to the public for 600 years: that it was an incumbrance in passing up and down the

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the river, and clumsy in its construction, were owing to the taste of the times. Perhaps few will be found that would be willing to insure an iron bridge against the ruin occasioned by the weather for the same time, or perhaps much above one-half that time. But this is not a fit place to enter into the full discussion of this subject. To return to the weight pressing upon a center-frame. Having now taken a view of the weight to be supported, it comes next to be considered what strength of wood is necessary to resist this force, and the most proper and commodious manner of combining the parts. To determine this, we must have recourse to such experiments as have been made for trying the strength of different species of stone and wood.

Experiments have been made to ascertain the strength of timber, and many of them appear to have been conducted with great care and attention. Some of these the reader will find collected and detailed under the article *Strength of Materials*. We shall here state the result of some of the curious experiments which were instituted by the Count de Buffon to ascertain this point. According to these experiments, the batten of five inches square, whose length was 14 feet, and which supported a weight of 5300, which may be called its breaking force, should have double the strength of a batten of 28 feet long. But it has a great deal more. The latter by the experiment is equal to 1775 only; whereas the half of 5300 is 2650. But it is to be considered, that the power of the lever is in proportion to its distance from the fulcrum; this power arising from the weight of the log, is the weight of one foot of wood acting as a weight at a distance from the fulcrum. The log increases in its power to break by its length; 12 inches of this log, five inches square, weighs about 10.4 lb. somewhat more or less; and 10.4 lb. at 13 feet distance, acts with a force of 135.2 lb.: this we consider the last term; and 0, the point of fracture, is the first term; the first and last term, multiplied by half the number of terms, are equal to the sum of all the terms; that is, $135.2 \times 6\frac{1}{2}$, amount 878.8 lb. added to 1775, equal 2653.8; so near to the half, that the difference may easily be accounted for, from the real weight of the wood on which the experiment was made; and our taking the weight from tables of specific gravity, of the supposed 60 lb. To take another example, a batten of nine feet is double the strength of one of the same size of 18 feet long. The weight that breaks a batten of nine feet, five inches square, is 8308 lb.; the half is 4154; but by the experiment, 3700 lb. break the batten at 18 feet. N. B. The weight being laid upon the middle, $9\frac{1}{4}$ is the number of terms, one-half is 4.625. Seventeen feet one-half is $8\frac{1}{2}$; 10.4 lb. multiplied by $8\frac{1}{2}$, is 102×4.625, half the number of terms, is $471.25 + 3700$, is 4171.25, somewhat greater, but which is so near, that the smallest accident for failure, not discernible in the wood, will occasion the difference. Now, to reduce the experiment of this given size to any other of greater dimensions; suppose one foot; similar solids of the same altitude are to one another as their bases; that is, 25, the base of the five inch square, is to 144, the base of the 12 inch square, as the weight that would break the batten of nine feet, to the weight that will break another of the same nine feet length, and of one foot square (5. 6. El. 12.), that is, as the base 25 is to the weight 8308, so is 144 to 47854 lb.: equal 213.8125 ton, and the proportion as above, for greater or less length of logs or spars. As we have no experiments made of logs of 12 inches square, unless there is something in the texture of the fibres, in pieces of different diameters, we have every reason to conclude, the above proportion will give the proper strength of the material used. It must, however, not be forgot, that the pieces upon which the experiments were made, were nicely chosen for the purpose. It will scarcely be practicable to find a piece of 12 inches square, and even of nine feet length, equally well adapted to bear a proportionable strain; and much more difficult to find a piece of still greater length. These experiments and proportions afford a safe criterion for proper limits to be attended to in practice. In this, we do not mean to apply such a load upon the beam as will break it; we intend the beam to support the load, without giving way or yielding to it.

In the same experiments, we are told by the author, that two-thirds of the weight broke the beam in the space of two months; that one-half the weight gave a set or bend which it did not recover, but shewed no farther tendency to break; that one-third of the weight, after long continuance, did not give it a set; but the weight being removed, the beam returned to the same position as before it was loaded. Betwixt one-third and the half of load or weight that would break the beam, is the strength we allot to it for permanent use. Before we proceed to put the above observations into full practice, let us examine whether the log is necessary to be square to give it the greatest strength; practice, in a great measure, determines that it is not. It is, however, necessary to inquire what breadth to a given depth is sufficient as a *maximum* that we ought not to exceed; or what is the *minimum* that we may use, so as not to lose the principal intended effect. Belidor has made a series of experiments on the transverse strength of bodies, which are detailed in his *Science des Ingenieurs*, but the spars are only of one inch, not exceeding two inches in breadth or thickness. Among these, we select one spar two inches breadth, one inch depth, and 18 inches length; which at the *medium* of three trials was broken, lying loose at both ends, by 805 lb. Another one inch board, two inches deep, and 18 inches long, broke with the force of 1580 lb.; nearly in the proportion of the square of the depth, being only a diminution of 20 lb. weight. In the present case, the quantity of matter is the same in both.

It may therefore be concluded from this experiment, that a batten of any depth, and one-half breadth, is equally strong in that position as if it had been square timber; and that the strength is according to the depth, if the breadth is only such as that it does not yield in that direction. And hence the advantage in point of economy; for if the piece is set upon its edge, suppose nine inches deep and one broad, provided that by straining the piece in depth, it shall not yield in the lateral direction, it will bear as much strain as if nine inches square. The experiment may be performed upon a small scale. Suppose five inches, and one inch broad, the thin section may be inclosed at different distances with pieces five inches square. Suppose at the distances of 1, 2, 3, &c. fig. 1. Plate CXXXVIII. and the weight applied that broke the five inch square of the length of 14 feet, viz. 5300 lb.

All

Center.

All the experiments which have been alluded to above were made upon scantling of sound oak. But it has already been observed, that in practice, such pieces cannot always, if at all, be selected. But the practical mechanic, confining himself to between one-third and one-half of the absolute strength, according as his judgment directs him, respecting the soundness of the piece he uses; there can be no doubt, that, upon occasions, he will be convinced, that he cannot, with safety, allow even one-third of the absolute strength, but must take it considerably below that proportion.

As to other species of wood, trials have also been made; and the result from different experiments has occasioned some deviation. We are told that Buffon makes fir about $\frac{6}{10}$ths of the strength of oak, Parent $\frac{10}{12}$ths, and Emerson $\frac{2}{3}$ds; all of them different. The difference between Buffon and Parent is $\frac{1}{10}$; between Parent and Emerson is $\frac{1}{6}$th; and between Buffon and Emerson is $\frac{1}{7}$th. It is easy to conceive that the different states of the wood, and different circumstances in the same species of fir and oak, will make a considerable difference; although the same persons were employed on the same materials, the experiments would probably vary; much more, may it be allowed that at different times different states of the wood must make the results different.

The experiments made by different persons vary in their amount. Belidor's experiments agree one part with another, and so do Buffon's, but differ in their results from Belidor's. Belidor's slips of oak are only of one inch square, and Buffon's are from four to eight inches square, and from 7 to 28 feet in length. When the one is reduced to the standard of the other, they do not agree: the difference may arise from various causes. We know that there is a difference in the strength of oak of different growths, and from different soils, as well as in other species of wood; there is likewise a difference in the degree of seasoning of the wood. Buffon gives the weight of his wood, Belidor does not. If Buffon's log or batten, four inches square, weighs about 60 lb. that is, about 77 lb. the solid foot; whereas a solid foot of dry oak will not weigh above 60 lb.; but Buffon acknowledges that his wood was in the sap, as vapours issued at both ends in the bending. These differences may make all the odds in the breaking, unless the proportion was established to be, as the squares of the diameter of the battens; but this is not the case, for in Buffon's experiments, the square of four, to the square of five of the seven feet batten, the breaking force is 8300lb.; but the experiment gives it 11525; that of six inches square 16 : 36 :: 5312.11952; exp. 18950. In the seven inch square 16 : 49.5312.16268; exp. 32200. In the eighth inch square 16.64.5312 : 21248; exp. 4709, the difference between the four and five inch square is one-third part of the experiment weight; the difference between the four and six is somewhat more than one-third the experiment weight; and in the seventh, the difference is a little less than half the experiment weight; between the seventh and the eighth the difference is greater than half the experiment weight.

There is likewise a difference at the different lengths; for it does not appear that the different lengths bear a proportion to their parts; a batten of four inches square of seven feet length, is expected to be double the strength of one of the same dimensions of 14 feet length; that is, the one of 14 feet length is expected to break with one half of the weight that breaks the seven feet batten; but we find it much less; but when it is considered that the weight of the materials acting at a greater distance from the center of motion, this must be taken into the account, and added to the weight of the breaking force. For example, the batten of five inches square and 12 inches length, weighs 13.368lb. at the rate of 77lb. per solid foot. This weight, acting upon the batten of 14 feet, taking the amount of the whole in an arithmetical ratio, is $13.368 \times 52\frac{1}{2} = 701.5$lb. acting upon the whole, added to 5300, the breaking force 6001. The breaking force, at seven feet, is 11525; one half is 5762.2.5, one twenty-fourth part greater than the half. The batten of six inches square, the breaking force at 14 feet is 7475, the weight of 12 inches of this batten is 19.25lb. at 77lb. per solid foot; the acting force of this weight at 14 feet length is $19.25 \times 52\frac{1}{2}$, is 1010.625, added to 7475, equal to 8485625. Now the breaking force of seven feet length is 18950; one half is 9475, difference is 989, that is, nine and a half times less than the half. In the seven inch batten of seven feet length, the breaking force is 32,200lb. and of 14 feet length, the breaking force is 13.225. The weight of 12 inches of the seven inch square is 2602lb. acting upon the 14 feet length, is $1370.5 + 1322.5 =$ 14600lb. which is one-ninth less than the half. Again, 12 inches of the eight inch batten weighs 34.2lb. at 77lb. per solid foot, acting upon the 14 feet length, is 1796lb. added to 19775, the force that broke it at 14 feet length is 21575lb. about one-tenth part less than the half of 47,649lb. which broke it at seven feet length. From the above comparison, it may be allowed, that the difference of the force that broke the spar at seven feet, and that which broke it at 14, so far as it differs from the half, is accounted for upon philosophical principles; and when we consider that the spars or battens cannot be supposed to be mathematically exact in their measure, and that a difference in point of breaking, may be accounted for from that cause; but further, it may be observed that the weight of the materials is not equal in the solid foot. For example, the spar four inches square, and several feet in length, weighs 60lb.; that is, at the rate of 77.14lb. per solid or cubic foot, the eight feet spar at the rate of 76.5lb. do.; the nine feet spar at the rate of 77 [illegible]; the 10 feet spar at the rate of 75.6; the 12 feet spar at the rate of 75lb. per cubic foot; which difference of weight, with the difference of exact mathematical measure, may fully account for all the difference that takes place in the manner of accounting for the above-mentioned difference of the weight of breaking at 7 and 14 feet; as also the difference that takes place between 8 and 16; 9 and 18, &c. The experiments being made upon green wood, cannot be approved of; they ought to have been made of such seasoned wood as is fitted for mechanical purposes, of which none of this kind can be used; or if experiments are made with unseasoned wood, as being of the greatest strength, they ought likewise to have been made with dry wood seasoned for use. A cubic foot of dry oak

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oak will not weigh much above 60lb. Those spars upon which the experiments were made, must have been very green, and very unfit for mechanical purposes, which gives an unfair account of the strength, when in a proper state for use. But experiments were made with wood of different weights, which may be supposed better seasoned. For example, the seven feet spar that weighs 56lb. that is, 72lb. per cubic foot; the nine feet spar is at 71lb. per solid foot, and the 10 feet spar at 73.8lb. per solid foot, none of which are seasoned wood. And yet it is not mentioned which of these were used. This may be adduced as a very good reason why the variations were so great.

We shall now consider the force in bruising materials, according as we may be directed by experiments made in this way. And, 1st, upon that of stone, which will in some measure lead to the pressure in the same direction upon other materials.

The experiments selected from M. Gauthey, engineer, in erecting the bridge of Chalons sur Saone (tom. iv. *Rozier Journal de Physique*, November 1774), are now to be considered.

Experiments Selected.

	Length of the Stone.	Breadth.	Superficies.	Force.	Upon each square line.	Proportion.	Difference.
		Lines.		lb.			
Hard Stone	8	8	$64\frac{4}{9}$	46	$10\frac{2}{3}$	12	$\frac{2}{13}$
	8	12	$96\frac{2}{3}$	164	27	24	$\frac{1}{8}$
	8	16	$128\frac{7}{8}$	281	$35\frac{1}{3}$	36	$\frac{1}{34}$
Soft Stone	9	16	144.1	35	$3\frac{2}{3}$	4	$\frac{11}{32}$
	9	18	$162.1\frac{1}{8}$	53	5	$4\frac{1}{2}$	$\frac{1}{9}$
	18	18	$324.2\frac{1}{4}$	183	$8\frac{1}{2}$	9	$\frac{15}{18}$
	18	24	432.3	131	$12\frac{2}{3}$	12	$\frac{11}{18}$

In general, the force is greater as the surfaces increase, but a regular proportion to fix upon a theory is not found; but the last line in the table, the weight that crushes the 432.3 surface must be greater than 131, the stone being of the same quality; if in the proportion of $8\frac{1}{2}$ to $12\frac{2}{3}$, the crushing weight will be 272.7 instead of 131.

The measures here taken are cubic, and the pressing force is upon cubic lines, the thickness one line; where the pressure is upon a square foot, it is likewise to be understood one foot deep, or upon a cubic foot; the stone used, he terms *Givry stone*, of which he gives its absolute force to be 870911, that it will bear 663552lb. In the cubic foot of soft stone the strength is 248832lb. The proportional force of the hard and soft is $2\frac{1}{4}$ to 1.

A cubic foot of a stone fixed in a wall, and projecting one foot, was broken by a force of 55728lb. And a cubic foot of soft, by 10080lb. the proportion $5\frac{1}{2}$ to 1.

A cubic foot of hard stone, supported upon two fulcrums at 1 foot distance, was broken by 205632lb. suspended from its middle; and the soft by 38592, the proportion about $5\frac{1}{4}$ to 1.

In fine, a cubic foot of the hard stone was torn asunder by 45,500lb.; and the soft by 15,850lb. the proportion $2\frac{1}{4}$ to 1. Thus far Gauthey's account.

It is to be observed, that the above table does not strictly correspond with itself; for the proportion upon the square line, or $\frac{1}{12}$ of an inch, in place of $10\frac{1}{3}$ is upwards of 11. Now, the increase of force which crushes 96 square lines, and 128 one line thick, is 7.8 oz. nearly upon the square line, that is a little more than $\frac{1}{5}$ of 35 oz. upon the square line; then, as 128 square lines is to 4496oz. so is 144 square lines to 5058, to which add one-fifth, viz. $1011\frac{1}{4}$, this makes $6069\frac{1}{4}$ upon the square inch, and this multiplied by 144, the square inches in a foot, is 874,022.4oz. but Mr Gauthey says, that the square foot of surface of one foot deep, is of the strength of 870,911lb.

Again there are 20,736 square lines in a square inch, the force upon a surface of 64 square inches being about 11.5 upon each square line, is 238,464 oz. upon the square foot. Upon the surface of 96 lines, 27oz. to the square line, gives 559,872 to the square foot. Upon the surface of 128 lines, $35\frac{1}{3}$ to the square line, is 878,806 to the square foot, the proportion of 238464oz. to 870,911 is about $53\frac{1}{4}$ nearly, and of 559,872 to 870,911 is $\frac{2}{3}$ nearly; but by the experiment the number 870,911 is lbs. upon the square foot; the other numbers are only ozs. The variation between the first difference and between the pressing force of $6069\frac{1}{4}$oz. upon the square inch, makes in that proportion 874,022oz. The increase of force from one square inch to one square foot, must be $\frac{1}{18}$ part of what the above experiment upon the square foot produces. Further experiments upon this therefore become necessary. In the mean time, we have no reason to doubt the experiment upon the square foot, or upon the smaller parts; intermediate experiments only can make them accord. One example adduced is of consequence. A pillar in the church of All Saints, in Angers, of 24 feet height, and 11 inches square, supports a weight of 60,000lb. that is $\frac{1}{5}$ being added 85685.9 upon the square foot, which is said not to be $\frac{1}{7}$ part of the load that would crush it. From this it is evident, that the load it supports exceeds the weight of an arch of 50 feet span, of a semicircular form; the arch-stones being $2\frac{1}{2}$ feet long, or depth of the arch, and 2 feet in breadth. It is asserted under the article BRIDGE, that instead of an arch $\frac{1}{5}$ of the opening or 10 feet thick, that a pier of 2 feet thick would be sufficient, but that it is given twice the length of the arch-stone, that is 5 feet thick in place of

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of 10; but from this example, it is five times thicker than necessary, and has therefore superabundant strength, allowing even for the force of a current. How superfluous then will these clumsy piers be reckoned, whose sole effect is a useless obstruction to the water! But as our principal design at present is upon the strength of wood, in prosecution of this inquiry, we have paid particular attention to the strength of this material, in the transverse direction, in so far as it can be supported by experiment. Before we proceed to make particular application to its use, it will be necessary to consider its strength or power of resistance in its breadth and thickness. In this it may be with safety averred that such force as will bruise or crush its fibres, although only of $\frac{1}{10}$ or $\frac{1}{12}$ of an inch; the same weight continued will produce the same effect upon the next stratum, till the whole piece is bruised, and its cohesive power overcome. This is supported by the experiments of celebrated mechanicians, as those of Buffon, Muschenbroek, Bouguer. Muschenbroek, in his *Essai de Physique*, says, that a piece of sound oak $\frac{27}{100}$ of an inch is torn asunder by 1150lb.; and that a plank 12 inches broad, and 1 thick, will just bear 189,168lbs. These give for the cohesion of an inch 15,755, and 15,763 lbs. Bouguer in his *Traité de Navire* says, that it is very well known that a rod of sound oak, of $\frac{1}{4}$ inch square can be torn asunder by 1000 lb.; this gives 16,000 for the square inch. Bouguer speaks with certainty, that $\frac{1}{4}$ inch square of sound oak can be torn asunder by 1000 lb. If we reduce the above proportion of the experiment, it will appear, that the force will be much greater than 16,000, to tear asunder a piece of sound oak of one inch square. It must in the mean time be allowed, that Buffon's experiments being upon a larger scale, can be followed with more security than those upon a smaller scale.

But, after all, we have not yet got sufficient data to form a criterion for an arch; nor can this be expected till we have more precisely ascertained the strength of an arch above a right line, parallel to the horizon.

In the first place, as an arch is in form, one part of it towards the perpendicular, and the other towards a horizontal line; the force that it will sustain, is between that force that a body will carry in the perpendicular, and that which produces a fracture upon any material in the horizontal direction. If the perpendicular is greater than the horizontal line, it will have more of the strength of the bruising force, than of the transverse fracture; and the force may be expressed by the ratio compounded of the bruising or crushing force, and that of the transverse fracture; or not improperly expressed, as it has been denominated by others, the absolute and relative force.

Unfortunately we have not yet a sufficient variety of experiments to ascertain the absolute force, as those made are only upon a small scale; and the number is not adequate to form a proportion of the increase for the force that will crush a piece of wood of $\frac{1}{10}$, or, as the French philosophers have done most this way, we take their measure $\frac{1}{12}$ of an inch, or one line, and from that to an inch; but the force required is found to be greater than that of the square of the diameter, as also the force to produce a transverse fracture, or to give the relative strength. This increases in a greater *ratio* than that of the square of the diameters; for in the above experiments, the weight that broke a batten 4 inches square, was to that weight which broke an 8-inch square batten, each of the length of 7 feet, more than double of the square of 4 to the square of 8 as above; we are, therefore, much limited as to an exact procedure.

At the same time, by keeping the experiments in view, and the observations made upon them, we shall be able to give such a *ratio*, as to the necessary strength, and will furnish the ingenious artist with a pretty sure principle to act upon, and prevent his using superfluous materials, either in their application to horizontal right lines, or inclined in the right-lined direction, or in curves.

If we attend to the weight that crushes one inch of sound oak, by Muschenbroek's experiments, we find that it is 17,300 lb. but, if computed from the increase, being as the squares of the diameters, it is only 16,000 lb. but it has been found as above, that the power to break, or make a transverse fracture in the same wood, of the same length, of different diameters, if a considerable difference in diameters is taken, the difference of weight is twice that produced by the square of the diameter. This comparison makes the proportion between the strength of stone, and that of wood, to be as 17,300 is to 6048, or 1 to 2½ nearly. Thus we may with a sufficient degree of accuracy substitute the one for the other in point of strength, and form a proportion between the arch and the strength of a horizontal line. As several experimentalists agree, that a square inch of wood can be crushed or pulled asunder with a weight of between 16,000 and 17,300lb. and that a piece of wood one inch square, 18 inches in length, can be broken by 406 lb. or at 12 inches by 609, or at 6 inches by 1218; attending to the addition as mentioned above, which has been proved by comparison of experiments, to be upon the principle of the lever. If, then, the geometrical mean is taken between the elevation of the arch, as pressure or absolute strength, and the length of the horizontal line, this mean will be the strength of the arch above the horizontal line; for it is evident, that so much as the piece of wood is elevated towards the perpendicular, so much the nearer it approaches to its absolute strength, and by so much as the arch is flatter or the piece of wood less inclined, the nearer it is to a straight line, and so much the more reduced to its relative strength; the position of the arch, therefore, must be in the ratio compounded of these two.

Having now established the principles, let us endeavour to apply them to practice, in forming a center or supporting an arch, to produce the intended curvature or mould for an arch of any intended span, and at the same time have strength to support the same. Several ingenious artists have not only formed, but have written and laid down principles for forming these moulds, both with regard to strength and economy; at the same time we have not found any that have treated the subject upon principles that are fully established. We have, therefore, been the more particular, according to the principles laid down. 1st, We have assigned the weight to be supported, as established by uncontroverted principles: And, 2dly, established the strength of of wood as to its thickness or diameter, that is sufficient to sustain such weight; which we have supported by the most approved experiments, comparing one with the other; and in the third place, we have considered the effects when the materials are applied in the horizontal direction, or elevated in any degree toward the perpendicular.

In a work of this kind, it is not only necessary to lay before our readers well grounded principles, and a well supported theory, but along with these, the different opinions, and various modes used by the most distinguished artists, who have exhibited their plans to the public, together with the principles on which they were founded, and the success they have met with, in answering the purposes proposed.

Among the most distinguished who have treated this subject, we may consider Pitot, a member of the Academy of Sciences, who wrote about the beginning of the last century. His method undoubtedly shows considerable ingenuity; but, at the same time, we must observe that he has been rather too profuse in the quantity of materials which he has employed.

To lay his plan of operation before our readers, we shall give a figure showing the constructions. The arch of the circle or ellipse being formed; as little or no weight lies upon the center, till between 30 and 35 degrees of the arch, a stretcher is extended at this height, to the same height on the opposite side; two struts support this stretcher from the spring of the arch; upon the upper part of the stretcher, immediately above, or a little within the upper end of the truss on each side, two spars joining upon the king-post, spring from about the middle of the arch, the stretcher being divided into four parts. Another strut springs from the rise of the arch, meeting the stretcher at this fourth part, from each side of the arch; these last struts are joined by a tie-beam, which gives additional strength to the first stretcher; upon these, on the upper side of the stretcher, two spars join the king-post, a little below the other; these spars are joined by bridles or cross spars, from the circular arch, to the lower strut; ribs of the same formation being placed at proper distances, according to the width of the bridge, and joined by bridging joints, which may be of greater or lesser strength, according to the span of the arch, and of consequence the weight it has to support. Pitot is the first writer who has given us any account of the method of forming frames, according to the above general description. If no rests are left at the spring of the arch, as a base for the center to rest upon; let AB, fig. 1. Plate CXXXVIII. be the ends of two planks raised from the foundation, upon which the center may rest; let CD be the stretcher, extended about 35 or 40 degrees from the spring of the arch; or, as little weight rests upon the center till that height, the stretcher may be as high as 45 degrees; let AE, AG, BD, BG be the two struts on each side; from each extremity of the center, let BE, AE, be fixed to the stretcher near C and D, and AG, BG, at $\frac{1}{4}$ of CD; their stretcher or tie-beam GG, equal to one-half of CD, the bridles, 1, 2, 3, &c. from A to C, and from B to D, are intended to prevent the arch from yielding from A to C, and from B to D. The struts EF, EF, meeting the king-post K in F, and the interior struts GH, GH, meeting the king-post in H, support the bridles 4, 5, 6, on each side of the king-post; their use is to stiffen the frame of the center, which supports the upper and more weighty part of the arch.

The arch for which Pitot allots this center, is of 60 feet span; and the arch stones seven feet in length, the weight of a solid cubic foot he makes 160 lb. The Portland stone is admitted to weigh 160 lb.; but we do not find any other freestone of such weight. It is however to be considered, that the Paris foot is 12.788 of our inches; that is, a little more than $12\frac{3}{4}$ths of our measure, which will make a difference of the weight upon the foot; as also their lb. is lighter than ours about 1.2 oz. by which the stone here mentioned is not better than ours. In a matter of this kind, such exactness is not necessary. As was proposed, we first consider the weight to be supported by the frame; and here it is evident from the figure that no strain lies upon the frame below C; the arch is raised, or can be raised to this height, before the frame is set; therefore the perpendicular C *c* determines the limits of the absolute pressure upon the frame. The triangle C *e c* presses on the frame, and the triangle C *f g* adds to the lateral pressure; the weight of the arch, that actually presses upon the frame, is contained between the perpendicular lines C *c*, D *d*; no more can press upon the center frame. The part of the arch below C will rest upon the abutment raised upon the pier; but if it is insisted that there is a pressure upon the lower part of the center frame, what can only possibly rest, or press upon it, must be contained between the parallels C *c* and *f g*: although it will be admitted, that the arch can be raised to the height C, without the center frame; but to indulge such as say it is not advisable to do it, we will admit what lies between these parallels to press upon the frame. Now to determine the weight of these parts of the arch, the distance between the perpendiculars C *c*, D *d* is 53 feet; the arch-stone is 7 feet, and admit it to be three feet broad, $53 \times 7 \times 3 \times 160$ lb. $= 178{,}080$ lb.

To determine the area between the two parallels C *c*, *f g*, the line *f g* perpendicular to the diameter AB, is $13\frac{1}{7}$, the base is $9\frac{1}{7}$, and C *f* perpendicular to it is 7 feet, the area is $33\frac{1}{2}$ feet; C *c* the base of the triangle C *f c* is 7.2, and *f c* is 7; the area is 25, the difference is $8\frac{1}{2}$. If this difference had been the excess of the triangle C *f c* above the triangle C *f g*, it would have been a pressure upon the frame; but as it is the reverse, the pressure is upon the abutment. This distinction is requisite to be taken notice of, that an unnecessary expence of wood and workmanship be not expended where it is unnecessary; as well as its being unworkman-like, or having an appearance of ignorance in the engineer.

Let us now inquire, what strength of materials is sufficient to support this weight. It has been laid down as a principle, that the parts of wood in an arch act upon one another by their absolute strength; but are liable to the transverse fracture; in proportion to the length of the piece, in a span of 60 feet, the length of the piece may be 7 feet without sensibly impairing its strength, in reducing it to the round; and experiment gives the relative strength of 7 feet to be 47649 lb. by 8 inches square. It has been formerly illustrated from

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from experiments, that the strength is according to the depth, with this precaution, that the breadth or thickness be such, that it is prevented from warping, the absolute strength being nearly, by last experiment mentioned, as the squares of the depth. The absolute strength to the relative force has been found nearly 60 to 1, although by some it is said to be only 42 to 1; the absolute strength of the plank 12 inches broad by one thick, is 189163lb.; if two inches, it would be no more than 189163lb. If it had been 8 inches square, then every 7 feet of the arch might be broken with the weight 189163 lb.; but the whole weight of the arch is only 178080lb. that is, 11080 less weight than what that part of the frame would bear; but 7 feet is only about one-seventh part of 53; the frame is therefore of sufficient strength to support the whole weight of the arch when equally divided along its whole length. This is not the case with the center frame of an arch, as it is loaded at one place, and not at another; it is therefore apt to yield between the parts where the load is laid; that is, it may rise in the middle, and thus change the form of the arch; for the center frame is not only intended to support the arch, but likewise to preserve its true form; for this cause some struts may be necessary to prevent its putting the arch out of shape. To remedy this, where the arch begins to press upon the frame at C, draw the chord line C *c*, fig. 2. which acts as a tie-beam to the arch, from C at 35 degrees to *c* at 51 degrees, as, beyond this, if the arch frame had been permitted to alter its shape, it would begin to be restored to it, at least the force would tend that way. At that part of the arch, where its weight begins to flatten the frame, as at 2, draw the stretcher 2, 2, which likewise acts as a tie-beam, and gives support to the bridle 1, on one side, and to 3 the bridle upon the other side, from D *d*; and thus the arch *c d* is prevented from sinking by the tie-beams *e d*. This will effectually prevent any warping or yielding of the frame, notwithstanding the enormous load from the size of the arch-stones.

But it is necessary to attend to the relative strength of different kinds of timber of which frames may be constructed. The relative proportion of the strength of oak and fir has been ascertained by different experiments; and although the results do not exactly agree, yet the mean or least proportion may be taken. Let us take $\frac{6}{10}$, that of Buffon. Now to reduce a frame of oak to one of fir of equal strength, divide 8 inches, the diameter of the oak, by $\frac{6}{10}$, the relative strength of fir; this gives $1\frac{1}{3}$ inches. Allow $1\frac{1}{2}$ inches. The depth of the frame will then be $9\frac{1}{2}$ inches by $\frac{1}{3}$ or $\frac{1}{4}$ inches in breadth; that is, $9\frac{1}{2}$ by $2\frac{1}{2}$ inches. In this way the strength of the fir arch is rendered equal, and by the additional allowance superior to the oak in strength, and of less expence in wood and workmanship.

We have here taken the most simple method of investigation and computation, that every mechanic, whether scientific or not, can easily follow it in every step, and judge of the propriety or impropriety of what is advanced.

It will now be necessary to follow Mr Pitot in estimating the quantity of materials which he allows. The ring of his arches consists of pieces of oak 12 inches broad and six thick. The stretcher CD is 12 inches square, the straining piece GG is likewise 12 inches square, the lower struts 10 inches by 8; the king-post 12 inches square, the upper struts 10 by 6, the ridges 20 by 8, French measure. Pitot allows the square inch to carry 8650lb. that is, one half of the absolute strength, which is ascertained by experiment to be 17300lb. nearly, and not by the square of the diameter, which would be only 16000lb. But on account of knots he reduces it to 7200lb. per inch. He then computes the whole load upon the frame to be 7075201b. which is the weight of the whole arch-stones, supposing each to be three feet broad, and the whole to press upon the frame. This comes so very near, that it would be needless to dispute about the difference. We have shown that no more than 1780801b. presses upon the frame; but we are not so fully satisfied as to the weight that rests upon the center. Pitot supposes it to be $\frac{11}{14}$ths of the whole weight; but he has assigned no reason for this conjecture. Mr Couplet assumes that it presses by $\frac{4}{5}$ths. Another writer, who makes some comment upon the whole, says that $\frac{11}{14}$ths is nearer the truth than $\frac{4}{5}$ths, but gives no reason for his opinion, which seems to be equally vague as the other. The pressure here allowed, and the reason of assigning such a pressure, have been already explained. Our readers, therefore have it in their power to examine the principles, and decide for themselves.

It has been asserted by some, that the arch does not press upon the center frame below C. At the same time, were we inclined to dispute this opinion, we might state our objection in the following manner: Suppose the area of the triangle C *c f* was equal to the area of the triangle C *f g*, so that the friction above would make the triangle C *c f* rest upon the side *c f*; and as the triangle C *f g* is greater than C *c f* in the proportion of $33\frac{1}{4}$ths to $25\frac{1}{3}$d, the cohesion of the parts will determine the intermediate space between C *c* and *g f*, to rest upon the abutment as has been said, and not on the perpendicular, unless a scissure is made in the direction *g f*, in which case it would be detached from the lateral pressure, and so rest upon the center. As this is not the case, any plea for a pressure below C is entirely removed; and a method to determine with precision the actual pressure upon the center frame is shewn. If the arch is the center of a circle or an ellipse, a frame so much stronger is necessary, as more of the arch presses upon the frame; but the method of determining the strength is the same as here laid down. A second figure of the ellipse and another calculation are required. It is here to be understood, that the frame calculated for is only one rib; and the weight it supports is that of the arch-stones, between the parallels C *c*, D *d*, to three feet in breadth. If, therefore, the bridge is 42 feet broad, it requires 14 ribs of the above strength. These are joisted over with planks, suppose of two inches thick, and upon these the arch-stones are laid, equally carried on from C and D, and rising equally on each side, till the key-stone is set, in which state they remain, till the engineer judges it proper to slacken the frame, by striking out the wedges at the rests, A and B (or, as the French use logs between the frame and arch), so far as to allow the arch-stones to press upon one another, by the equilibrated curvature

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curvature of the arch; after which, it being found, that the arch is perfectly just and secure, the frame is entirely removed. In the frame, fig. 2. the tie-beams are not taken into the account for strength, the arch being abundantly strong without them. Their use is merely to stiffen the frame, on account of the manner in which the weight is laid on. In an elliptic arch, it has been mentioned that it is somewhat different, requiring more strength and the binding likewise different. In what are termed elliptical arches, few or none are strictly so, the true elliptic curve being difficult to form on so large a scale. It may therefore be acceptable to our readers, and also to the ingenious mechanic, if we give the form of an ellipse that will answer nearly to the elliptic equation, and upon an universal plan, easy of construction. The greater and lesser axes of the ellipse being given, divide the excess of the greater axis above the lesser into three equal parts; set off two of these from the center of the greater axis each way; upon this distance describe an equilateral triangle on each side of the greater axis, and produce the sides of the triangle both ways from the vertex of these triangles, to the extremity of the lesser axis; describe two arches till terminated by the sides of the triangle produced gives the flat part of the ellipse. At the intersection of the produced sides of the triangle as a center, with the distance of the extremity of the greater axis, describe an arch which will meet the other arch, and complete the ellipse. Let AB, fig. 3. be the greater axis 60, and DE the lesser axis 40, be drawn at right angles, bisecting one another in C. Set off AF 40, upon AB, then the excess FB is 20, which divide into three parts; set off two of these from C to G and H; upon GH describe the equilateral triangles GHK, GHL; produce KG, KH, to any indefinite length; which may be cut by the arch drawn through D and E; from the centers KL at the intersections GH, and distance AB, let the other part of the ellipse be described; thus an universal method of describing a beautiful ellipse, and so just that it answers the elliptic equation exceedingly near, at least till it becomes very flat.

A second form of a center frame described by Pitot, is adapted to an elliptical arch. The construction differs nothing from the former, only the two upper struts are parallel; the strength as in the former is superabundant, which is easily accounted for, from not knowing the real weight that lies upon the frame, or by considering the whole weight of the arch to rest upon the frame. Both this and the former Pitot has considered as divisible into three pieces, which renders it more manageable in erecting, particularly in large spans. See fig. 4.

Fontana has given a description of a very neat frame consisting of two pieces, the upper and the lower. The struts 1 2, 1 2 taken from fig. 4. leave a representation of Fontana's frame. Different constructions being laid before our readers, the ingenious artist may improve the hints that have been thrown out; and thus form a more simple or better construction.

We shall now select draughts of the most approved center frames that we are able to collect; and make such remarks upon them as may occur. Fig. 5. exhibits a form, which the experienced engineer will readily allow to be neat and ingenious; but there is much more wood and work expended than is necessary. It is divided into two parts, the base or stretcher LL, of the upper part, resting upon the lower part of the frame, the greatest part of which at least must appear quite superfluous. The lower rests, EF, appear only necessary to prevent the stretcher LL from yielding, and thereby allowing the arch to lose its true curvature.

The general maxim of construction adopted by Perronet, a celebrated French architect, is to make the truss consist of several courses of separate trusses, independent, as he supposes, of each other, and thus to employ the united support of them all. Each truss spans over the whole distance of the piers. It consists of a number of struts, set end to end, so as to form a polygon. By this construction, the angles of the ultimate truss lie in lines pointing towards the centre of the curve. It is the invention of Perrault, a physician and architect, and was practised by Mandsard de Sagonne at the great bridge of Moulins.

In the centering of the bridge of Cravant, fig. 6. the arches are elliptic. The longer axis or span is 60 feet, the semi-transverse axis or rise 20 feet. The arch-stones weigh 176 lb. per foot, and are four feet in length, which is the thickness of the arch. The truss beams were from 15 to 18 feet long, and 9 inches deep by 8 broad. The whole frame was constructed of oak. The distance between the trusses, which were five in number, $5\frac{1}{2}$ feet. The whole weight of the arch amounted to 1,350,000lb. which is nearly equal to 600 tons, making 112 tons for the weight on each truss. Ninety tons of this must be allowed really to press the truss; but a great part of the pressure is sustained by the four beams which make the feet of the truss, joined in pairs on each side. The diagonal of the parallelogram of forces drawn for these beams is to one of the sides as 360 to 285. Then $360:285::90:17\frac{3}{4}$ tons the weight on each foot. The section of each is 144 inches. Three tons may be laid with perfect safety on every inch; and the amount of this is 432 tons, which is six times more than the real pressure on the foot-beams in their longitudinal direction. The absolute strength of each foot-beam is equal to 216 tons. But being more advantageously placed, the diagonal of the parallelogram of forces which corresponds to its position is to the side as 438 to 285. This is equal to $58\frac{1}{18}$ tons for the strain on each foot; which is not much above one-fourth of the pressure it is able to bear. This kind of centering, therefore, undoubtedly possesses the advantage of superabundant strength. The upper row of struts is quite sufficient; nothing is wanted but to procure stiffness for it.

In his executing the bridge at Neuilly, fig. 7. of 120 feet span, and only 30 feet rise; the arch 5 feet thick; his strut-beams are 17 by 14 inches of size, and king-post 15 by nine, the strut-beams placed in three parallel polygons, each abutting upon the king-post, he uses the binders or bridges of 9 inches square. This arch is remarkable for its flatness. The account Perronet gives of his success with this frame, and the effects it produced in his work, are as follows. Notwithstanding the different improvements he had made upon his center frame, he here found that it sunk 13 inches, before the

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the key-stones were set, and that the crown rose and sunk as the different courses were laid. At 20 courses on each side, with a load of 16 tons upon the crown, it sunk an inch; when 20 more courses were laid, it sunk half an inch more, and continued sinking as the work advanced. When the key-stone was set, it had sunk 13 inches; and, as it sunk at the crown, and in the advance, to the crown, it rose at the haunches, so as to open the upper parts of the joints almost an inch; which gradually lessened towards the crown, and of consequence the joints in the lower part opened as the upper part was compressed. This no doubt showed a suppleness in the frame, and at the same time inattention in the architect, to load the crown, when he perceived it sinking with having already too much weight upon it. If he had observed the crown to rise, it would then have been proper to give it additional weight.

Let us now attend to the description of the centre frame of the bridge of Orleans, fig. 8. The architect to this bridge was Hupeau; and it is universally allowed to be an elegant structure. The arch stones are six feet in length, the form is elliptical, the span 100 feet, and rise 30. Hupeau died before any of the arches were complete. The center-frame had been placed, and some rows of the arch laid. Upon his demise, Perronet succeeded as architect, and finished the bridge. As the work advanced, he found that the crown of the center rose; he then found it sink as remarkably, which showed that there was some defect; he inserted the long beam AB, on each side; he then found the frame sufficiently stiff; for this made a change in the nature of the strut.

Having taken a view of the practice of the French architects, as to their form and effects, let us direct our attention to those of our own country, which are well worthy of notice. We shall only name some that have used trussings, and among these we find the center-frame of Blackfriars bridge, fig. 9. The span here is 100 feet; the form is elliptical, the arch-stones from the haunches seven feet, near the key-stone not quite so much, as they decrease in length from the haunch to the key-stone.

A particular description of this arch is not necessary: a view of the figure will show the use of the different parts; it may be sufficient to observe, that when the arch stone was placed, it had changed its shape only one inch, and when the frame was taken out, the arch remained firm without any sinking of consequence. The great arch did not sink above one inch, and none of them above an inch and a half; whereas those already mentioned sunk by the suppleness of the frame 13 inches, and some of them 9 inches more when the frame was removed.

Different methods are employed for easing the frame or disengaging it from its weight. We shall give a short description of Mr Mylne's method of placing and disengaging his center-frame from the mason-work. Each end of the truss was mortised into a plank of oak cut in the lower part as in the figure; a similar piece of oak was placed to receive the upper part of the posts. The blocks rested upon these posts, but were not mortised into them, pieces of wood being interposed. The upper part of this block was cut similar to the lower part of the other; the wedge E, being intended to be driven betwixt them, was notched as in the figure, and filled up with small pieces of wood, to prevent the wedge from sliding back by the weight of the arch; which, it will appear from the figure, would have been the case: the event proved the fact. When the centre was to be struck, the inserted pieces of wood were taken out, and the wedge, which was prepared for driving back by being girt with a ferule round the top, was removed by a piece of iron driven in with the head so broad as to cover the whole of the wood. A plank of wood was prepared armed with iron in the same manner at the one end, and suspended so that it could freely act in driving back the wedge to any distance, however small, with certainty. Thus, by an equal gradation, the centre was eased from the arch, which appeared to have been so equally supported throughout the whole of the operation, and the arch-stones so properly laid, that it did not sink above one inch; and thus it was evident that the centre might be entirely removed, having completely answered the purpose.

The above examples may be considered as sufficient to show the effects of the trussed arches, which have been employed by the French architects. We shall now take the liberty of suggesting some hints which may tend to improve the construction, and remedy the faults and failures that have occurred in practice.

Trussed arches for center frames being found expedient in navigable rivers, and almost in every river which is apt to be raised by rains, or other rise in the river, the frame is apt to be endangered or carried off, to the great risk of bringing down the arch, and ruining the work before it is finished. In arches were there is no such danger, the frame may be properly secured by posts from below, which are made to abut upon these parts of the arch where the greatest strain must fall.

In the centre used by Pitot we have only to complain of an unnecessary expenditure of wood and workmanship. We have already shown what strength of oak is necessary, and have reduced the strength of oak to an equal strength of fir-wood for the ring of his frame, which alone ought to have the strength required to be fully adequate to the load; but as this weight must be gradually applied, the frame must likewise have such a degree of firmness as to form the exact mould of the arch that is intended. And, for this purpose, it must be prevented from yielding in any part of its arch. Now, as it has been made to appear, that the frame supports no part of the arch till it rise from the spring to about 35 degrees, if a semicircle, and so in proportion for a segment of a circle; in an ellipse, to a part similar according to the nature of that curve; the supporting struts and ties can be more particularly directed to support that part of the arch which produces the greater strain upon the centre. In fig. 2. where the necessary strength for Pitot's arch is pointed out, the frame of fir requisite to stiffen the frame is $9\frac{1}{7}$ by $2\frac{1}{7}$. The tie-beam C *c* is joined to those parts of the arch where the strain being greatest, would tend most to raise it in the crown. The strength of this tie-beam being $9\frac{1}{7}$ by $2\frac{1}{7}$ and its length 25 feet, would require a weight of 30495 lb. to make the transverse

Centre.

verse fracture; one-third of this at the bridle 1, 3, is sufficient to resist the strain at the part of the arch; and the abutment, being according to the principles laid down under the article BRIDGE, prevents the possibility of its rising at the haunches; but if not formed according to these principles, the two tie-beams *C c D d* are joined by a third tie-beam 2, 2 with its bridle 3, 4. Fig. 4. is Pitot's centering for his elliptic arch: the strength of fig. 2. may suffice to this by giving the ring and tie-beams ½ an inch more depth.

Fig. 6. represents two centerings used by Perronet; A is that used by him in erecting the bridge at Nogent, and B that at Maxence; they differ little from one another. That at Nogent is 90 feet by 28 of height. The span of the latter being greater, we shall here consider the weight to be supported. This is the arch from A to C, which is an arch of 47° 45′. The measurement is 42 feet; the arch stones 4½, and supposing them 3 feet broad, they would amount to 567.9 solid feet, which at 160 lb. per foot, is equal to 90866.88 lb. This is little more than one-half of the semicircular arch: and although it is flatter, the weight is so much less, that no additional strength is necessary to be given to the frame, fig. 2. for the 60 feet span. There is likewise abundance of strength of materials for the 90 feet arch; but on the greater extent, that it may be rendered more stiff, a tie-beam 1, 4, 3, 4 may be added on each side of the arch, as represented by the dotted line.

It is scarcely necessary to make any farther calculations on the centering used by Perronet. It appears, that notwithstanding the superabundance of wood employed, they were so supple as when used upon an extended arch, they rose and sunk so much, that the arch was changed from its intended form by a radius of several feet. These changes took place in erecting the bridges at Nogent and Maxence, which are represented in fig. 6. Perronet, it would appear, was not satisfied with these; and, convinced of their insufficiency, changed the form of the frame of the bridge at Neuilly. But this form is far from answering the purpose; for, when the arch-stones began to press upon the centering, it yielded to the weight. He then loaded the crown to prevent its rising there, but it still sunk; he added more weight to the crown, it continued sinking as the work advanced. When the key-stone was set, it had sunk more than 13 inches, and it was found to have raised the haunches; for when the centering was slackened, the arch still sunk for about 9 inches more. The arch-stones being raised at the haunches, the joints were of necessity opened; for the pressure from the crown, when the centering was removed, forced them again into contact, by which the arch flattened to such a degree, that from an arch intended to have a radius of 150 feet, it flattened till part of it was as if formed from a radius of 244 feet. It here appeared to be settled, from which a considerable deformity must appear in the structure; which deformity took its rise from two evident causes; the want of firmness in the centering, and the bridge not properly loaded at the haunches. It is evident, that if the load at the haunches is only equal to the weight of the arch-stones from the place where they begin to rest on the centering to the crown of the arch, the pressure of the arch could never overcome itself or its equal weight upon the haunches; much more, if the weight upon the haunches, before it comes to press upon the centering, was made to exceed that part of the arch that did press upon it, the load upon the crown of the arch would have restored the figure of the centering. It seems to be a strange oversight, that Perronet, when he saw that his centering was rising at the haunches, did not apply his loading to this part of the arch, by which he might have restored it to its equilibrium before his centre was struck, and before his lime had lost the band; if this is once done, it is allowed that it does not again recover it.

Centre.

From the whole of this it appears evident, that filling up the haunches to a proper height, so as to make a firm abutment to the pressing part of the arch, serves two good purposes. It acts as an abutment to the centre frame, in preventing its sinking by the load as the work advances; and likewise prevents the arch-stones at the haunches being raised from their beds; for it is only acted upon by a force considerably less than what they have a power to resist. Having now seen the defects of this centering, and animadverted on the manner of executing the work, let us now examine the weight of this arch, and what resistance would have prevented its change in shape, and preserved its intended form.

The part of the arch that presses upon the center, is from C to C, fig. 10. an arch of 36 degrees, and measures 94¼ feet nearly; the stones 5 feet in length, and breadth 3, make 1979.035 solid feet, × 160 lb. the weight of a solid foot, make the whole weight 216645.88 lb. Allow each beam of the truss to be 7 feet, and its absolute strength, to tear it at 12 inches deep, by one inch thick, 189163; the absolute power of transverse fracture, 95416 lb. The strength of the arch is the mean of these, or ratio compounded; taking one-third of each, the geometrical mean is 44285 lb. that each 7 feet can sustain when formed into an arch; there are 13 times 7 in 94 feet, equal to a power of 582764, to sustain the weight of 316645.68 if equally distributed. But this not being the case, a tie-beam of about 30 feet marked *c c*, *d d*, will prevent the arch yielding to the pressure. It is supported at *e* by the struts *E e*, *h h*; and these by the joint support of *e f*, *h f* tied at *k*. The whole centre frame is supported by the upright posts CC, DD. Two wedges A and B are placed across between two blocks which are fitted for a rest to the frame. When it is required to be slackened, and the frame withdrawn from the arch, they allow it to rest by its own pressure. This, it must appear obvious, ought to be done when the key-stone is set before the lime has begun to be dry and solid.

The centre frame of the bridge of Orleans is represented fig. 8. It has been already noticed in this undertaking, that Perronet succeeded Hupeau. As the work advanced, he found the arch and frame to sink, and trying his ordinary mode of loading the crown of the arch, he was now taught by experience to strengthen his centre frame, and happily succeeded by continuing his strut. By forming the base of the triangle 1, 2, 3, on each side, his frame was rendered sufficiently stiff, and the inner part below AB, AB became superfluous. The weight that presses upon this frame is great both on

Center. on account of the flatness of the arch, and the length of the arch-stone. The pressing arch is an arch of 57 degrees; it measures 88.87 feet, ×6 the length of the arch-stone, and by 3 in width, makes 1599.66 solid feet × 160lb. the weight of a solid foot, gives 255945.6lb. The length of each plank of the truss being 7 feet, depth 12 inches by 2 inches thick, the strength is 189163 lb. The weight for every 7 feet in length of the arch, one third of this 63054⅓lb. in 88 feet, there is 12 times 7, that is 63054.3+12=756,652lb. to support 255945.6lb. more than 3 times stronger, without taking into account the strength of the arch, being the mean of the splitting force and transverse section: the tie-beams, as in fig. 7. will be of abundant strength to stiffen the frame.

The next we take notice of is, the truss-frame, fig. 9. used by Mr Mylne, at Blackfriars bridge, London. This is supported by ties and struts in such a manner, that no sinking took place during the mason work going on, although the arch-stones at the haunches were 7 feet, gradually lessening to the crown of the arch; and, when the frame was struck, which was done by a very ingenious method, by the wedges of the constructions as in the figure, in place of sinking 9 inches, it did not sink above 1, which may well be accounted for by the compression of the mortar; whether a smaller quantity of materials might not have answered the same purpose, such as fig. 7. we shall refer to the judicious reader, or to the ingenious artist who may have occasion to depend upon such frames for support of this work, or a tie-beam between 1 and 3 on each side, represented by the dotted line. As there is a strain upon the frame at *s*, *s*, let these tie-beams be supported by the struts *a* 3, *b* 3 on each side, and tied at 4, 4 as represented by the dotted line 4, 4. It does not appear that what lies between the dotted line *a* 4, 4 *b* bears any part in the support or stiffness of the frame, and therefore becomes unnecessary; nor does it appear, that the different beams used as king-posts are of so much advantage for strengthening the frame, as tie-beams would be. At the same time, those used by Mr Mylne are employed with so much judgment, that none of their effects are misapplied. This cannot be said of any of the frames used by the French architects, even of that used at the bridge of Orleans. They are not often employed by the British architects; they rather prefer a tie-beam at the spring of the arch from one side to the other. This, however, might be as judiciously applied at the height where the arch begins to rest upon the frame, especially if the shoulders are properly loaded or filled up, so as to be a counterpoise to the arch-stones, that rest upon the frame. In this case they effectually prevent the necessity of a tie-beam, as a diameter at the spring of the arch; and from the spring proper supports may be given at the upper tie-beam, and from it to any part of the arch, where the greatest strain lies.

Having, from the examples adduced, and the observations made upon them, found center-frames of sufficient strength to support arches of very extensive spans, and even greater extent than they have yet been applied; it may be said, why not continue these frames for the bridge, without the very great additional expence of throwing a stone arch over them? The mason would answer, that the stone was more durable, and had other advantages, particularly as to neatness, when once thrown, and freed from the uncouth trusses and tie-beams necessary in the wooden frame. The carpenter would reply, that if wood was not so durable as stone, it could be raised at much less expence; and, when it failed in any part, it could be replaced at a small expence, and made to last longer than a stone arch; which latter, when it fails, requires as much expence as at first, and even more, in clearing off the rubbish of its decayed and now useless materials. As to neatness, the frame of wood vies with the arch of stone in elegance, and is erected at half the expence, and even less. But now since iron materials are introduced in place of stone, there is room for experiments with regard to neatness and extent of span.

We shall here suppose the carpenter exhibits this plan. Let AB be a span of 60 feet, (fig. 11.) the arch a semicircle, the absolute strength of oak a plank 12 inches by one is 189163 lb. Let the arch be composed of pieces 5 feet long, 12 inches deep, and 2 inches broad; a second arch joining to this, of the same depth and breadth in close contact, but the joints of the one to the middle of the other, like brick-building, or as the carpenters express it breaking-joint. The absolute strength of this arch is, before the two trusses are joined, more than 84 ton, as may be collected from the calculations above, which is more than 3 times what can ever come upon it. The beauty of this arch would be hurt by placing struts below to stiffen it, for which there is not the smallest occasion: for it can be stiffened to better advantage above the arch. But this is not practicable in center-frames. Let the road-way be CDEF, resting upon the perpendicular support 1, 2, 3, &c. As the carriage acts upon these in the oblique direction, transepts from the arch in a radial direction, give them the advantage of equal pressure upon the arch. Each of these perpendiculars is mortised into short pieces, that will form into an arch, the pieces all abutting one upon another, and forming a fillet over the arch, and projecting so far, that the faces of an architrave of any order may be formed along the face of the arch, which adds both to its strength and beauty. Thus there is formed a rib, 12 inches deep and 4 thick, with its fillet over it 4 inches deep and 6 inches broad, to cover the faces of the architrave. Suppose the arch 44 feet wide, 7 of these ribs may give a strength not inferior to the strength of stone or any metal; but it will be said, it will not be so durable. It is well known how long wood lasts in the roofs, and joists of flooring, and even when it forms a part of the wall of a house built of brick. The interstices between these perpendicular bearings of the wood may be built up with brick; even brick on edge, or brick thick will render its preservation equal to what it is in a house, and will preserve it from the bad effects of wet and dry; and the lower part of the ribs covered with a thin lining. A door being left in the side to observe at different times any failure in the wood, it may be repaired without interrupting the passage by the bridge. It ought to be so covered above, that water may be prevented from going through to the injury of the bridge. It has been formerly mentioned, in speak-

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ing of the proportional strength of oak and fir, and by the calculation it appeared, that fir plank $13\frac{1}{2}$ inches is equal in strength to oak of 12 inches. And thus a framing of wood does not much exceed the expence of centering either a stone or iron bridge; and is not inferior even in elegance.

The span here proposed is only 60 feet. But an arch of 600 feet may be required, which must have a centering to support the weight and preserve the figure; the size of that center frame can be made of strength equal, and even to exceed the weight it has to support. It can be rendered stiff by the method proposed for the 60 feet arch. This, therefore, will be a bridge that will support any weight that can be laid upon it, and may be of any figure, elliptical, or at the pleasure of the architect, any other curve which may be required. It may be framed in a similar manner to those formed of iron, but it is natural to suppose that one arch over the other will be equally strong and more easily preserved from the weather, constructed in the way described above.

In the simple wooden bridges not curved, it is only necessary to refer to fig. 7. where the struts E *c*, *f*, *h g*, will be a support for planks, that will form a straight bridge, joining so many ribs as are necessary for the bridge according to its breadth.

The joints may be secured from opening by dovetailed pieces being inserted across the joints on the inside of the rib; the abutments prevent the ends of the arch from flying out. The pressure above coming upon it obliquely, may be said to tend to make it rise at the crown, especially when of a great span. In the center-frame, the only manner of preventing this is by struts and tie-beams judiciously applied. Here the rise may be prevented more effectually without hurting the ornamental part of the arch. In the abutment, which must be of mason-work, let a beam be built into the wall, the ends at G and K projecting 1 foot, corresponding to each rib, the road-way formed by the beam DE: let a tie-beam GD, KE, join these in the manner the carpenter knows to be the most secure: from this tie-beam, let the radial struts be mortised into the fillets at G, K, formerly described, instead of the perpendiculars there named, and perpendiculars joining the road-way CPEF, and resting on the tie-beam GD, KE, supported by the radial struts 4, 5, 6, as in the figure. Thus the crown of the arch cannot rise without lifting up the whole body of the abutment at each end, and it cannot sink till the weight laid upon it is sufficient to crush the materials of which the arch is composed. In this manner a neat and elegant arch is procured, that may at a small comparative expence be kept up for centuries. Here is then a choice of three species of arches, that may vie with each other in point of strength. With the last none may compare in point of elegance, and in duration perhaps not inferior to the iron bridge.

CENTER *of Gravity*, in *Mechanics*, that point about which all the parts of a body do in any situation exactly balance each other.

CENTER *of Motion*, that point which remains at rest, while all the other parts of a body move about it.

CENTER *of a Sphere*, a point in the middle, from which all lines drawn to the surface are equal.

Hermes Trismegistus defines God an intellectual sphere, whose center is everywhere, and circumference nowhere.

CENTESIMA USURA, that wherein the interest in a hundred months became equal to the principal, *i. e.* where the money is laid out at one per cent. per month; answering to what in our style would be called 12 per cent., for the Romans reckoned their interest not by the year, but by the month.

CENTESIMATION, a milder kind of military punishment in cases of desertion, mutiny, and the like, when only every hundredth man is executed.

CENTILOQUIUM, denotes a collection of 100 sentences, opinions, or sayings.

The centiloquium of Hermes contains 100 aphorisms, or astrological sentences, supposed to have been written by some Arab, falsely fathered on Hermes Trismegistus. It is only extant in Latin, in which it has several times been printed.—The centiloquium of Ptolemy is a famous astrological piece, frequently confounded with the former, consisting likewise of 100 sentences or doctrines, divided into short aphorisms, entitled also in Greek καρπος, as being the fruit or result of the former writings of that celebrated astronomer, viz. his *quadripartitum* and *almagestum;* or rather, by reason that herein is shown the use of astrological calculations.

CENTIPES, in *Zoology*. See SCOLOPENDRA.

CENTIPED WORM, a term used for such worms as have a great many feet, though the number does not amount to 100, as the term seems to import.—M. Malouet relates the history of a man, who, for three years, had a violent pain in the lower part of the forehead near the root of the nose; at length he felt an itching, and afterwards something moving within his nostril, which he brought away with his finger; it was a worm of the centiped kind, an inch and a half long, which run swiftly. It lived five or six days among tobacco. The patient was free of his pain ever after. Mr Littre mentioned a like case in 1708, of a larger centiped voided at the nose, after it had thrown the woman, in whose frontal sinus it was, into convulsions, and had almost deprived her of her reason.

CENTLIVRE, SUSANNA, a celebrated comic writer, was the daughter of Mr Freeman of Holbeach, in Lincolnshire; and had such an early turn for poetry, that it is said she wrote a song before she was seven years old. Before she was twelve years of age, she could not only read Moliere in French, but enter into the spirit of all the characters. Her father dying, left her to the care of a step-mother, whose treatment not being agreeable to her, she determined, though almost destitute of money and every other necessary, to go up to London to seek a better fortune than what she had hitherto experienced. As she was proceeding on her journey on foot, she was met by a young gentleman from the university of Cambridge, the afterwards well known Anthony Hammond, Esq. who was so extremely struck with her youth and beauty, that he fell instantly in love with her; and inquiring into the particulars of her story, soon prevailed upon her unexperienced innocence to seize on the protection he offered her, and go with him to Cambridge. After

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Fig. 1.

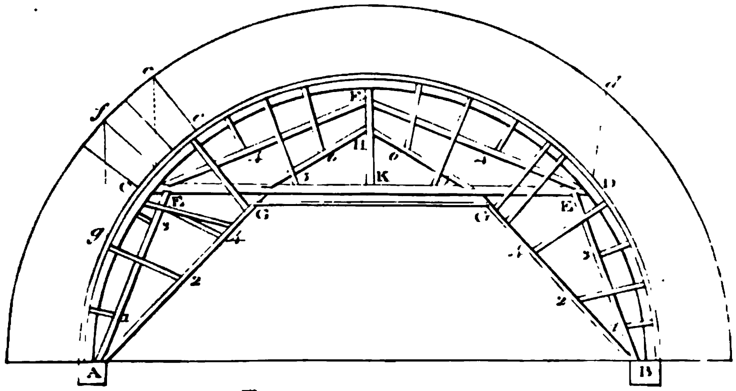

Fig. 2.

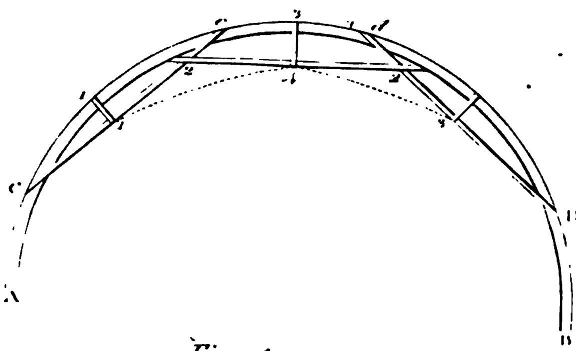

Fig. 3.

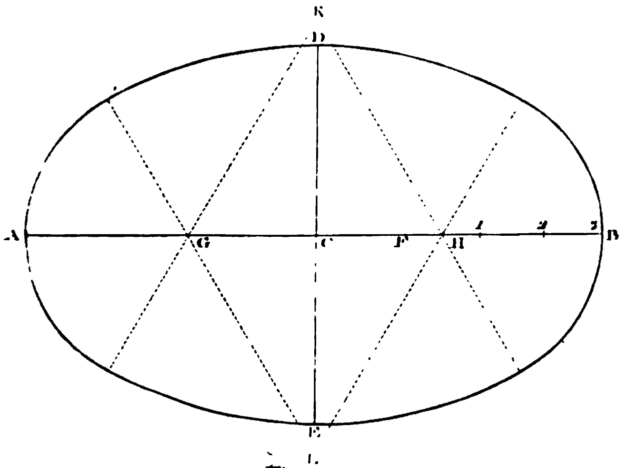

Fig. 4.

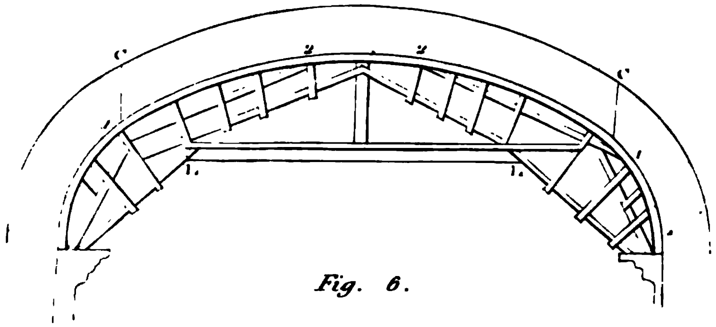

Fig. 5.

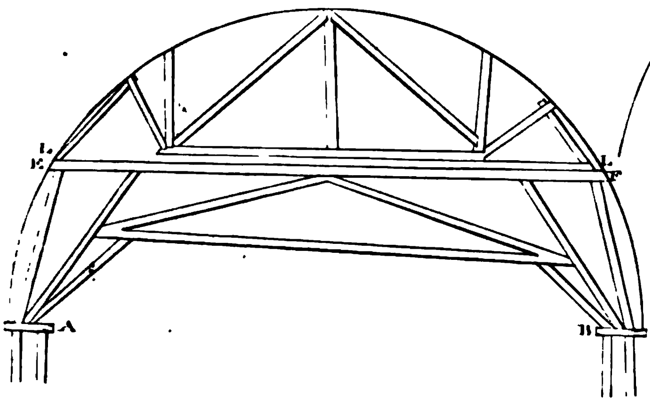

Fig. 6.

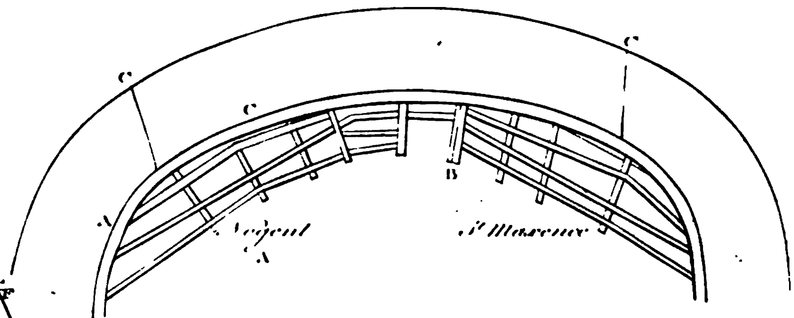

Fig. 7.

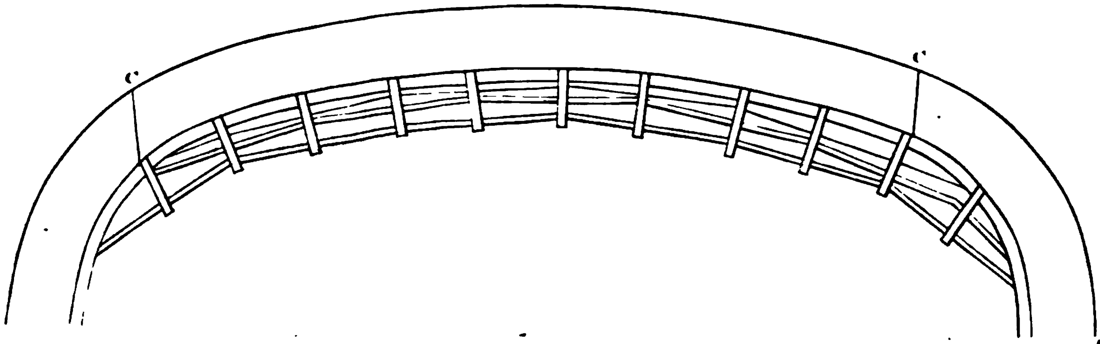

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Fig. 8.

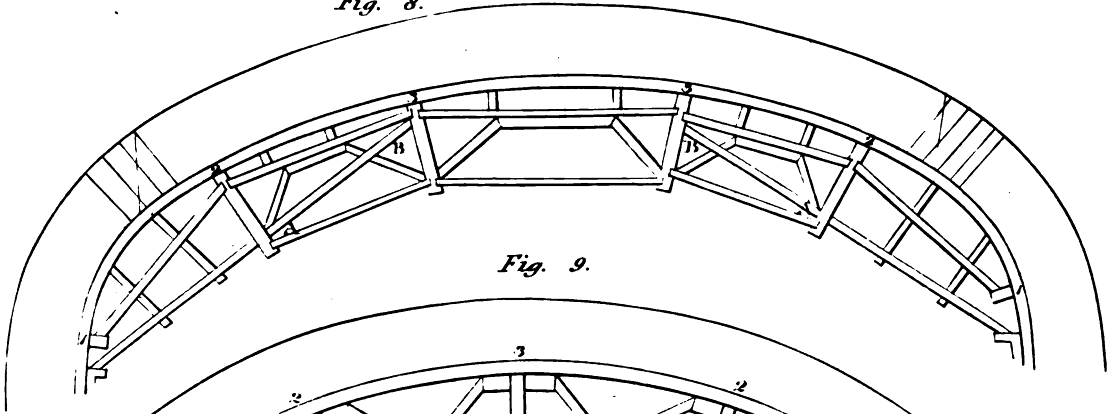


Fig. 9.

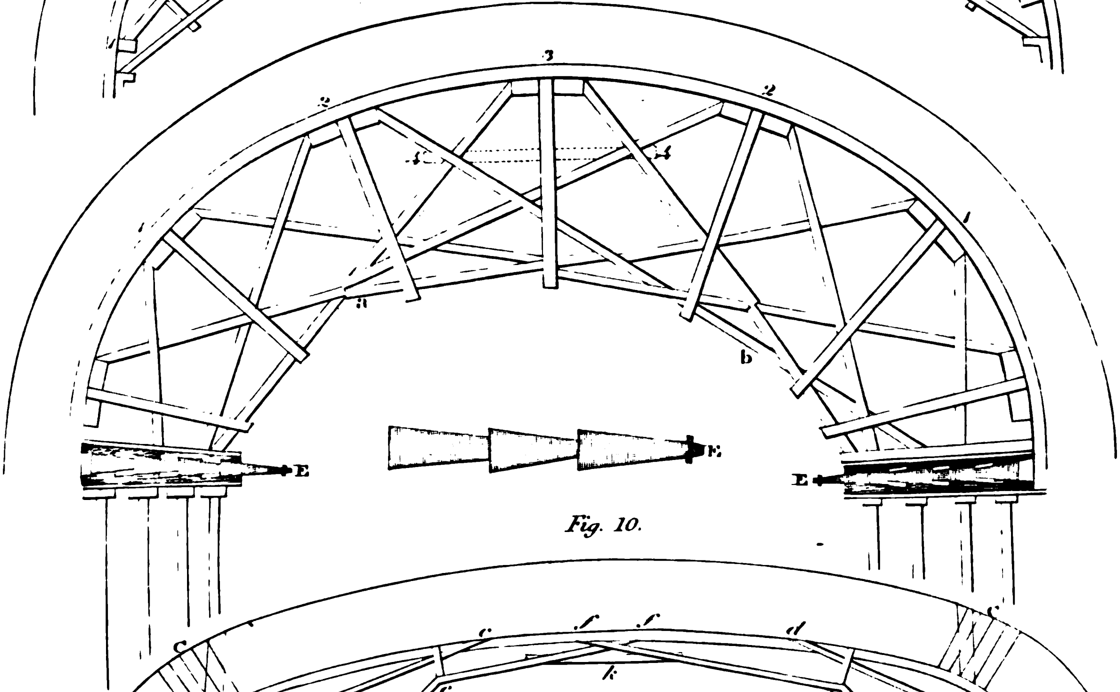


Fig. 10.

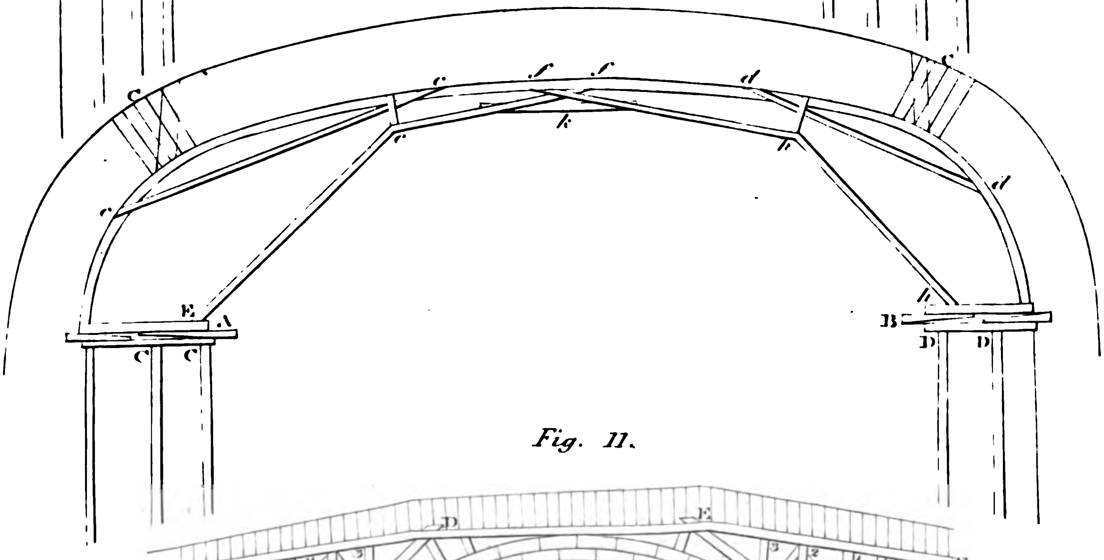
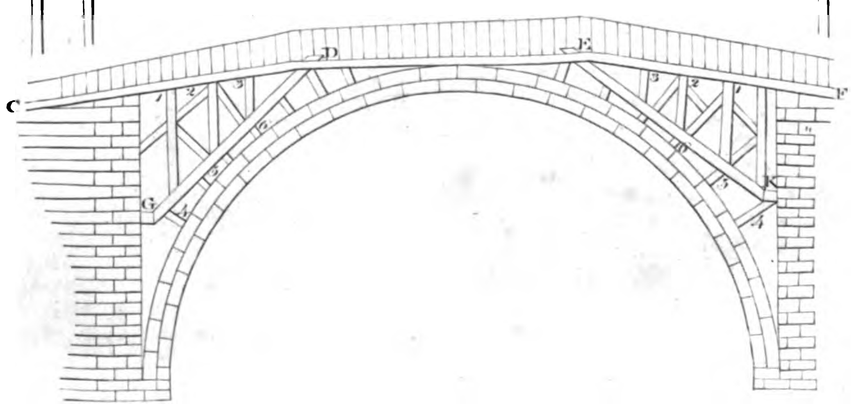


Fig. 11.



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some months cohabitation, he persuaded her to come to London, where, in a short time, she was married to a nephew of Sir Stephen Fox. But that gentleman not living with her above a twelvemonth, her wit and beauty soon procured her a second husband, whose name was Carrol, and who was an officer in the army; but he having the misfortune to be killed in a duel about a year and a half after their marriage, she became a second time a widow. For the sake of support she now applied to her pen, and became a votary of the muses: and it is under this name of Carrol that some of her earlier pieces were published. Her first attempt was in tragedy, in a play called the *Perjured Husband;* yet natural vivacity leading her afterwards to comedy, we find but one more attempt in the buskin, among 18 dramatic pieces which she afterwards wrote.

In 1706, she wounded the heart of one Mr Joseph Centlivre, yeoman of the mouth, or, in other words, principal cook to her majesty, who married her; and, after passing several years happily together, she died at his house in Spring Garden, Charing-cross, in December 1723.

This lady for many years enjoyed the intimacy and esteem of the most eminent wits of the time, viz. Sir Richard Steele, Mr Rowe, Budgell, Farquhar, Dr Sewell, &c.; and very few authors received more tokens of esteem and patronage from the great. With regard to her merit as a writer, it must be allowed that her plays do not abound with wit, and that the language of them is sometimes even poor, enervate, incorrect, puerile; but then her plots are busy and well conducted, and her characters in general natural and well marked.

CENTNER, or Docimastic Hundred, in *Metallurgy* and *Assaying*, is a weight divisible, first into a hundred, and thence into a greater number of other smaller parts; but though the word is the same both with the assayers and metallurgists, yet it is to be understood as expressing a very different quantity in their different acceptation of it. The weights of the metallurgists are easily understood, as being of the common proportion; but those of the assayers are a thousand times smaller than these, as the portions of metals or ores examined by the assayers are usually very small.

The metallurgists, who extract metals out of their ores, use a weight divided into a hundred equal parts, each part a pound; the whole they call a *centner* or *hundred weight;* the pound is divided into thirty-two parts, or half ounces; and the half ounce into two quarters of ounces, and these each into two drachms.

These divisions and denominations of the metallurgists are easilly understood; but the same words, though they are equally used by assayers, with them express very different quantities; for as the centner of the metallurgists contains a hundred pounds, the centner of the assayers is really no more than one dram, to which the other parts are proportioned.

As the assayers weights are divided into such an extreme degree of minuteness, and are so very different from all the common weights, the assayers usually make them themselves in the following manner, out of small silver, or fine solder plates, of such a size, that the mark of their weight, according to the division of the dram, which is the *docimastic* or essaying *centner*, may be put upon them. They first take for a basis one weight, being about two-thirds of a common dram: this they mark (64 lb.) Then having at hand some granulated lead, washed clean, well dried, and sifted very fine, they put as much of it into one of the small dishes of a fine balance as will equipoise the (64 lb.) as it is called, just mentioned: then dividing the granulated lead into very nice halves, in the two scales, after taking out the first silver weight, they obtain a perfect equilibrium between the two scales; they then pour the granulated lead out of one dish of the scales, and instead of it put in another silver weight, which they make exactly equiponderant with the lead in the other scale, and mark it (32 lb.). If this second weight, when first put into the scale, exceed by much the weight of the lead, they take a little from it by a very fine file; but when it comes very near, they use only a whetstone to wear off an extremely small portion at a time. When it is brought to be perfectly even and equal to the lead, they change the scales to see that no error has been committed, and then go on in the same manner till they have made all the divisions, and all the small weights. Then to have an entire centner or hundred weight, they add to the (64 lb.) as they call it, a 32 lb. and a 4 lb. and weighing against them one small weight, they make it equal to them, and mark it (100.) This is the docimastical or essaying centner, and is really one dram.

CENTO, in poetry, a work wholly composed of verses or passages promiscuously taken from other authors, only disposed in a new form and order.—Proba Falconia has written the life of Jesus Christ in centos taken from Virgil. Alexander Ross has done the like in his Christiados, and Stephen de Pleure the same.

CENTONARII, in antiquity, certain of the Roman army, who provided different sorts of stuff called *centones*, made use of to quench the fire which the enemy's engines threw into the camp.

These centonarii kept with the carpenters and other officers of artillery.

CENTRAL forces, the powers which cause a moving body to tend towards, or recede from, the centre of motion. See Mechanics.

Central Rule, a rule discovered by Mr Thomas Baker, whereby to find the centre of a circle designed to cut the parabola in as many points as an equation to be constructed hath real roots. Its principal use is in the construction of equations, and he hath applied it with good success as far as biquadratics.

The central rule is chiefly founded on this property of the parabola, that, if a line be inscribed in that curve perpendicular to any diameter, a rectangle formed of the segments of the inscript is equal to the rectangle of the intercepted diameter and parameter of the axis.

The central rule has the advantage over Carter and De Latere's methods of constructing equations, in that both these are subject to the trouble of preparing the equation by taking away the second term.

CENTRIFUGAL force, that force by which all bodies that move round any other body in a curve endeavour to fly off from the axis of their motion in a tangent

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Centrifugal Force, Centrifugal Machine.

tangent to the periphery of the curve, and that in every part of it. See MECHANICS.

CENTRIFUGAL *Machine*, a very curious machine, invented by Mr Erskine, for raising water by means of a centrifugal force combined with the pressure of the atmosphere.

It consists of a large tube of copper, &c. in the form of a cross, which is placed perpendicular in the water, and rests at the bottom on a pivot. At the upper part of the tube is a horizontal cog-wheel, which touches the cogs of another in a vertical position; so that by the help of a double winch, the whole machine is moved round with very great velocity.

Near the bottom of the perpendicular part of the tube is a valve opening upwards; and near the two extremities, but on the contrary sides of the arms, or cross part of the tube, are two other valves opening outwards. These two valves are, by the assistance of springs, kept shut till the machine is put in motion, when the centrifugal velocity of the water forces them open, and discharges itself into a cistern or reservoir placed there for that purpose.

On the upper part of the arms are two holes, which are closed by pieces screwed into the metal of the tube. Before the machine can work, these holes must be opened, and water poured in through them, till the whole tube be full: by this means all the air will be forced out of the machine, and the water supported in the tube by means of the valve at the bottom.

The tube being thus filled with water, and the holes closed by the screw caps, it is turned round by means of the winch, when the water in the arms of the tube acquires a centrifugal force, opens the valves near the extremities of the arms, and flies out with a velocity nearly equal to that of the extremities of the said arms.

The above description will be very easily understood by the figure we have added on Plate CXXXVII. which is a perspective view of the centrifugal machine, erected on board of a ship. ABC is the copper tube. D, a horizontal cog-wheel, furnished with twelve cogs. E, a vertical cog-wheel, furnished with thirty-six cogs. F, F, the double winch. *a*, the valve near the bottom of the tube. *b*, *b*, the two pivots on which the machine turns. *c*, one of the valves in the cross piece; the other at *d*, cannot be seen in this figure, being on the other side of the tube. *e*, *e*, the two holes through which the water is poured into the machine. GH, the cistern or reservoir. I, I, part of the ship's deck. The distance between the two valves *c*, *d*, is six feet. The diameter of these valves is about three inches: and that of the perpendicular tube about seven inches.

If we suppose the men who work the machine can turn the winch round in three seconds, the machine will move round its axis in one second; and consequently each extremity of the arms will move with a velocity of 18.8 feet in a second. Therefore a column of water of three inches diameter will issue through each of the valves with a velocity of 18.8 feet in a second: but the area of the aperture of each of the valves is 7.14 inches; which being multiplied by the velocity in inches = 225.6, gives 1610.784 cubic inches, the quantity of water discharged through one of the apertures in one second; so that the whole quantity discharged in that space of time through both the apertures is =3221.568 inches; or 193294.08 cubic inches in one minute. But 60812 cubic inches make a tun beer-measure; consequently, if we suppose the centrifugal machine revolves round its axis in one second, it will raise nearly 3 tuns 44 gallons in one minute: but this velocity is certainly too great, at least to be held for any considerable time; so that, when this and other deficiencies in the machine are allowed for, two tuns is nearly the quantity that can be raised by it in one minute.

Centrifugal Machine ‖ Centurion.

It will perhaps be unnecessary to observe, that as the water is forced up the perpendicular tube by the pressure of the atmosphere, this machine cannot raise water above 32 feet high.

An attempt was made to substitute this machine in place of the pumps commonly used on shipboard; but the labour of working was found to be so great as to render the machine inferior to the chain-pump. A considerable improvement, we apprehend, would be, to load with a weight of lead the ends of the tubes through which the water issues, which would make the machine turn with a great deal more ease, as the centrifugal force of the lead would in some measure act the part of a fly.

CENTRIPETAL FORCE, that force by which a body is everywhere impelled, or any how tends, towards some point as a centre. See MECHANICS.

CENTRISCUS, in *Ichthyology*, a genus of fishes belonging to the order of amphibia nantes. See ICHTHYOLOGY *Index*.

CENTRONIA, in *Natural History*, a name by which the echini marini have been distinguished. Dr Hill makes them a distinct class of animals, living under the defence of shelly coverings formed of one piece, and furnished with a vast number of spines moveable at the creature's pleasure.

CENTUMCELLÆ, in *Ancient Geography*, Trajan's villa in Tuscany, on the coast, three miles from Algæ; with an excellent port, called *Trajanus Portus*, (Ptolemy); and a factitious island at the mouth of the port, made with a huge block of stone, on which two turrets rose, with two entrances into the bason or harbour, (Rutilius). Now *Civita Vecchia*. E. Long. 12. 30. N. Lat. 42°.

CENTUMVIRI, in Roman antiquity, judges appointed to decide common causes among the people: They were chosen three out of each tribe; and though five more than a hundred, were nevertheless called *centumviri*, from the round number *centum* a hundred.

CENTUNCULUS. See BOTANY *Index*.

CENTURION, among the Romans, an officer in the infantry, who commanded a century, or a hundred men.

In order to have a proper notion of the centurions, it must be remembered, that every one of the thirty manipuli* in a legion was divided into two *ordines*, or ranks; and consequently the three bodies of the hastati, principes, and triarii, into 20 orders a piece, as into 10 manipuli. Now, every manipulus was allowed two centurions, or captains, one to each order or century: and, to determine the point of priority between them, they were created at two different elections. The 30 who were made first always took the precedency of their fellows; and therefore commanded the right-hand orders, as the others did the left. The triarii, or

* See *Manipulus*.

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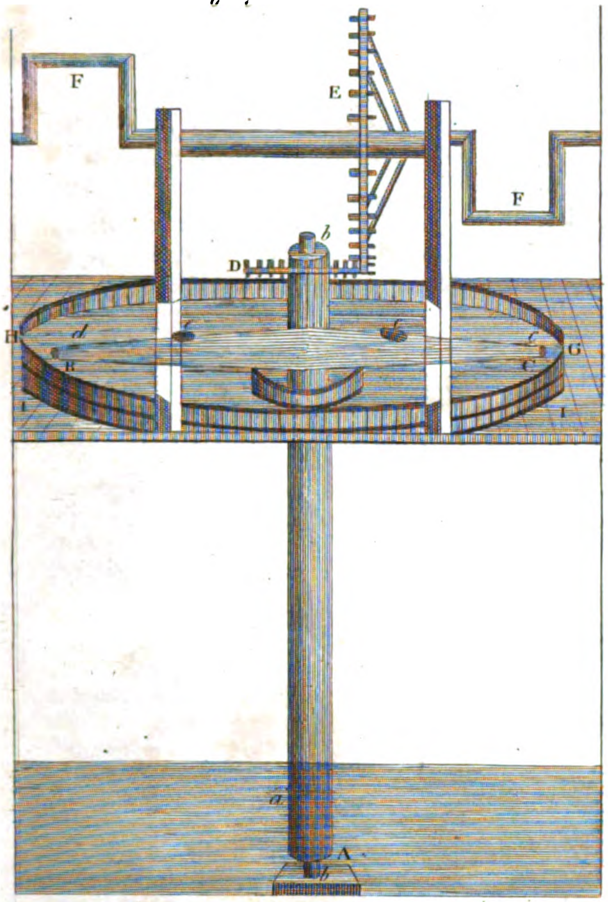
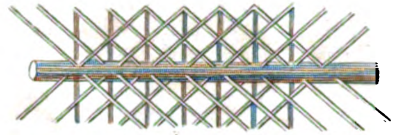
PLATE CXXXVII.

Centrifugal Machine

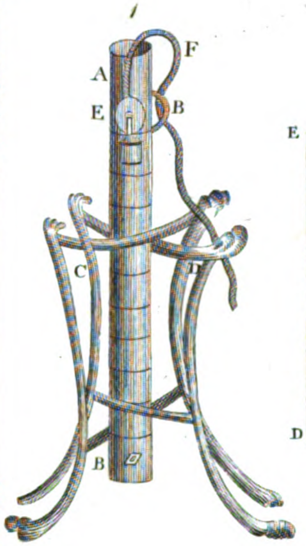


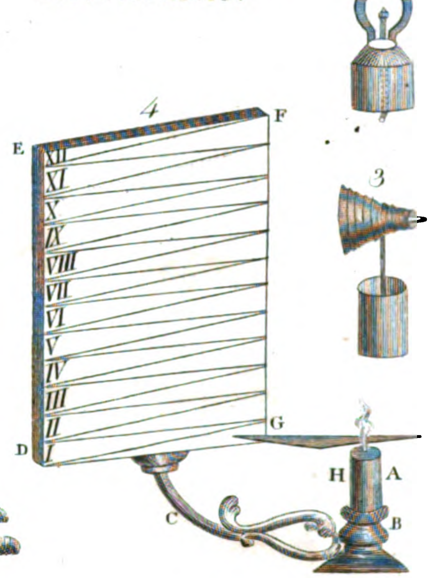
Chain wales

Cheval de Frise

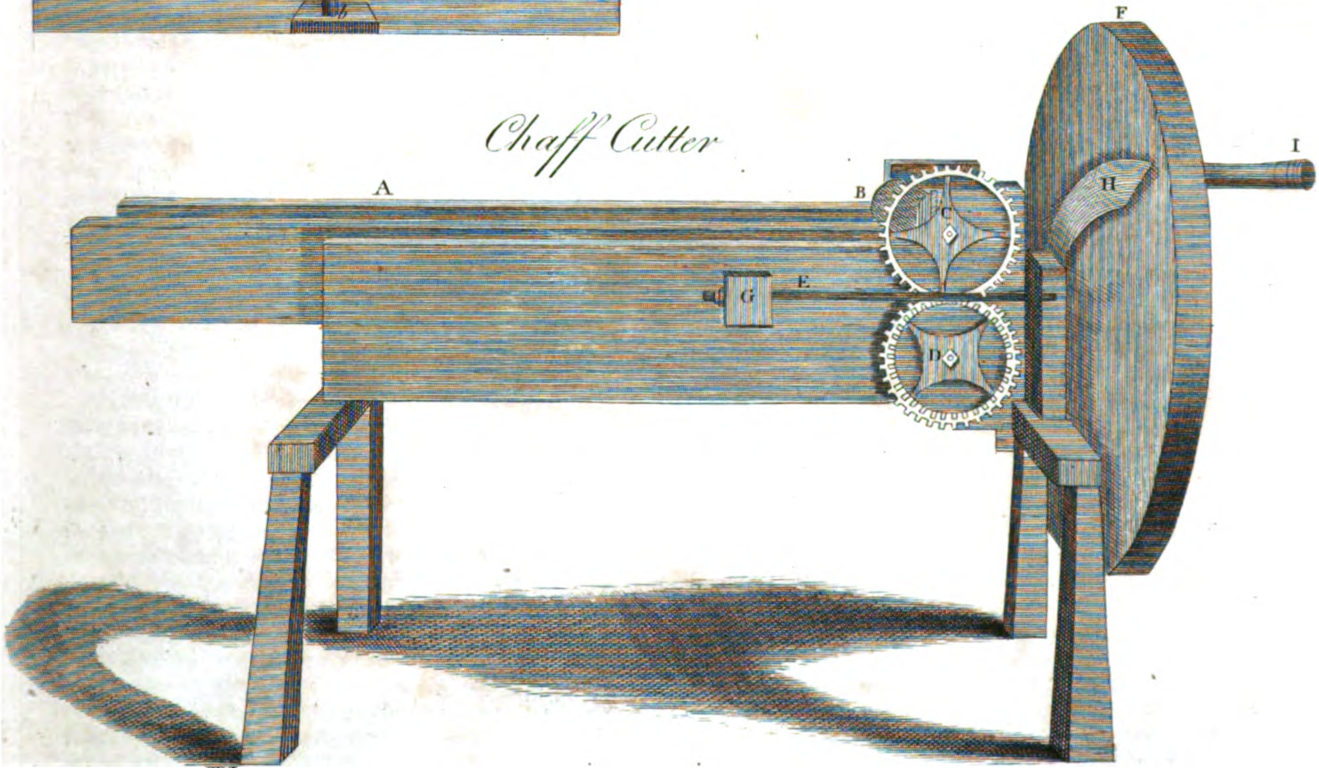


Chronometer





Chaff Cutter



W. Archibald sc.

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or *pilani*, so called from their weapon the *pilum*, being esteemed the most honourable, had their centurions elected first, next to them the principes, and afterwards the hastati; whence they were called *primus et secundus pilus*, *primus et secundus princeps*, *primus et secundus hastatus*; and so on. Here it may be observed, that *primi ordines* is sometimes used in historians for the centurions of these orders; and the centurions are sometimes styled *principes ordinum*, and *principes centurionum*. We may take notice too what a large field there lay for promotion: first through all the orders of the hastati; then quite through the principes; and afterwards from the last order of the triarii to the primipilus, the most honourable of the centurions, and who deserves to be particularly described. This officer, besides his title of primipilus, went under the several titles of *dux legionis*, *præfectus legionis*, *primus centurionum*, and *primus centurio*: and was the first centurion of the triarii in every legion. He presided over all the other centurions, and generally gave the word of command by order of the tribunes. Besides this, he had the care of the eagle or chief standard of the legion: hence, *aquilæ præesse* is to bear the dignity of primipilus; and hence *aquila* is taken by Pliny for the said office. Nor was this station only honourable, but very profitable too: for he had a special stipend allowed him, probably as much as a knight's estate; and, when he left that charge, was reputed equal to the members of the equestrian order, bearing the title of *primipilarius*, in the same manner as those who had discharged the greatest civil offices were styled ever after, *consulares*, *censorii*, *&c.*

CENTURIPÆ, CENTORIPA, or CENTURIPE, in *Ancient Geography*, a town in the south-west of the territory of Etna, on the river Cyamasorus: Now *Centorbi* or *Centurippi*. It was a democratical city, which, like Syracuse, received its liberty from Timoleon. Its inhabitants cultivated the fine arts, particularly sculpture and engraving. In digging for the remains of antiquities, cameos are nowhere found in such abundance as at Centurippi and its environs. The situation of the place is romantic: it is built on the summit of a vast group of rocks, which was probably chosen as the most difficult of access, and consequently the properest in times of civil commotion. The remains still existing of its ancient bridges are a proof of its having been a considerable city. Cicero speaks of it as such. It was taken by the Romans, plundered and oppressed by Verres, destroyed by Pompey, and restored by Octavius, who made it the residence of a Roman colony.

CENTURY, in a general sense, any thing divided into, or consisting of, a hundred parts.

The marquis of Worcester published a *Century* of inventions, (for a specimen of which, see ACOUSTICS,) and Dr Hooke has given a *decimate* of inventions, as part of a *Century*, of which he affirmed himself master. It is remarkable, that both in the century of the former, and the decimate of the latter, we find the principle on which Savary's fire or steam engine is founded. See *STEAM-Engine*.

CENTURY, in antiquity. The Roman people, when they were assembled for the electing of magistrates, enacting of laws, or deliberating upon any public affair, were always divided into centuries, and voted by centuries, in order that their votes might be the more easily collected, whence these assemblies were called *comitia centuriata*. The Roman cohorts were also divided into centuries. See CENTURION and COHORT.

CENTURY, in *Chronology*, the space of 100 years. This method of computing by centuries is generally observed in church history, commencing from the time of our Saviour's incarnation: in which sense we say the first century, the second century, &c.

CENTURIES of Magdeburg, a famous ecclesiastical history, ranged into 13 centuries, carried down to the year 1298, compiled by several hundred Protestants of Magdeburg, the chief of whom was Flavius Illyricus.

CENTUSSIS, in Roman antiquity, a coin containing 100 asses.

CENTZONTLI, in *Ornithology*, the Mexican name of the *Turdus polyglottus*. See TURDUS, ORNITHOLOGY *Index*.

CEODES, in *Botany*, a genus of the diœcia order, belonging to the polygamia class of plants. There is no calyx; the corolla is monopetalous, with a short turbinated tube; the stamina are ten subulated filaments; the antheræ roundish.

CEORLES, the name of one of the classes or orders into which the people were distinguished among the Anglo-Saxons. The ceorles, who were persons completely free, and descended from a long race of freemen, constituted a middle class between the labourers and mechanics (who were generally slaves, or descended from slaves), on the one hand, and the nobility on the other. They might go where they pleased, and pursue any way of life that was most agreeable to their humour: but so many of them applied to agriculture, and farming the lands of the nobility, that a ceorl was the most common name for a husbandman or farmer in the Anglo-Saxon times. These ceorls, however, seem in general to have been a kind of gentlemen farmers; and if any one of them prospered so well as to acquire the property of five hydes of land, upon which he had a church, a kitchen, a bell-house, and great gate, and obtained a seat and office in the king's court, he was esteemed a nobleman or thane. If a ceorl applied to learning, and attained to priest's orders, he was also considered as a thane; his weregild, or price of his life, was the same, and his testimony had the same weight in a court of justice. When he applied to trade, and made three voyages beyond sea, in a ship of his own, and with a cargo belonging to himself, he was also advanced to the dignity of a thane. But if a ceorl had a greater propensity to arms than to learning, trade, or agriculture, he then became the fithconman, or military retainer, to some potent and warlike earl, and was called the *huscarle* of such an earl. If one of these huscarles acquitted himself so well as to obtain from his patron either five hydes of land, or a gilt sword, helmet, and breastplate, as a reward of his valour, he was likewise considered as a thane. Thus the temple of honour stood open to these ceorls, whether they applied themselves to agriculture, commerce, letters, or arms, which were then the only professions esteemed worthy of a freeman.

CEOS, CEA, CIA, or COS, in *Ancient Geography*, one of the Cyclades, lies opposite to the promontory of Achaia called *Sunium*, and is 50 miles in compass. This island is commended by the ancients for its fertility and the richness of its pastures. The first silk stuffs, if

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Pliny and Solinus are to be credited, were wrought here. Ceos was particularly famous for the excellent figs it produced. It was first peopled by Aristæus, the son of Apollo and Cyrene, who being grieved for the death of his son Actæon, retired from Thebes, at the persuasion of his mother, and went over with some Thebans to Ceos, at that time uninhabited. Diodorus Siculus tells us, that he retired to the island of Cos; but the ancients, as Servius observes, called both these islands by the name of Cos. Be that as it will, the island of Ceos became so populous, that a law prevailed there, commanding all persons upwards of sixty to be poisoned, that others might be able to subsist; so that none above sixty were to be seen in the island, being obliged, after they arrived at that age, either to submit to the law, or abandon the country, together with their effects. Ceos had, in former times, four famous cities, viz. Julis, Carthæa, Coressus, and Præessa. The two latter were, according to Pliny, swallowed up by an earthquake. The other two flourished in Strabo's time. Carthæa stood on a rising ground at the end of a valley, about three miles from the sea. The situation of it agrees with that of the present town of Zea, which gives name to the whole island. The ruins both of Carthæa and Julis are still remaining; those of the latter take up the whole mountain, and are called by the modern inhabitants Polis, that is, *the city*. Near this place are the ruins of a stately temple, with many pieces of broken pillars, and statues of most exquisite workmanship. The walls of the city were of marble, and some pieces are still remaining above 12 feet in length. Julis was, according to Strabo, the birthplace of Simonides, Bacchylides, Erasistratus, and Aristo. The Oxford marbles tell us that Simonides the son of Leoprepis invented a sort of artificial memory, the principles of which he explained at Athens; and add, that he was descended of another Simonides, who was a poet no less renowned than himself. One of these two poets invented those melancholy verses which were sung at funerals, and are called by the Latins *næniæ*. Strabo says, that the Athenians, having besieged the city of Julis, raised the siege, upon advice that the inhabitants had resolved to murder all the children under a certain age, that useful persons might not be employed in looking after them. Ceos was, with the other Greek islands, subdued by the Romans, and bestowed upon the Athenians by Mark Antony the triumvir, together with Ægina, Tinos, and some other adjoining islands, which were all reduced to one Roman province by Vespasian. The island is now called *Zea*.

CEPA, the Onion. See Allium, Botany *Index*.

CEPHALANTHUS, Button-Wood. See Botany *Index*.

CEPHALIC, in a general meaning, signifies any thing belonging to the head.

Cephalic Medicines, are remedies for disorders of the head. Cordials are comprehended herein, as are also whatever promotes a free circulation of the blood through the brain.

Except when the disorder arises from excess of heat, or an inflammatory disposition in the head, moist topicals should never be used, but always dry ones.

To rub the head after it is shaved proves an instantaneous cure for a cephalalgia, a stuffing of the head, and weakness of the eyes, arising from a weak and relaxed state of the fibres. And as by every fresh evacuation of the humours their quantity is not only lessened, but also their recrementitious parts derived thither, the more frequently the head is shaved, the larger quantity of humour is discharged; so that the frequent shaving of the head and beard is likewise a perpetual blister; and in as much as it is useful, it is a cephalic.

Cephalic Vein, in *Anatomy*, creeps along the arm between the skin and the muscles, and divides it into two branches; the external goes down to the wrist, where it joins the basilica, and turns up to the back of the hand; the internal branch, together with a small one of the basilica, makes the mediana.

The ancients used to open this vein for disorders of the head, for which reason it bears this name; but a better acquaintance with the circulation of the blood informs us that there is no foundation for such a notion.

CEPHALENIA, or Cephallenia, the largest of the islands constituting the Ionian republic. It was known in Homer's time by the names of Samos and Epirus Melæna, is about forty miles in length, twenty in breadth, and a hundred and thirty in compass. It had anciently four cities, one of which bore the name of the island. Strabo tells us, that in his time there were only two cities remaining; but Pliny speaks of three; adding, that the ruins of Same, which had been destroyed by the Romans, were still in being. Same was the metropolis of the island, and is supposed to have stood in the place which the Italians call Porto Guiscardo. It contains now three small towns, 130 villages, and 60,000 inhabitants. This island was subdued by the Thebans, under the conduct of Amphitryo, who is said to have killed Pterelas, who then reigned here. After it had been long in subjection to the Thebans, it fell under the power of the Macedonians, and was taken from them by the Ætolians, who held it till it was reduced by M. Fulvius Nobilior, who having gained the metropolis after a four months siege, sold all the citizens for slaves, adding the whole island to the dominions of the republic. It was subject to the Venetians from the year 1449 till the peace of Campo Formio in 1797. It was taken from the French in 1799, and formed into an independent commonwealth. It was again brought under the dominion of the French in 1807, but was taken by the British in 1809, and continues under their protection. See Ionian Isles, Supplement.

CEPHALONIA, the capital of the island of the same name, situated in the Mediterranean, near the coast of Epirus, and subject to the Venetians. E. Long. 21. N. Lat. 38. 30.

CEPHEUS, in fabulous history, a king of Arcadia, on whose head Minerva fastening one of Medusa's hairs, he was rendered invincible.

Cepheus, in *Astronomy*, a constellation of the northern hemisphere. See Astronomy *Index*.

CERAM, an island in the Indian ocean, between the Molucca islands on the north, and those of Amboyna and Banda on the south, lying between E. Long. 126. and 129. in S. Lat. 3. It is about 150 miles long, and 60 broad; and here the Dutch have

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have a fortress, which keeps the natives in subjection.

CERAMBYX, in *Zoology*, a genus of insects, of the beetle kind, belonging to the order of insecta coleoptera. See ENTOMOLOGY *Index*.

CERASTES, in *Zoology*, the trivial name of a species of ANGUIS and COLUBER. See OPHIOLOGY *Index*.

CERASTIUM, MOUSE-EAR. See BOTANY *Index*.

CERASUS. See PRUNUS, BOTANY *Index*.

CERATE, in *Pharmacy*, a thickish kind of ointment applied to ulcerations, excoriations, &c. See PHARMACY *Index*.

CERATION, the name given by the ancients to the small seeds of ceratonia, used by the Arabian physicians as a weight to adjust the doses of medicines; as the grain weight with us took its rise from a grain of barley.

CERATION, or *Ceratium*, was also a silver coin, equal to one-third of an obolus.

CERATOCARPUS. See BOTANY *Index*.

CERATONIA, the CAROB TREE, or *St John's bread*. See BOTANY *Index*. The pods of this plant are called *St John's bread*, from an ill-founded assertion of some writers on Scripture, that these were the locusts which St John ate with his honey in the wilderness.

CERATOPHYLLUM. See BOTANY *Index*.

CERAUNIA, CERAUNIAS, or CERAUNIUS *Lapis*, in *Natural History*, a sort of flinty stone, of no certain colour, but of a pyramidical or wedge-like figure: popularly supposed to fall from the clouds in the time of thunder-storms, and to be possessed of divers notable virtues, as promoting sleep, preserving from lightning, &c. The word is from the Greek κεραυνος, *thunderbolt*. The ceraunia is the same with what is otherwise called the thunder-stone, or thunder-bolt; and also sometimes *sagitta* or arrow's head, on account of its shape. The cerauniæ are frequently confounded with the ombriæ and brontiæ, as being all supposed to have the same origin. The generality of naturalists take the ceraunia for a native stone, formed among the pyrites, of a saline, concrete, mineral juice. Mercatus and Dr Woodward assert it to be artificial, and to have been fashioned thus by tools. The ceraunia, according to these authors, are the heads of the ancient weapons of war, in use before the invention of iron; which, upon the introduction of that metal, growing into disuse, were dispersed in the fields through this and the neighbouring country. Some of them had possibly served in the early ages for axes, others for wedges, others for chissels; but the greater part for arrow-heads, darts, and lances. The ceraunia is also held by Pliny for a white or crystal-coloured gem, that attracted lightning in itself. What this was, is hard to say. Prudentius also speaks of a yellow ceraunia; by which he is supposed to mean the carbuncle or pyropus.

CERBERA. See BOTANY *Index*.

CERBERUS, in fabulous history, a dreadful three-headed mastiff, born of Typhon and Echidna, and placed to guard the gates of hell. He fawned upon those who entered, but devoured all who attempted to get back. He was, however, mastered by Hercules, who dragged him up to the earth, when, in struggling, a foam dropped from his mouth, which produced the poisonous herb called *aconite* or *wolf's bane*.

Some have supposed that Cerberus is the symbol of the earth, or of all-devouring time; and that its three mouths represent the present, past, and future. The victory obtained by Hercules over this monster denotes the conquest which this hero acquired over his passions. Dr Bryant supposes that Cerberus was the name of a place, and that it signified the temple of the Sun; deriving it from *Kir Abor*, *the place of light*. This temple was called also *Tor-Caph-El*, which was changed to τρικεφαλος; and hence Cerberus was supposed to have had three heads. It was likewise called *Tor-Keren*, *Turris Regia;* whence τρι καρηνος, from τρεις, *three*, and καρηνον, *head*.

CERCELE, in *Heraldry*. A cross cercele is a cross which, opening at the ends, turns round both ways like a ram's horn. See CROSS.

CERCIS, the JUDAS TREE. See BOTANY *Index*.

CERCOPITHECI, in *Natural History*, the name given by Mr Ray to monkeys, or the class of apes with long tails. See SIMIA, MAMMALIA *Index*.

CERDA, JOHN LEWIS DE LA, a learned Jesuit of Toledo, wrote large commentaries on Virgil, which have been much esteemed; also several other works. He died in 1643, aged 80.

CERDONIANS, ancient heretics who maintained most of the errors of Simon Magus, Saturninus, and the Manichees. They took their name from their leader *Cerdon*, a Syrian, who came to Rome in the time of Pope Hyginus, and there abjured his errors; but in appearance only; for he was afterwards convicted of persisting in them, and accordingly cast out of the church again. Cerdon asserted two principles, the one good and the other evil; this last, according to him, was the creator of the world, and the god that appeared under the old law. The first, whom he called *unknown*, was the father of Jesus Christ; who, he taught, was incarnate only in appearance, and was not born of a virgin; nor did he suffer death but in appearance. He denied the resurrection, and rejected all the books of the Old Testament, as coming from an evil principle. Marcion, his disciple, succeeded him in his errors.

CEREALIA, in antiquity, feasts of Ceres, instituted by Triptolemus, son of Celsus king of Eleusine in Attica, in gratitude for his having been instructed by Ceres, who was supposed to have been his nurse, in the art of cultivating corn and making bread.

There were two feasts of this kind at Athens; the one called *Eleusinia*, the other, *Thesmophoria*. See the article ELEUSINIA. What both agreed in, and was common to all the *cerealia*, was, that they were celebrated with a world of religion and purity; so that it was esteemed a great pollution to meddle, on those days, in conjugal matters. It was not Ceres alone that was honoured here, but also Bacchus. The victims offered were hogs, by reason of the waste they make in the products of the earth; whether there was any wine offered or not, is matter of much debate among the critics. Plautus and Macrobius seem to countenance the negative side; Cato and Virgil the positive. Macrobius says, indeed, they did not offer wine to Ceres, but *mulsum*, which was a composition of wine and honey boiled up together; that the sacrifice

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crifice made on the 21st December to that goddess and Hercules, was a pregnant sow, together with cakes and mulsum; and that this is what Virgil means by *Miti Baccho*. The *cerealia* passed from the Greeks to the Romans, who held them for eight days successively; commencing, as generally held, on the fifth of the ides of April. It was the women alone who were concerned in the celebration, all dressed in white: the men, likewise in white, were only spectators. They ate nothing till after sunset; in memory of Ceres, who in her search after her daughter took no repast but in the evening.

After the battle of Cannæ, the desolation was so great at Rome, that there were no women to celebrate the feast, by reason they were all in mourning; so that it was omitted that year.

Cerealia, in *Botany*, from *Ceres*, the goddess of corn; Linnæus's name for the larger esculent seeds of the grasses: these are rice, wheat, rye, barley, oats, millet, panic grass, Indian millet, holcus, zizania, and maize. To this head may be likewise referred darnel *(lolium)*; which, by preparation, is rendered esculent.

CEREBELLUM, the hinder part of the head. See Anatomy *Index*.

CEREBRUM, the Brain. Its structure and use are not so fully known as some other parts of the body; and different authors consider it in various manners. However, according to the observations of those most famed for their accuracy and dexterity in anatomical inquiries, its general structure is as given in Anatomy. See *Index*.

Dr Hunter observes, that the principal parts of the medullary substance of the brain in idiots and madmen, such as the *thalami nervorum opticorum*, and *medulla oblongata*, are found entirely changed from a medullary to a hard, tough, dark-coloured substance, sometimes resembling white leather.

CEREMONIAL *(ceremoniale)* a book in which is prescribed the order of the ceremonies to be observed in certain actions and occasions of solemnity and pomp. The ceremonial of the Roman church is called *ordo Romanus*. It was published in 1516 by the bishop of Corcyra; at which the college of cardinals were so scandalized, that some of them voted to have the author as well as book burnt, for his temerity in exposing the sacred ceremonies to the eyes of profane people.

Ceremonial is also used for the set or system of rules and ceremonies which custom has introduced for regulating our behaviour, and which persons practise towards each other, either out of duty, decency, or civility.

Ceremonial, in a more particular sense, denotes the manner in which princes and ambassadors used to receive and to treat one another. There are endless disputes among sovereigns about the *ceremonial*: some endeavouring to be on a level, and others to be superior; insomuch that numerous schemes have been proposed for settling them. The chief are, 1. To accommodate the difference by compromise or alteration; so that one shall precede now, the other the next time; or one in one place, and the other in another: 2. By seniority; so that an elder prince in years shall precede a younger, without any other distinction. These expedients, however, have not yet been accepted by any, except some *alternate princes*, as they are called, in Germany.

Ceremonial is more particularly used in speaking of the laws and regulations given by Moses relating to the worship of God among the ancient Jews. In this sense it amounts to much the same with what is called the *Levitical law*, and stands contradistinguished from the moral as well as judicial law.

CEREMONY, an assemblage of several actions, forms, and circumstances, serving to render a thing more magnificent and solemn.

In 1646, M. Ponce published a history of ancient ceremonies, tracing the rise, growth, and introduction of each rite into the church, and its gradual advancement to superstition therein. Many of them were borrowed from Judaism; but more seemingly from Paganism. Dr Middleton has given a fine discourse on the conformity between the Pagan and Popish ceremonies, which he exemplifies in the use of incense, holy water, lamps, and candles, before the shrines of saints, votive gifts or offerings round the shrines of the deceased, &c. In effect, the altars, images, crosses, processions, miracles, and legends; nay, even the very hierarchy, pontificate, religious orders, &c. of the present Romans, he shows, are all copied from their heathen ancestors.—We have an ample and magnificent account of the religious ceremonies and customs of all nations in the world, represented in figures designed by Picart, with historical explanations, and many curious dissertations.

Master of the Ceremonies, an officer instituted by King James I. for the more honourable reception of ambassadors and strangers of quality. He wears about his neck a chain of gold, with a medal under the crown of Great Britain, having on one side an emblem of peace, with this motto, *Beati pacifici*; and on the other, an emblem of war, with *Dieu et mon droit*: his salary is 300l. per annum.

Assistant Master of the Ceremonies, is to execute the employment in all points, whensoever the master of the ceremonies is absent. His salary is 141l. 13s. 4d. per annum.

Marshal of the Ceremonies, is their officer, being subordinate to them both. His salary is 100l. per annum.

CERENZA, a town of Italy, in the kingdom of Naples, and in the Hither Calabria, with a bishop's see. It is seated on a rock, in E. Long. 17. 5. N. Lat. 39. 23.

CERES, a pagan deity, the inventor or goddess of corn; in like manner as Bacchus was of wine.

According to the poets, she was the daughter of Saturn and Ops, and the mother of Proserpine, whom she had by Jupiter. Pluto having stolen away Proserpine, Ceres travelled all over the world in quest of her daughter, by the help of a torch, which she had lighted in Mount Ætna.

As Ceres was thus travelling in search of her daughter, she came to Celeus king of Eleusis, and undertook to bring up his infant son Triptolemus. Being desirous to render her charge immortal, she fed him in the day time with divine milk, and in the night covered him with fire. Celeus observing an unusual improvement in his son, resolved to watch his nurse; to

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to which end he hid himself in that part of the house where she used to cover the child with fire: but when he saw her put the infant under the embers, he cried out and discovered himself. Ceres punished the curiosity and indiscretion of the father with death. Afterwards she taught the youth the art of sowing corn and other fruits, and mounted him in a chariot drawn by winged dragons, that he might traverse the world, and teach mankind the use of corn and fruits. After this, having discovered, by means of the nymph Arethusa, that Proserpine was in the infernal regions, she applied to Jupiter, and obtained of him that Proserpine should be restored, on condition that she had tasted nothing during her stay in that place: but it being discovered, by the information of Ascalaphus, that, as she was walking in Pluto's orchard, she had gathered an apple, and had tasted of some of the seeds, she was for ever forbidden to return. Ceres, out of revenge, turned Ascalaphus into an owl. At length, Jupiter, to mitigate her grief, permitted that Proserpine should pass one half of the year in the infernal regions with Pluto, and the other half with her mother on earth.

Cicero speaks of a temple of Ceres at Catanea in Sicily, where was a very ancient statue of that goddess, but entirely concealed from the sight of men, every thing being performed by matrons and virgins.

CERET, a town of France in Rousillon, with a magnificent bridge of a single arch. It is seated near the river Tec, in E. Long. 2. 46. N. Lat. 42. 23.

CEREUS, in *Botany*. See CACTUS.

CERIGO, an island in the Archipelago, anciently called *Cytherea;* noted for being the birthplace of Helen and of Venus. It is now one of the seven isles constituting the Ionian republic. At present there is nothing very delightful in the place; for the country is mountainous, and the soil dry. It abounds in hares, quails, turtle, and excellent falcons. It is about 50 miles in circumference, and produces corn, wine, flax, oil, and cotton. The town of the same name is strong both by art and nature, being seated on a craggy rock. The inhabitants, who are Greek Christians, were about 10,000 in number in 1806.

CERINES, a town in the island of Cyprus, with a good castle, a harbour, and a bishop's see. E. Long. 33. 35. N. Lat, 35. 22.

CERINTHE, HONEYWORT. See BOTANY *Index*.

CERINTHIANS, ancient heretics, who denied the deity of Jesus Christ.—They took their name from Cerinthus, one of the first heresiarchs in the church, being contemporary with St John. See CERINTHUS.

They believed that Jesus Christ was a mere man, born of Joseph and Mary; but that, in his baptism, a celestial virtue descended on him in form of a dove; by means whereof he was consecrated by the Holy Spirit, and made Christ. It was by means of this celestial virtue, therefore, that he wrought so many miracles; which, as he received it from heaven, quitted him after his passion, and returned to the place whence it came; so that Jesus, whom they called a *pure man*, really died and rose again; but that Christ, who was distinguished from Jesus, did not suffer at all. It was partly to refute this sect that St John wrote his gospel. They received the gospel of St Matthew, to countenance their doctrine of circumcision, from Christ's being circumcised; but they omitted the genealogy. They discarded the epistles of St Paul, because that apostle held circumcision abolished.

CERINTHUS, a heresiarch, cotemporary with the apostles, ascribed the creation not to God, but to angels. He taught that Jesus Christ was the son of Joseph, and that circumcision ought to be retained under the gospel. He is looked upon as the head of the converted Jews, who raised in the church of Antioch the tumult of which St Luke has given the history in the 15th chapter of the Acts. Some authors ascribe the book of the Apocalypse to Cerinthus; adding, that he put it off under the name of St John, the better to authorize his reveries touching Christ's reign upon earth: and it is even certain that he published some works of this kind under the title of *Apocalypse*. See APOCALYPSE.

CEROPEGIA. See BOTANY *Index*.

CERTHIA, in *Ornithology*, the CREEPER or OX-EYE, a genus belonging to the order of picæ. See ORNITHOLOGY.

CERTIFICATE, *Trial by*, in the law of England, a species of trial allowed in such cases where the evidence of the person certifying is the only proper criterion of the point in dispute *. For when the fact in question lies out of the cognizance of the court, the judges must rely on the solemn averment or information of persons in such a station as affords them the most clear and competent knowledge of the truth. As therefore such evidence, if given to a jury, must have been conclusive, the law, to save trouble and circuity, permits the fact to be determined upon such certificate merely. Thus, 1. If the issue be whether A was absent with the king in his army out of the realm in time of war, this shall be tried by the certificate of the mareschal of the king's host in writing under his seal, which shall be sent to the justices. 2. If, in order to avoid an outlawry, or the like, it was alleged that the defendant was in prison, *ultra mare*, at Bourdeaux, or in the service of the mayor of Bourdeaux, this should have been tried by the certificate of the mayor, and the like of the captain of Calais. But when this was law, those towns were under the dominion of the crown of England. And therefore, by a parity of reason, it should now hold, that in similar cases arising at Jamaica or Minorca, the trial should be by certificate from the governor of those islands. We also find that the certificate of the queen's messengers, sent to summon home a peeress of the realm, was formerly held a sufficient trial of the contempt in refusing to obey such summons. 3. For matters within the realm; the customs of the city of London shall be tried by the certificate of the mayor and aldermen, certified by the mouth of their recorder, upon a surmise from the party alleging it, that the custom ought to be thus tried; else it must be tried by the country: As, the custom of distributing the effects of freemen deceased; of enrolling apprentices, or that he who is free of one trade may use another; if any of these, or other similar points come in issue. 4. The trial of all customs and practice of the courts shall be by certificate from the proper officers of those courts respectively; and

* See *Trial*.

Blackst. Comment.

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and when returned was made on a writ by the sheriff or under sheriff, shall be only tried by his own certificate.

CERTIORARI, in *Law*, a writ which issues out of the chancery, directed to an inferior court, to call up the records of a cause there depending, in order that justice may be done. And this writ is obtained upon complaint, that the party who seeks it has received hard usage, or is not likely to have an impartial trial in the inferior court. A certiorari is made returnable either in the king's bench, common pleas, or in chancery.

It is not only used out of the court of chancery, but likewise out of the king's bench; in which last mentioned court it lies where the king would be certified of a record. Indictments from inferior courts, and proceedings of the quarter-sessions of the peace, may also be removed into the king's bench by a certiorari: and here the very record must be returned, and not a transcript of it; though usually in chancery, if a certiorari be returnable there, it removes only the tenor of the record.

CERTITUDE, considered in the things or ideas which are the objects of our understanding, is a necessary agreement or disagreement of one part of our knowledge with another: as applied to the mind, it is the perception of such agreement or disagreement: or such a firm well-grounded assent, as excludes not only all manner of doubt, but all conceivable possibility of a mistake.

There are three sorts of certitude, or assurance, according to the different natures and circumstances of things. 1. A physical or natural certitude, which depends upon the evidence of sense; as that I see such or such a colour, or hear such or such a sound; nobody questions of the truth of this, where the organs, the medium, and the object, are rightly disposed. 2. Mathematical certitude is that arising from mathematical evidence: such as, that the three angles of a triangle are equal to two right ones. 3. Moral certitude is that founded on moral evidence, and is frequently equivalent to a mathematical one; as that there was formerly such an emperor as Julius Cæsar, and that he wrote the commentaries which pass under his name; because the historians of these times have recorded it, and no man has ever disproved it since: this affords a moral certitude, in common sense so great, that one would be thought a fool or madman for denying it.

CERTOSA, a celebrated Carthusian monastery, in the territory of the Pavese, in the duchy of Milan, four miles from Pavia: its park is surrounded with a wall 20 miles in circumference; but there are several small towns and villages therein.

CERVANTES. See SAAVEDRA.

CERVERA, a town of Spain in Catalonia, seated on a small river of the same name, in E. Long. 1. 9. N. Lat. 41. 28.

CERVIA, a sea-port town of Italy, in Romagna, with a bishop's see, seated on the gulf of Venice, in E. Long. 13. 5. N. Lat. 44. 16.

CERVICAL NERVES, are seven pair of nerves, so called, as having their origin in the *cervix*, or neck.

CERVICAL Vessels, among anatomists, denote the arteries, veins, &c. which pass through the *vertebræ* and muscles of the neck up to the skull.

CERVIX, in *Anatomy*, properly denotes the hind part of the neck; as contradistinguished from the fore part, which is called *jugulum*, or the throat.

CERVIX of the *Scapula*, denotes the head of the shoulder blade, or that upper process whose *sinus* receives the head of the *humerus*.

CERVIX of the Uterus, the neck of the *uterus*, or that oblong canal or passage between the internal and external orifices, which receives and encloses the *penis* like a sheath, whence it is also called VAGINA.

CERUMEN, a thick, viscous, bitter, excrementitious humour, separated from the blood by proper glands placed in the *meatus auditorius*, or outer passage of the ear.

CERUSS, WHITE LEAD, a sort of calx of lead, made by exposing plates of that metal to the vapour of vinegar. See CHEMISTRY *Index*.

Ceruss, as a medicine, is used externally, either mixed in ointments or by sprinkling in on old gleeting and watery ulcers, and in many diseases of the skin. If, when it is reduced into a fine powder, it is received in with the breath in inspiration, and carried down into the lungs, it causes incurable asthmas. Instances of the very pernicious effects of this metal are too often seen among those persons who work lead in any form, but particularly among the workers in white lead.

The painters use it in great quantities; and that it may be afforded cheap to them, it is generally adulterated with common whiting.

CERVUS, or DEER, in *Zoology*, a genus of quadrupeds belonging to the order of Pecora. See MAMMALIA *Index*.

SERVUS Volans, in *Natural History*, a name given by authors to the stag-fly, or horned beetle, a very large species of beetle with horns sloped, and something like those of the stag.

CERYX, in antiquity. The ceryces were a sort of public criers, appointed to proclaim or publish things aloud in assemblies. The *ceryx* among the Greeks answered to the *præco* among the Romans. Our criers have only a small part of their office and authority.

There were two kinds of ceryces, *civil* and *sacred*. The former were those appointed to call assemblies, and make silence therein; also to go on messages, and do the office of our heralds, &c. The sacred ceryces were a sort of priests, whose office was to proclaim silence in the public games and sacrifices, publish the names of the conquerors, proclaim feasts, and the like. The priesthood of the ceryces was annexed to a particular family, the descendants of Ceryx, son of Eumolpus. To them it also belonged to lead solemn victims to slaughter. Before the ceremonies began, they called silence in the assembly, by the formula, *Ευφημειτε σιγη πας εστω λαος*; answering to the *favete linguis* of the Romans. When the service was over, they dismissed the people with this formula, *Λαοις αφεσις*, *Ite, missa est.*

CESARE, among logicians, one of the modes of the second figure of syllogisms; the minor proposition of which is an universal affirmative, and the other two universal negatives: thus,

CE No immoral books ought to be read;
SA But every obscene book is immoral;
RE Therefore no obscene books ought to be read.

CESENA,

CESAROTTI, Melchior, an Italian poet. See Supplement.

CESENA, a town of Romagna in Italy, with a bishop's see, subject to the pope, and seated on the river Savio, in E. Long. 12. 46. N. Lat. 44. 8.

CESPITOSÆ plantæ (from *cespes*, turf or sod), are those plants which produce many stems from one root, and thence form a close thick carpet on the surface of the earth.

Cespitosæ Paludes, turf bogs.

CESSATION, the act of intermitting, or discontinuing, the course of any thing, work, or action.

Cessation of Arms, an armistice or occasional truce. See Truce.

When the commander of a place finds things reduced to an extremity, so that he must either surrender, or sacrifice the garrison and inhabitants to the mercy of the enemy, he plants a white flag on the breach, or beats the chamade; on which a cessation of arms commences, to give room for a capitulation.

CESSIO Bonorum, in *Scots Law*, the name of that action by which an insolvent debtor may apply for liberation from prison, upon making over his whole real and personal estate to his creditors.

CESSION, in *Law*, an act by which a person surrenders and transmits to another person a right which belonged to himself. Cession is more particularly used in the civil law for a voluntary surrender of a person's effects to his creditors to avoid punishment. See the article Bankrupt.

In several places the cession carried with it a mark of infamy, and obliged the person to wear a green cap or bonnet; at Lucca, an orange one; to neglect this was to forfeit the privileges of the *Cession*. This was originally intended to signify that the cessionary was become poor through his own folly. The Italian lawyers describe the ceremony of cession to consist in striking the bare breech three times against a stone, called *Lapis Vituperii*, in presence of the judge. Formerly it consisted in giving up the girdles and keys in court; the ancients using to carry at their girdles the chief utensils wherewith they got their living; as the scrivener his escritoire, the merchant his bag, &c. The form of cession among the ancient Gauls and Romans was as follows: The cessionary gathered up dust in his left hand from the four corners of the house, and standing on the threshold, holding the door-post in his right hand, threw the dust back over his shoulders; then stripping to his shirt, and quitting his girdle and bags, he jumped with a pole over a hedge; hereby letting the world know that he had nothing left, and that when he jumped, all he was worth was in the air with him. This was the cession in criminal matters. In civil cases it was sufficient to lay a broom, a switch, or a broken straw, on the threshold: this was called *chrenecruda per durpillum et festucam*.

Cession, in the ecclesiastical law, is when an ecclesiastical person is created a bishop, or when a parson of a parish takes another benefice, without dispensation, or being otherwise qualified. In both these cases their first benefices become void by cession, without any resignation; and to these livings that the person had, who was created bishop, the king may present for that time, whosoever is patron of them; and in the other case the patron may present: but by dispensation of retainder, a bishop may retain some or all the preferments he was entitled to before he was made bishop.

CESTRUM, Bastard Jasmine. See Botany *Index*.

CESTUI, a French word, signifying *he* or *him*, frequently used in the English law writings. Thus, *Cestui qui trust*, a person who has lands, &c. committed to him for the benefit of another; and if such person does not perform his trust, he is compellable to it in chancery. *Cestui qui vie*, one for whose life any lands, &c. are granted. *Cestui qui use*, a person to whose use any one is infeoffed of lands or tenements. Formerly the feoffees to uses were deemed owners of the land, but now the possession is adjudged *in cestui qui use*.

CESTUS, among ancient poets, a fine embroidered girdle said to be worn by Venus, to which Homer ascribes the power of charming and conciliating love. The word is also written *cestum* and *ceston*: it comes from κεστος, *a girdle* or other thing embroidered or wrought with a needle; derived, according to Servius, from κεντειν, *pungere*; whence also *incestus*, a term used at first for any indecency by undoing the girdle, &c. but now restrained to that between persons near a-kin. See Incest.

CETACEOUS, an appellation given to the fishes of the whale kind. See Cetology.

CETE, the name of Linnæus's seventh order of mammalia, comprehending the Monodon, Balæna, Physeter, and Delphinus. See Cetology.

CETERACH, the trivial name of a species of Asplenium. See Asplenium, Botany *Index*.

CETOLOGY.

1 Definition of the title.

UNDER this general title is comprehended the history of that division of marine animals, which in the Linnæan arrangement constitutes the seventh order of the class mammalia. This is the order *cete* or *whales*. Ray and Willoughby have included this order of animals under the class of fishes. Ray, in his arrangement of fishes, divides them into two principal sections. The one comprehends those fishes which are furnished with lungs for respiration; and the other, those which breathe by means of gills, and may be considered as truly fishes. In the former section are included the cetaceous fishes; and the reasons which he assigns for arranging them in this manner are, that they agree in external form with fishes; that they are entirely naked, or covered only with a smooth skin; and that they live entirely in the water, and have all the actions of fishes. Although this tribe of animals resembles fishes, not only in manners and habits, but also in being inhabitants of the same element, Linnæus thought proper to class them with the mammalia, on

2 Arrangement of fishes by Ray.

3 Of whales by Linnæus.

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Introduction.

on account of the similarity of their internal structure, having a double heart and warm blood, and respiring like them by means of lungs.

4 by Pennant.

Mr Pennant, in his British Zoology, has objected to the classification of cetaceous animals with the mammalia, as Linnæus has done, because, "to have preserved the chain of beings entire, he says that Linnæus should have made the genus *phocæ* or *seals*, and that of the *trichecus* or *manati*, immediately precede the whale, those being the links that connect the mammalia or quadrupeds with the fish; for the seal is in respect to its legs the most imperfect of the former class; and in the *manati* the hind feet coalesce, assuming the form of a broad horizontal tail." On this account, Mr Pennant has arranged the cetaceous order of animals under his class of fishes, including them under the first division

5 Treated of separately.

of that class. For the same reasons we have separated them from the class of fishes; but although they resemble the quadrupeds, which compose chiefly the class mammalia, in being warm-blooded, and in the functions of circulation and respiration; yet, as they possess characters so totally distinct from any of the mammalia, we judged it more natural to separate them also from this class, and to treat of them in the present article.

6 Their history important,

This tribe of animals is also entitled to a separate treatise, both on account of the interest to be derived from their natural history, and on account of their importance in a commercial view.

7 but deficient.

The history of cetaceous animals, as well as that of the other inhabitants of the ocean, cannot be expected to be complete. They are beyond the reach of the naturalist, from the nature of the element in which they live; and even when he is favoured with a transient glimpse, the rapidity of their motions precludes

8 Reasons.

the possibility of obtaining much accurate knowledge of their manners and habits. But the abode of the whale is the most inaccessible parts of the ocean. The frozen regions of the north and south are his chief retreat—regions so inhospitable, as to forbid the approach of the most hardy naturalist with all his zeal and ardour, and to be visited only by the adventurous fisherman, prompted by the hope of gain. To the latter, chiefly, we are indebted for what knowledge we possess of this tribe of animals. And from men who had a very different object in view, who, in this hazardous trade, had to struggle with the severest seasons, in a climate where the rigour of winter rarely relaxes, information on this subject could neither be accurate nor extensive.

9 Sources of information.

This, however, was the principal source from which the earlier writers on this department of natural history derived their information. Such were Sibbald, Martens, Dudley, Clein, and Anderson, who composed their descriptions from the relations and memoirs which were communicated to them by fishermen and voyagers. Hence have originated these erroneous and inaccurate details which have been introduced into the works of naturalists.

10 Name limited.

The name of *Cete*, as the word which is derived from the Greek language originally signifies, was given indiscriminately to all marine animals of extraordinary size. It has been limited by later naturalists to that tribe of fishes which are distinguished from other fishes by the functions of respiration and circulation, and by being viviparous. These are now included under the general term *cetaceous* fishes. Beside the discriminative marks of respiration, circulation, and being viviparous, others may be mentioned.

11 Different from other fishes,

In the cetaceous fishes the skin is not covered with scales as in other fishes; there are one or two orifices in the upper part of the head for discharging water; the lateral fins are furnished with articulations as in the human hand, and the tail is horizontal.

12 in fat,

There is another remarkable difference between the cetaceous and other fishes, in the greater quantity of blood, and the thick covering of fat or *blubber*, for which the former are distinguished. And considering the temperature of the climate, and the element in which these animals live, this seems to be a wise and necessary provision of nature.

13 and quantity of blood.

The great quantity of blood produces a greater degree of heat, and the spongy porous mass of blubber, being from its nature a slow conductor of heat, is an excellent defence against the rigour of the seasons in the polar regions.

In the following treatise we propose to lay before our readers, 1st, The Classification and Natural History of Cetaceous Fishes; 2d, Their Anatomy and Physiology; and, lastly, The History of the Whale Fishery as an object of trade. These shall be the subjects of three chapters.

Chap. I. *Of the Classification and Natural History of Cetaceous Fishes.*

14 Classes four.

Cetaceous fishes have been divided into four classes, the characters of which are taken from the want of teeth, from the structure of the teeth, and from their position in one or both jaws. The following table exhibits the characters of these classes, with a translation opposite for the sake of the English reader.

1st, Balæna, or *Whale.*

Dentium loco laminæ corneæ in maxilla superiore.	In place of teeth there are horny plates in the upper jaw.

2d, Monodon, or *Unicorn Fish.*

Dens unicus aut duo in parte antica maxillæ superioris horizontaliter exserti.	One or two teeth horizontally inserted in the anterior part of the upper jaw.

3d, Physeter, or *Spermaceti Whale.*

Dentes veri in maxilla inferiore; aliquot vero plani, vix conspicui in maxilla superiore.	Teeth in the lower jaw, but scarcely conspicuous in the upper jaw.

4th, Delphinus, or *Dolphin.*

Dentes in utraque maxilla.	Teeth in both jaws.

15 Genera.

Each of the four classes which we have now enumerated and characterised, comprehends only a single genus, the characters of which are as follows:

Generic Characters.

1st Genus, Balæna, or *Whale.*

Maxilla superior dentium loco, laminis corneis instructa; fistula duplex in vertice.	The upper jaw is furnished with horny plates in place of teeth, and there are two blow-holes on the top of the head.

2d,

Classification, &c.

2d Genus, MONODON, or *Unicorn-Fish.*

Dens unicus aut duo, longi aut breves, recti vel recurvi, in parte antica maxillæ superioris exserti; fistula in occipite.	In the anterior part of the upper jaw there is one or two teeth which are either straight or curved, long or short; the spout in the back part of the head.

3d Genus, PHYSETER, or *Spermaceti Whale.*

Dentes veri et visibiles in maxilla inferiore, in quibusdam vero maxilla superior dentibus planis vix conspicuis instructa; fistula in angulo superiore rostri.	The teeth distinctly seen in the lower jaw, but scarcely visible in the upper jaw; the spout in the upper part of the forehead.

4th Genus, DELPHINUS, or *Dolphin.*

Maxilla utraque dentata: fistula in fronte.	Both jaws are furnished with teeth; the spout in the forehead.

CLASS I. BALÆNA.

Genus 1st, BALÆNA, or *Whale.*

16 Generic characters. The body is naked, elliptical, or of an oblong conical shape, and of a black or brownish colour.

The head is very long, laterally compressed, and diminishing towards the beak. The opening of the mouth is very large. The jaws are nearly equal, and without teeth; but in place of teeth, the upper jaw is furnished on both sides with horny plates, transversely disposed. The lower jaw is anteriorly of an oval or roundish form, broader than the upper jaw, and having a furrow on the margin for receiving the horny plates. The eyes are small; they are placed near the insertion of the lateral fins. The ears are also small, and are situated behind the eyes.

In some of the species the anterior part of the body is plicated or folded underneath.

The penis is enclosed in a sheath. The female is furnished with two mammæ; and the organs of generation are placed between them. Behind them is the anus.

There are three or four fins; two lateral fins, one at the extremity of the tail, which is placed horizontally. The dorsal fin is often wanting.

* *Species which have no Dorsal Fin.*

Plate CXL. fig. 1. 1. BALÆNA MYSTICETUS, the *Greenland*, or *large Whalebone Whale.*

French, *Baleine Franche. Baleine de grande baie;* Spaniards, *Vallena; Whallfesch*, by the Germans; *Whallvisek*, Dutch; *Hvafisch, Sletback*, by the Norwegians; *Hvalfisk*, by the Swedes; *Slitcheback, Sandhual*, by the Danes; *Vatuskalr*, by the Icelanders; and *Arbek, Arbavirksoak*, by the Greenlanders.

17 Characters. In this species the jaws are nearly of equal length; the lower is of an oval form, and broad in the middle; the back is spotted, black and white.

18 Description. This is the largest of animals known. The body, from a side view, appears of an elliptical form. The head is very nearly equal to one-third of the whole length of the body. It is as it were composed of two inclined planes joined together under a larger or smaller angle, and has something the appearance of the roof of a small house.

19 Blow-holes. In the middle of the line formed by the junction of the two inclined planes, there rises a large tubercle, in which are situated the spouts or blow-holes opposite to each other, and curved in the shape of the letter S. The jaws are nearly equal in length; the lower is broader towards the middle of its length than the upper; and besides it spreads out and has membranous coverings, which terminate in a broad deep furrow, which is destined to receive the horny teeth of the upper jaw. When the jaws are close, the opening of the mouth folds upwards towards the orbit of the eyes, and exhibits by its inflection the curved form of a sickle.

20 Whalebone. The want of teeth is supplied by about 500 horny laminæ. This is the substance called *whalebone.* They are attached to the upper jaw on both sides, and supported at the base by a kind of bone which extends the whole length of the roof of the mouth. They are arranged transversely, and in an oblique direction. Each of them is from three to five feet long, is thickest at the base, tapers towards the point, is a little curved, and terminates in a fringe of long hair which hangs about the tongue. Towards the two extremities of each row, there are besides many other small laminæ, which are of a square form, of the thickness of a writing quill, and about four inches long. These latter are arranged in the same direction as the former; but are of a softer substance, and do not come so close to each other.

21 Tongue. The tongue is soft and spongy, strongly attached to the lower jaw, and rounded at the extremity. On the upper side it is white, but on the sides it is marked with black spots. It is often 10 feet broad and 18 feet long.

22 Eyes. The eyes are placed very low, at the broadest part of the head, just above the angles of the mouth, and very near the origin of the lateral fins. They are furnished, as the means of defence, with eyelids and eyelashes; and resemble in form and magnitude those of an ox. The crystalline lens, which is white and transparent, is not larger than a pea. The external organ of hearing, consists of a small hole of the diameter of a quill, which is placed immediately behind the eyes. 23 Ear.

The back forms a gentle curvature from the tubercle on the top of the head; towards the middle of the trunk it is again elevated, and then tapers gradually to the tail. The lower part of the body diminishes in the same proportion. The lateral fins have their origin near the angle of the mouth. They are two large thick masses, of an oval irregular form, and are often 10 feet long. The tail fin is divided into two oval fleshy lobes, which terminate in a point. 24 Fins.

The male is furnished with a penis which is eight feet long, and surrounded with a double skin, which gives it something of the appearance of a knife in its sheath. The female has two mammæ, which are placed on each side of the organs of generation.

25 Skin. The skin of the whale is divided into the epidermis or scarf-skin, the true skin, the fat or blubber, and the muscle or flesh. The epidermis is as thin as parchment,

Classification, &c. ment, and very easily separated, when the process of putrefaction first commences. The true skin is an inch thick, and covers a layer of fat of 15 inches.

26 Colour. The back of the whale is usually of a fine black, marked with whitish rays, which have some resemblance to the veins of wood; and in the thickest, as well as the finest of these traces, there pass other veins of a dirty white. This mixture of colours presents an agreeable appearance, especially when the back of the fish is illuminated with the rays of the sun. The different changes of colour from white to yellow then exhibit the splendour and brilliancy of silver.

The under part of the trunk, and of the lower jaw, is of a bright white. But these colours are subject to considerable variation, according to the age of the fish. Some have been observed to be entirely black; others spotted with white, yellow, and brown. Martens assures us, that he observed on the tail of a whale, the number 1222, as neatly traced as if it had been executed by the hand of a painter. But probably the resemblance to those figures was helped out by the aid of fancy.

Ellis and some other naturalists assert, that the whale is found perfectly white in the western parts of the northern ocean. It is not uncommon to see the young whale spotted with brown; and old whales marked on the back with a transverse band, which extends to the belly. Sometimes, however, the spots observed on the whale have been undoubtedly occasioned by wounds; for it is certain, that a white scar always remains on the place which has been wounded.

27 Size. The size of the whale has not been very accurately ascertained. Some have been taken of 80, and even of 100 feet long, and almost as much in circumference. The female is in general larger than the male. The period of pregnancy is nine or ten months; and one, very rarely two, is brought forth at a time. The young whale is 20 feet long at birth.

28 Haunts. This species of whale is very common towards the north pole, in the seas of Greenland and Spitzbergen, and especially in that part of the arctic sea which lies under the 76th degree of latitude.

29 Food. The principal food of the whale is a species of *helix* and different species of actiniæ. It is not a little surprising that the whale, of such immense size, should feed on such small animals, and should acquire such a quantity of fat as to yield above 150 tons of oil. But according to the testimony of those employed in the whale fishery, these worms are found in such abundance in the seas about Spitzbergen, that the whale has only to open his mouth to receive thousands at once, and then rejecting the water through the fringe or beard attached to the jaws, these little animals remain behind, taken as it were in a net. And indeed there seems to be a wise provision of nature for the subsistence of this monstrous animal, in impressing on these worms and insects, which are to be his food, a kind of instinct, which guides them to sport about the fringes of the jaws, in the very gulf which is to swallow them up. Linnæus says that the whale also feeds on *medusæ*. But to this it has been objected, that the medusæ are not in sufficient abundance in the northern seas, to furnish the necessary quantity of food for so large an animal. It seems not improbable, however, that the medusæ as well as the actiniæ may form part of its food. Classification, &c.

The excrement of the whale has some degree of solidity, and it is of a yellow colour, approaching somewhat to the colour of saffron.

The whale fishery, or rather it might be termed the chase of the whale, constitutes one of the principal occupations of the inhabitants of Greenland. The capture of a single whale is sufficient for the subsistence of a whole family for a long time. The flesh is eaten raw, baked, or after being half rotten, or dried in the heat of the sun; and according to Horrebow, it has a very good taste. The skin, the tail, and the fins, undergo no kind of preparation; for it seems these parts furnish, in the raw state, a very delicate morsel to the Greenlanders. The fat is either eaten, or burnt for the purpose of giving light. The intestines are employed to shut up the doors and windows of their habitations; and the tendons furnish thread for sewing, or for the construction of nets. Of the bones the Greenlanders make stools or chairs, and instruments that are used in hunting and fishing. The best lines are made of the hair that terminates the horny plates of the upper jaw. 30 Fishery by the Greenlanders. 31 Uses.

The following are the dimensions of a whale taken towards the north pole, and recorded by M. de Pages in the account of his voyage round the world.

	Ft.	Inch.
Total length,	48	0
Circumference of the head, which is the thickest part of the body,	26	5
Length of the head, about	18	0
Length of the jawbones,	18	0
Diameter of the orbit of the eyes,	0	3
Opening of the eyelids,	0	5
Distance of the eyes from the opening of the breathing holes,	6	0
Length of the cavity, which includes the penis,	4	0
Depth of this cavity,	0	8
Distance of this cavity from the anus,	1	0
Diameter of each mamma,	0	6
Length of the papilla,	0	2
Diameter of it,	0	$1\frac{1}{2}$
Distance of the two lobes of the tail fin, about	17	0
Depth of the hollow which separates the two lobes,	2	6
Length of the lateral fins,	8	0
Breadth of the same, about	7	0

2. Balæna Glacialis, *Iceland Whale*.

French, *Le Nord Caper*, *Baléine de Sarde*; German, *Nordkaper*; Norwegian, *Sildqual*, *Nordkaper*.

In this species, the jaws are nearly of equal length. The under jaw is rounded, and broader towards the middle of its length. There is no dorsal fin. The back is whitish. 32 Specific characters.

The Iceland whale differs from the former only in the colour and dimensions of the body. The head and horny laminæ of the upper jaw are much smaller. The trunk of the body is more slender, and is of a light 33 Body.

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Classification, &c.

light brown colour. It has been observed, that the lower jaw of this species is more elongated and rounder than that of the common whale.

34 Mode of taking by the Icelanders.

As it is very dangerous to harpoon this species of whale, on account of its extreme agility, it is mentioned by Anderson, that the Icelanders have a very ingenious method of taking it. When they perceive the whale in chase of the herrings, they instantly launch their canoes furnished with harpoons, spears, and knives, and endeavour to get between the whale and the ocean. They continue the pursuit by rowing, and approach as near as possible. If the wind blow towards the shore, they pour on the sea a quantity of blood, with which they are always provided, and as it is carried by the waves to the coast, they endeavour to direct it as near to the shore as they can. The whale perceiving himself pursued, attempts to regain the ocean, but when he approaches the blood he is alarmed, and rather than swim across it, he makes his escape to the shores, where he often throws himself on the rocks. But if the wind blow from the land, the fishermen endeavour to get between the whale and the ocean, as in the other case; and when he attempts to make for the deep, they throw stones from their canoes, and shout and make a noise, so that the whale is terrified and is driven on shore. This, however, is contradicted by Horrebow, who remained two years in Iceland, and had good opportunities of being well informed of every thing relating to the whale-fishery. He says, that the Icelanders are neither hardy enough to make this hazardous attempt, nor so fortunate or dexterous as to take the whale so easily. The only method which is practised there, he says, is the following: When the boat approaches the whale, the harpooner discharges his harpoon, and the boat instantly retreats. The harpoon is known by having the mark of the proprietor, and when the whale has been successfully wounded, he dies and is thrown ashore. A certain portion belongs to the person who was so fortunate as to inflict the wound, and the remainder is claimed, according to a law of the country, as the right of the person on whose property he lands. According to this author, this is the whole art practised by the inhabitants of Iceland in the whale-fishery.

The Iceland whale yields only from 10 to 30 tons of blubber.—The food of this whale consists of some species of *helix*, *medusæ*, and herrings.

This whale inhabits the northern ocean, about the coasts of Norway and Iceland.

Klein has made two varieties of this whale, distinguishing them by names derived from that part of the ocean where they are found. 1. Var. *Australis*, which is found in the southern ocean, has the back very flat. 2. Var. *Occidentalis*, found in the western ocean, which has the back more elevated. The same naturalist has distinguished the *Balæna glacialis* by the name *borealis*.

** *Species which have a Fin or Bunches on the Back.*

3. Balæna Physalus, or *Fin Fish.*

French *Le Gibbar;* German, *Finnfisch;* Dutch, *Vinvisch;* Norwegian, *Ror-hual*, *Finne-fisk;* Greenland, *Tummilik;* Iceland, *Hunfubaks.*

35 Characters.

The jaws are equal and pointed; the horny laminæ of the upper jaw are short, and of a bluish colour. There is one fin on the back.

36 Description.

According to the fishermen, the fin fish is as long but not so thick as the common whale. When the jaws are shut, the head resembles a cone, which constitutes nearly one-third part of the whole length of the whale, and terminates in a sharp snout. On the top of the head are two respiratory orifices divided longitudinally. This whale, it is said, ejects the water with much greater force than the common whale. The horny laminæ of the upper jaw are fringed and disposed in the same manner as those of the preceding. They differ in being shorter, and of a blue colour. The length is from 10 to 12 inches. The long hair which terminates the laminæ, is so twisted that the edges of the upper jaw seem covered with a thick cord interwoven together. The eyes are placed very low, nearly in the direction of the angles of the mouth. Towards the posterior extremity of the back, there arises a triangular fin, about 3 or 4 feet high, having the summit bent backwards. The lateral fins are of an oval figure, from 6 to 7 feet long. The tail fin is divided into two lobes which form nearly a right angle.

This species lives on the herring, the mackerel, a kind of salmon frequent in the northern sea, and other small fish. Food. 37

The upper part of the body is of a shining brown colour. The belly and the under part of the lower jaw are of a splendid white.

This species of whale is found in the Greenland seas, in the European seas, in the Indian ocean, and in the new world. In March 1673, Martens mentions that he saw a whale of this species in the straits of Gibraltar. As the mass of the body constitutes the third or the fourth of that of the common whale, the fat is less thick. It yields, it is said, only ten tons of oil. This whale is therefore less an object of the fisherman's pursuit, for the produce of oil is not equivalent to the expence, the risk, and the danger that attend it.

It has been remarked, that as soon as the fin fish makes its appearance in the seas round Spitzbergen, the common whale is no longer to be seen.

In Greenland the flesh, the fins, the skin, and the tendons, are employed as food by the poorer inhabitants; and the bones are applied to a great many domestic uses. It is said that the flesh has the same taste as that of a sturgeon. Uses. 38

4. Balæna Nodosa, *the Bunch* or *Humpback Whale.*

French, *Baleine-tampon;* German, *Plock-fish;* Dutch, *Pen-fish.*

The lateral fins are white. There is a bunch near the tail larger than the head of a man. Characters. 39

Of this species less is known than of the others. In place of the dorsal fin, there is a bunch near the tail which declines posteriorly. It is about a foot high, and a little thicker than the human head. The lateral fins are white, placed near the middle of the body, and are 18 feet long. The blubber of the bunch-whale resembles that of the fin fish. According to Klein, the beard of this species is not held in much estimation, though it is more valued than that of the latter species. It is a native of the seas of New England. Description. 40

Classification, &c.

5. Balæna Gibbosa, the *Scrag-whale.*

French, *La Baleine à six bosses;* German, *Knotenfisch;* Dutch, *Knobbelfisch.*

41 Characters. The horny laminæ of the upper jaw in this species are white; and there are six bunches on the back.

42 Description. In external form this species resembles the common whale. It is nearly of the same colour, and yields an equal quantity of blubber. It seems difficult to reconcile this with the specific name given by Klein, viz. *Balæna macra*, or lean whale. But it has been supposed that this refers to the muscular parts, which are of smaller size.

The dorsal fin is wanting. Its place seems to be supplied by six bunches or knots towards the tail. The laminæ are white, and are found to split with much difficulty.

Like the former, it inhabits the seas of New England.

**** Species which have a Protuberance in form of a Fin on the Tail, and Folds on the Belly.*

6. Balæna Boops, the *Pike-headed Whale.*

French, *La Jubarte;* Greenland, *Keporkak;* Iceland, *Hrafin, Reydus.*

43 Characters. The lower jaw is a little shorter and narrower than the upper. The protuberance on the back is curved and stretching to the tail.

44 Description. M. O. Fabricius, who was present and assisted at the capture of a whale of this species, has given the following description of it. The body is round and very thick near the lateral fins. It gradually diminishes to the end of the tail, the thickness of which is not greater than what a man can embrace. The head is oblong, inclining, and terminates in a broad obtuse snout. Towards the middle of the head is the protuberance, in the middle of which are the two respiratary orifices, which are so close to each other as to appear to be only one. Before the orifices there are three rows of circular protuberances, of which the use is not known. The lower jaw is shorter and narrower than the upper. The eyes are placed on the sides of the head behind the orifices. The external opening of the organ of hearing forms two holes immediately behind the orbits of the eyes, but are almost imperceptible. The horny laminæ of the upper jaw are black, and scarcely a foot in length. They are disposed in the same manner as in the common whale, but the interstices in the fore part of the jaw are not filled up with small laminæ. The tongue is large, fat, and spongy; its colour resembles that of the liver. It is covered with a loose skin, which stretches towards the gullet, where it forms a kind of operculum or covering.

The lateral fins are large, oval, interiorly entire, rounded, and notched posteriorly, and a little hollowed externally. The tail fin is hollowed or notched in form of a crescent, and terminates in a point. From the lower part of the mouth to the region of the anus, the inferior surface of the body is marked with folds or furrows which unite in pairs, and form angles at the two extremities. The two external furrows are always of the greatest length; and it would appear that the whale has the power of dilating and contracting them at pleasure.

The colour of the upper part of the body is black; the lower part of the mouth and the lateral fins are white; the cavity of the furrows is of a blood red; the interior folds, the belly, and the tail fin, are marked with black and white spots. Under the epidermis is the skin which covers the fat, which in this species is but a thin layer, and consequently yields less oil than the preceding.

When the pike-headed whale takes in food, it opens its capacious mouth, and swallows a great quantity of water along with its prey. It is then that the folds of the skin on the belly are observed to dilate considerably; and then too the contrast between the fine red in the cavity of the furrows, the black colour of the laminæ of the jaw, and the bright white on the under part of the mouth, produces a very striking effect.

At every attempt at progressive motion, this species ejects the water by the respiratory orifices, but with less violence than other whales. The moment after, it disappears under the water. And when it plunges and shews the tail fin, it is considered as a sign that it is going to descend to a great depth, and that it will remain a longer time under the surface. When the sea is calm, it is seen asleep on the surface of the water; and the moment it awakes, it performs a number of different motions with inconceivable rapidity. Sometimes it lies on its sides; in an instant it strikes the water with the lateral fins with prodigious force, and then turns on its back. It springs up into the air, and returns to the water in a whirling motion, at a considerable distance from the place from which it arose.

The food of the pike-headed whale consists of a species of *helix*, a small species of salmon which frequents the northern ocean, and the sand-eel. It has only a single young one at a time. The young whale follows its mother till another is brought forth; but this does not happen every year. 45 Food.

The slightest wound is observed to occasion the death of this species of whale; for the wound very soon runs into gangrene. The animal often goes to a great distance from the spot where it received the fatal blow. The surest method seems to be to strike with the spear immediately behind the lateral fins; and if it happen that the intestines are wounded, the whale instantly plunges into the ocean.

This species frequents chiefly the Greenland seas, between the 61st and 65th degree of latitude. In winter it appears only in the open seas, but in summer it approaches the shores, and enters the great bays.

The length varies from 50 to 54 feet. Sibbald has given a description of a young one which was thrown ashore on the coast of Scotland. The following are the dimensions of the principal parts of the body.

	Ft.	In.
From the end of the snout to the extremity of the tail,	46	0
The greatest thickness at the lateral fins,	20	0
The greatest thickness at the dorsal fin,	12	0
Greatest breadth of the lower jaw,	4	6
Length of the opening of the mouth,	10	0

Breadth

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Classification, &c.

	Ft.	In.
Breadth of the mouth,	4	0
Length of the tongue,	5	0
Breadth of this organ at the root,	3	0
Length of the pectoral fins,	5	0
Breadth of ditto,	1	6
Breadth of the tail fin,	9	6
Length of the penis,	2	0

7. Balæna Musculus, the *Round-lipped Whale.*

French and Greenland, *Rorqual;* Iceland, *Steipe, Reydus.*

46 Characters. In this species the lower jaw is longest and broadest. The protuberance on the back is straight, triangular, and stretches to the tail.

47 Description. This species resembles the preceding in the form of the body. In both there is a prodigious enlargement of the side of the head, which gradually diminishes towards the tail. The structure of the lower jaw furnishes the principal characteristic distinction. In the pike-headed whale it is pointed; but in this species it is rounded, which gives the head an obtuse shape. The opening of the mouth is so wide, that it will admit fourteen men standing upright at the same time. The upper jaw is narrower than the lower; it is also more pointed at the extremity, and is received into the lower jaw. The tongue is composed of a soft spongy substance; and is covered with a fine membrane or skin. At the base of the tongue, on each side, there is a fleshy mass of a red colour, which shuts up the entrance of the gullet so closely that only small fish can be admitted. The whole palate is covered with black laminæ, which terminate at their extremity in a silky hair which hangs over the tongue. The laminæ and the hair are of unequal length and breadth. Those which are attached to the anterior part of the jaw are 3 feet long, and 12 inches broad; while those near the entrance to the gullet are scarcely six inches long by one inch broad.

The eyes are placed above the angle of the mouth; they resemble those of the ox. Above the eyes, in the middle of the head, are situated the two respiratory orifices, which are of a pyramidal form.

The pectoral fins are large, a little oval, and tapering; and situated opposite to the angle of the mouth. The dorsal fin is placed directly opposite to the opening of the anus. It tapers a little, and is curved backward. The tail fin is divided into two lobes, which are curved like a scythe, and end in a point.

From the end of the lower jaw to the navel, the under part of the body is covered with rugæ or folds, which are two inches broad, having the cavities by which they are separated of the same breadth. The sides are covered with a layer of fat or blubber, 4 inches thick; and on the head and neck, where the fat is more abundant, it is a foot in thickness. The upper part of the body is black, the belly is white.

48 Food. The herring is the food of this species of whale.

In the month of September 1692, a whale of this species was thrown ashore on the coast of Scotland, as we find it recorded by Sibbald. For twenty years before the fishermen had observed it occasionally in pursuit of the herrings; and they recognised it in consequence of a wound which it had received from a musket. The ball had pierced through the dorsal fin. The following are the principal dimensions, by the same author.

	Ft.	In.
Whole length of the body, from the snout to the extremity of the tail,	78	0
Circumference of the body at its greatest thickness,	35	0
Length of the lower jaw,	13	2
Length of the tongue,	15	7
Breadth of ditto,	15	0
Length of the pectoral fins,	10	0
Greatest breadth of ditto,	2	6
Length of the dorsal fin,	2	0
Height of ditto,		
Distance between the extremity of the lobes of the tail,	18	6
Length of the penis,	5	0

8. Balæna Rostrata, the *Piked Whale.*

French, *La Baleine à Bec.*

The jaws are long, narrow, and pointed; the lower jaw is longest. The protuberance which is placed on the extremity of the back, is roundish at the apex. 49 Characters.

A side view of this species of whale presents a lengthened oval form, which has the greatest transverse diameter towards the middle of the body. The head constitutes a fourth part of the length of the body, and is of a conical form. The jaws are larger, narrower, and more pointed than in the other species. The upper jaw is the shortest. The eyes are placed little above the angles of the mouth, and the blowholes are on the top of the head. The laminæ of the upper jaw, according to Fabricius, are white and very short. 50 Description.

The lateral fins occupy the middle of the height of the sides; they are broad, nearly oval, and rounded. The dorsal fin is opposite to the anus. It is rounded at the top, inclining towards the tail. The tail fin is divided into two lobes, which form by their junction a crescent, the horns of which are directed behind.

The under part of the body, from the point of the lower jaw to the middle of the trunk, is covered with rugæ or folds in parallel rows, which stretch on both sides to the insertion of the pectoral fins. The back is black; but this gradually diminishes towards the belly, which is pure white, varied with a mixture of reddish shades.

This species of whale swims with extraordinary velocity. The fat or blubber is very compact, and yields but a small quantity of oil. The fishermen are therefore not very eager in the pursuit of it. But as the inhabitants of Greenland consider the flesh very delicate food, they are often employed in taking this whale. They never approach so near as to strike it with the harpoon; but discharge arrows from a distance, the wounds of which almost always prove mortal.

The food of this whale is the same as of some of the other species; chiefly, the small species of salmon of the northern seas, and the other small fish, which it pursues with such avidity, that they are often seen leaping from the sea to avoid the pursuit. This is the smallest species of whale. 51 Food.

It.

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Classification, &c.

52 Where found.

It is found most frequently in the Greenland seas; and often also in the European. One which was taken on the Dogger bank, measured 17 feet in length. It had lost the dorsal fin, and by some other accident the jaws were so swelled, that the head formed a mass specifically lighter than water, and therefore did not sink in that element.

Class II. MONODON.

Genus 1st, Monodon, *Unicorn-fish*, or *Sea-Unicorn*.

53 Generic characters.

The body is naked, oval, oblong, round and spotted. The head is small, and not easily distinguished from the rest of the body. There is only one respiratory orifice, which is placed on the top of the head, and shut up by a covering cut in form of a comb. The opening of the mouth is small. There are no teeth in the mouth; but from the upper jaw there proceeds, inclining sometimes to the right side, and sometimes to the left, one long tooth which is twisted in a spiral form. There are rarely two; but when that is the case, they are nearly of the same length; and there is only one species which has the teeth curved at the extremity. The eyes and ears are very small. The penis of the male is enclosed in a kind of sheath; and the female has two mammæ on the belly, between which are the organs of generation.

There are three or four fleshy fins; two pectoral fins; one at the extremity of the tail; and that of the back is often replaced by a projection which runs its whole length.

Species.

Plate CXL. fig. 2.

I. Monodon Monoceros, the *Narhwal*, or *Unicorn-Fish*.

French, *Narhwal*, *Licorne de mer;* Norwegian, *Lighval;* Iceland, *Narhwal;* Greenland, *Tavvar*.

54 Characters.

One tooth in shape of a horn, inserted in the upper jaw, and spirally twisted; there are rarely two.

There is no tail fin.

55 Description.

The body of the narhwal is oblong and oval; the back broad, convex, and tapering towards the tail; the head is round, small, enlarged at the top, and terminates in an obtuse rounded snout. There are no teeth; but a long twisted tooth, which is attached to the upper jaw. It was long supposed that this bony instrument of defence was the horn of a very rare quadruped, and consequently it was sold at a very high price. Each tooth is from nine to ten feet in length, and possesses some of the properties of ivory. It is however easy to distinguish them. The fibres of the tooth of the unicorn-fish are finer than ivory; it is more compact, heavier, and less apt to become yellow. The narhwal is rarely furnished with more than one tooth, but under the common skin of the head on the other side, the rudiments of another may be observed. There have been, however, different examples of two teeth, and both nearly of the same length. In the year 1604, a female having two teeth was taken, and the bones of the head, with the teeth inserted, were brought to Hamburgh. The two teeth proceeded in a right line from the anterior part of the skull. At the place of insertion they were only two inches asunder, but gradually diverging, they were separated at the extremity 18 inches. The left tooth was 9 inches in circumference, and 7 feet 5 inches long. The right was 7 feet long, and 8 inches in circumference at the base. Both teeth entered 13 inches into the bones of the head, which was 2 feet long, and 18 inches broad.

The opening of the mouth is in general very small; not larger, according to some, than to admit the hand of a man. The tongue is nearly of the same size. The head ends in a rounded snout. The lower lip is thin, and shorter than the upper.

The eyes are placed opposite to the opening of the mouth; and they are surrounded by a kind of eye-lid. On the top of the head there is one respiratory orifice. which may be shut and opened at pleasure by means of a fringed covering.

The pectoral fins are about a foot long, and eight inches broad. The fin of the tail is divided into two obtuse oval lobes. In place of the dorsal fin, there is a ridge or projection about nine inches high, which extends from the breathing hole on the head to the base of the fin, which terminates the trunk of the body, and diminishes gradually in height as it approaches to the tail.

The skin is about one inch in thickness. The colour is of a grayish white, marked with a great number of black spots which seem to penetrate the substance of the skin. The skin of the belly is of a shining white, and soft as velvet to the touch.

The oil which the unicorn-fish yields is in small quantity, but is considered to be of a superior quality to that of the Greenland or common whale. The food of this fish is one of the species of the *Pleuronectes*, and some species of *helix*. 56 Food.

The length of the unicorn-fish is from 20 to 22 feet, the circumference about 12 feet. According to some authors indeed, some fish have been found 60 feet long. It inhabits chiefly the northern seas of Europe and America, about Davis straits, and the coasts of Iceland.

It would be difficult to take this fish singly and in the open sea; for they are excellent swimmers, and move with astonishing velocity by means of the tail fin. But as they live in very cold climates, and cannot remain long under water without respiring, they frequent the bays that are free of ice. In these places they crowd together in such numbers, that they force their teeth into the body of each other; and in this situation they can neither plunge into the deep water, nor avoid the pursuit and blows of the fishermen.

There is no part of this fish which is not applied to some useful purpose by the inhabitants of Greenland. They are extremely fond of the flesh, which they eat roasted or dried in the smoke. The intestines also are regarded as a very delicate food. They are also roasted. The fat affords an oil for burning. From the gullet they obtain bags or bladders which they employ in fishing. The tendons are made into excellent thread or small cords. Of the teeth they make several instruments which are used in the chase, or stakes for the construction of their huts. 57 Uses.

The kings of Denmark have a most magnificent throne, which is entirely composed of the teeth of the unicorn-fish. It is preserved in the castle of Rosenberg; and it is esteemed of greater value than if it were made of gold. 58 Magnificent throne of the teeth.

It has been affirmed by some naturalists, that these have

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Classification, &c. have been found, individuals of the unicorn fish having protuberances on the back, and that in others the teeth were not spirally twisted, but smooth from the base to the extremity. Should these differences turn out to be uniform and constant, other species beside those already known must be admitted.

2. Monodon Spurius, the *Spurious Narhwal or Unicorn-fish.*

French, *L'Anarnak.*

59 Characters. In this species there are two small curved teeth in the upper jaw, and one fin on the back.

60 Description. This species, which has been described by Fabricius in his *Fauna Greenlandica*, properly belongs to the genus monodon, at least the characters correspond more nearly to this genus than any other. The body is oblong, rounded, and of a black colour. There are no teeth in the mouth; but to the upper jaw are attached two small teeth which are of a conical form, a little curved at the extremity, and about one inch long. Beside the two pectoral fins, there is a small one on the back.

This species is one of the smallest fishes belonging to this class. It respires like the other cetaceous fishes by a breathing hole on the top of the head.

It rarely happens that the tail fin is seen when it plunges into the water; but when it respires the air, it rises above the surface of the sea as high as the insertion of the pectoral fins.

The flesh and fat are found to have a violently purgative effect. From this property the Greenlanders have given it the name of *Anarnak*, which is adopted by the French naturalists.

It inhabits chiefly the open sea, and very rarely approaches the shores. It is most commonly found in the Greenland seas.

Class III. PHYSETER.

Genus 1st, Physeter, *Spermaceti Whale.*

61 Generic characters. The body is naked, sometimes oval, and sometimes in the form of a lengthened cone. The head is very thick, anteriorly truncated, and occupying nearly one half or one third of the whole length of the body. There is only one breathing hole, which is placed on the snout. The jaws are unequal. The lower is shorter and narrower, and it is furnished with teeth which are sometimes of a conical form, and sometimes blunt; sometimes straight, but often curved in form of a sickle. In the upper jaw there are corresponding cavities. It is also furnished with teeth, but they are flat, lie horizontally, and are scarcely visible.

The eyes are small, and are situated near the insertion of the pectoral fins. The external opening of the organ of hearing is very small, and not easily detected.

The penis, as in the other classes, is included in a sheath. The female has two mammæ situated in the abdomen, and between them are placed the parts of generation, near which is the external opening of the anus.

There are three fleshy fins. Two of these are the pectoral; and the third is at the extremity of the tail. The place of the dorsal fin is occupied by a false fin, and often by a kind of callosity.

Species. Classification, &c.

1. Physeter Macrocephalus, *the Large Spermaceti Whale.*

French, *Cachalot;* Germ. *Pottfisch;* Dutch, *Potvisch;* Norweg. *Kaskelot, Potfisk, Trold Hual.* Plate CLX. fig. 3.

62 Characters. There is a spurious fin on the back. The teeth are curved and a little pointed at the extremity.

63 Description. Of all the species belonging to this genus, this, on account of its great bulk, is entitled to the first place. The head, which occupies the third part of the body, is a large mass of a square form angular at the sides, and truncated before. The upper is of much greater length than the lower. It is also broader, its edges forming a very considerable projection, and folded back towards the centre, where there is an oval longitudinal cavity destined to receive the lower jaw. The lower jaw is furnished on each side with a row of strong conical teeth, a little curved towards the mouth, and projecting from the alveolar process about one and a half inch. The two teeth at the anterior extremity of the jaw, and the four which terminate on each side the two rows, are smaller and more pointed. The colour of them externally approaches to that of ivory: but internally they are less hard and compact, and are of an ash colour. It has been supposed that the teeth become longer, thicker, and more curved, in proportion to the age of the animal. The ordinary length is about six inches, and three inches in circumference at the base. The upper jaw is furnished with as many cavities as there are teeth in the lower jaw; but, in the interstices which separate these cavities, there are about 20 small teeth placed horizontally, and raised a little above the flesh. These teeth are sharp on the side opposite to the place of insertion, but present a smooth, plain, and oblique surface, which fills up the interval that separates the cavities. This oblique surface is only visible; the rest of the tooth is covered with flesh. And from not attending to the form and disposition of these teeth, it has been generally said that the spermaceti whale had none in the upper jaw.

The tongue is a mass of flesh of a square form, and of a livid red colour, which fills almost the whole of the bottom of the mouth.

The breathing holes, passing diagonally through the head, unite into one at the superior extremity of the snout, where the opening is about six inches diameter.

The eyes are black, very small when compared to the bulk of the body, and surrounded with a strong short hair, which is not very perceptible. The opening of the ears is not easily detected. It is placed behind the orbit of the eyes, on a cutaneous excrescence between the eyes and the pectoral fins.

The head is separated from the trunk by a transverse groove, which extends to the place of insertion of the pectoral fins. These fins are of an oval form, three or four feet long, and three inches thick.

On the back there is a callosity which extends two-thirds of the whole length. It rises several inches above the surface, and is slightly inclined. Where it terminates behind it is truncated.

The organs of generation resemble those of quadrupeds. The penis of the male is enclosed in a sheath.

On

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Classification, &c. On each side of the same organs in the female are placed the mammæ, which are four or five inches long.

The tail, which is small for the size of the fish, terminates in a fin, which is divided into two lobes, hollowed out in form of a sickle.

The back is black, or of a slate blue, spotted with white. The belly is also white. The fat or blubber, which lies immediately under the skin, is about five or six inches thick on the back, and rather less on the belly. The flesh is of a pale red, like that of pork. The head, though very large, is the least fleshy part of the body. But it yields the substance called *spermaceti*, in great abundance. This seems to vary in colour according to the climate in which the whale has lived.

The food of the spermaceti whale is the dog-fish and the lump-fish.

This whale swims with great velocity; and he often appears on the surface of the water. It is at this time that the fishermen take the opportunity of striking him with their spears; and it often happens that the parts of the body which have been wounded become gangrenous, and fall off before the death of the animal.

The flesh, the skin, the fat, and the intestines, are applied to the same purposes as those of the unicorn-fish. The tongue, roasted, is reckoned excellent food; and of the different bones of the body beside the teeth, instruments for the chase are made.

This whale inhabits chiefly the Greenland seas and Davis straits; but occasionally is found on the European shores to the southward. In the year 1784, in the month of March, 31 of these fishes came on shore on the western coast of Audierne in Lower Brittany in France. The following are the dimensions of one of these taken at the time.

	Ft.	In.
Total length,	44	6
From the anterior extremity of the snout to the eyes,	8	0
From the eyes to the pectoral fins,	3	0
From the pectoral fins to the organs of generation,	19	7
Length of the tail,	6	9
Distance of the lobes of the tail,	10	0
Circumference at the greatest thickness,	34	8
Length of the upper jaw,	5	0
——— lower jaw,	4	6
Opening of the mouth,	3	10
Breadth of the snout,	5	0

2. Physeter Catodon, *the small Spermaceti Whale*.

French *Le Petit Cachalot*; Norwegian, *Swine-Hual*; Greenland, *Kegutilik*.

64 Characters. In this species, there is a rough spurious fin on the back. The teeth are curved and blunt.

65 Description. Without attending to the form and disposition of the teeth in the cetaceous fishes, the characteristic marks are often ambiguous. All naturalists agree that the characters taken from the teeth are the most certain, because they are most constant and uniform in structure and appearance, and less subject to those variations which age and climate seem to produce. This species is, in this manner, easily distinguished from the others. The head is of a round form; the opening of the mouth is of a moderate size; the lower jaw is longer, but not so broad as the upper. It is furnished with a row of teeth on each side; and these correspond to the cavities in the upper jaw, which receive them. There is a peculiar structure of the teeth in this species. That part of the tooth which rises above the gum has a greater thickness than where it is inserted into the jaw; and besides, each tooth is flat at the top, and marked with concentric lines. The longest teeth are two inches in length, and about an inch in circumference at the greatest thickness.

Sibbald has mistaken the breathing holes for nostrils; and this seems to have arisen from the position of the breathing holes near the snout of the fish.

This species is chiefly an inhabitant of the northern seas.

Towards the end of the 17th century, 102 of this species came on shore at Cairston in the Orkney islands. The longest was 24 feet.

3. Physeter Trumpo, the *Spermaceti Whale*.

French, *Le Cachalot de la Nouvelle Angleterre; Le Trumpo.*

This species is distinguished by a bunch on the back, and having the head straight and pointed. 66 Characters.

The head of this species is of an immense size. It divides the body nearly into two equal parts. The upper jaw is much longer and thicker than the lower, which is furnished with 18 teeth, straight and pointed, about three inches distant from each other; and when the mouth is shut, they are received into cavities of the upper jaw. 67 Description.

The eyes are small. The breathing hole is at least a foot in diameter, and it is placed at the superior extremity of the snout.

The thickest part of the body is near the insertion of the pectoral fins. These are very small, and that of the tail is divided into two lobes. In place of the dorsal fin, there is a bunch on the back which is more than a foot thick. It is placed nearly opposite to the parts of generation.

The skin is of a grayish colour, and very soft to the touch. The length of this whale varies from 48 to 60 feet.

It is chiefly an inhabitant of the seas which wash the shores of New England.

An individual of this species landed in the year 1741, near Bayonne in France. It yielded ten tons of spermaceti, which was reckoned of a superior quality to that of the large spermaceti whale. In the stomach of the same whale was found a round mass of seven pounds weight, which was taken for ambergrease.

The substance called *spermaceti* is lodged in particular cells in the head near the seat of the brain. It is extracted by making a hole in the skull. 68 Spermaceti.

It has been observed by some naturalists that this whale is more agile and more dangerous than any other of the species. When it is wounded, it is said that it throws itself on its back, and defends itself with its mouth.

Mr Pennant has described this under the name of the *blunt-headed whale* (Physeter Microps, Lin.). But if we attend to the form of the body, the structure of the

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Classification, &c. the head, the number and structure of the teeth, it seems to constitute a distinct species.

Dimensions of the Spermaceti Whale thrown ashore near Bayonne.

	Feet.	Inches.
Total length,	49	0
Greatest circumference at the eyes,	27	0
From the extremity of the tail fin to the opening of the anus,	14	0
Length of the penis,	4	0
——— sheath which encloses it,	1	6
Diameter of the penis	0	7
Distance of the extremities of the two lobes of the tail,	13	0

4. Physeter Cylindricus, the *Round Spermaceti Whale.*

69 Characters. There is a bunch on the back; the teeth are curved and pointed at the top; the breathing hole is in the middle of the snout.

70 Description. The form and relative situation of the trunk and head, the position of the breathing-hole, the relative length of the jaws, the number and structure of the teeth, and especially the size of the dorsal fin, present differences which sufficiently distinguish this from the following species. The body is cylindrical, from the extremity of the snout to a line drawn perpendicular to the place where the penis is inserted, and from thence to the tail fin it gradually diminishes. The head is at least the third of the whole length of the body. The profile of the head presents a kind of parallelogram. The jaws are nearly of equal length. On each side of the lower jaw there is a row of 25 curved, sharp-pointed teeth. The breathing-hole is placed at the superior extremity of the snout. The dorsal fin is replaced by a bunch, 18 inches high, and four and a half inches long at the base. The tail fin is divided into two lobes, forming a kind of crescent.

One of this species is described by Anderson, which was 48 feet long, 12 of perpendicular height, and 36 in circumference, at its greatest thickness.

5. Physeter Microps, the *Black-headed Spermaceti Whale* or *Cachalot.*

French, *Cachalot Microps, Cachalot à dents en Faucille;* Norwegian, *Staur-Hyming;* Greenland, *Tisagusik.*

71 Characters. In this species there is a long straight fin on the back. The teeth are curved, the point is at first directed to the mouth, and then turns outwards.

72 Description. The descriptions of naturalists who have treated of this species of whale are greatly confused; and this probably arises from not having attended sufficiently to the form of the teeth. According to Fabricius, there are only 22 teeth in the lower jaw, 11 on each side. All these teeth are curved, having the concave side towards the mouth, and are sunk in the jaw-bone, two-thirds of their whole length. The external part of the teeth is white as ivory, of a conical form; and the point which is sharp inclines a little outwardly. That part of the tooth which is sunk in the jaw is compressed on two sides, and furrowed on that side next to the gullet. The Greenlanders say that this whale has teeth in the upper jaw; but this is not clearly ascertained. Perhaps they are only flatted teeth, similar to what we have described in the great spermaceti whale. Each tooth extends to a finger length, and is about one and a half inch broad. The longest occupy the middle part of the jaw. The smaller are at the extremities. The snout ends in a blunt surface; and, according to most naturalists, the upper jaw is the longest.

The pectoral fins are about four feet long. What occupies the place of a fin on the back is of considerable height, and has been by some naturalists compared to a long needle.

This whale is the declared enemy of some of the other whales, as the pike-headed whale and the porpoise, which it pursues as its prey. In Greenland the flesh of this whale is greatly esteemed, even more than that of any of the other species. It is rarely taken with the harpoon.

It inhabits chiefly the northern ocean.

6. Physeter Mular.

French, *La Cachalot Mular.*

This species is distinguished by a very elevated fin on the middle of the back. The teeth are slightly curved and obtuse. 73 Characters.

This species resembles the former in the general structure of the body. It differs in the form of the teeth, which are less curved, and are obtuse. The longest, which are eight inches in length, and nine inches in circumference, occupy the front of the jaw. The others are only six inches long. Sometimes the teeth are found to be hollow, and sometimes they are solid. Is this owing to the difference of age in the individuals in which it has been observed? Beside the pectoral fins, that which is placed on the back is very remarkable on account of its length. Sibbald compares it to the mizzen mast of a vessel. 74 Description.

According to Anderson, this species is farther distinguished by having three bunches or protuberances towards the extremity of the back: the first is 18 inches high; the second, six inches; and the last only three inches. The same historian has observed, that he was informed by the captain of a ship, that he saw on the coast of Greenland a great number of this species of whale, at the head of which was one of 100 feet long, which seemed to be the leader; and which, at the appearance of the ship, gave such a terrible shout, spouting water at the same time, as to shake the vessel. At this signal, the whole made a precipitate retreat.

This species is gregarious, and frequents the seas about the North Cape. They are but rarely taken; for they are very wild and difficult to wound. It appears, that the harpoon can only pierce them in one or two places near the pectoral fins.

The fat or blubber is very tendinous, and yields but a small proportion of oil.

Class IV. DELPHINUS.

Genus 1st, Delphinus, the *Dolphin.*

The body is naked, oval, or of an oblong conical shape, of a blue colour, inclining to black. The head is conical, diminishing gradually towards the snout. 75 Generic characters.

Classification, &c. The breathing hole, which is on the top of the head, is in form of a crescent, the horns of which are directed towards the snout. The jaws are of equal length, sometimes beaked, and sometimes rounded. They are furnished with teeth, which are conical or compressed, pointed or obtuse, and in some species notched.

The eyes are placed near the angles of the mouth. The pupil of the eye is black, and the iris white. The external opening of the ears is situated behind the eyes. The nostrils terminate in the snout.

The penis of the male is included in a sheath; and the mammæ of the female are attached to the belly; and between them are the organs of generation.

There are four fins; two are pectoral; there is one on the back, and one at the extremity of the tail. In one species only the dorsal fin is wanting.

Species.

1. Delphinus Phocæna, the *Porpoise* or *Porpesse*.

French, *Le Marsouin*; Spanish, *Marsopa*: Dutch, *Bruinvisch*; German, *Meerschwein, Braunfisch*; Danes, *Marswin, Tumler*; Norweg. *Nise*; Greenland, *Nisa*.

76 Characters. The form of the body is conical. The dorsal fin is triangular. The snout is pointed. The teeth are enlarged at the summit, rounded and cutting.

77 Description. The body of this fish is round, thick, and diminishes towards the tail. The head resembles an obtuse cone. It is swelled out towards the top above the orbits of the eyes. It then gradually diminishes, and ends in a sharp snout.

The eyes are placed opposite to the opening of the mouth; and the pupil of the eye, which is black, is surrounded with a white iris. Behind the eyes there is a small round hole, about one inch in diameter: This is the organ of hearing. The nostrils are placed between the breathing hole and the extremity of the snout. The breathing hole is situated on the top of the head, in a line perpendicular to the interval between the eyes and the angles of the mouth.

The pectoral fins are attached to the edges of the lower surface of the body. The dorsal fin is triangular, and is situated very nearly on the middle of the trunk. Directly under the dorsal fin on the belly are the parts of generation. The anus is situated at an equal distance between the parts of generation and the tail fin.

The length of the porpoise is from four feet to six and eight. This fish is an excellent swimmer. When it rises to the surface to respire, the back only appears; the head and tail are kept under water. But when it is dead, it becomes straight.

78 Food. It feeds on small fishes, and pursues them with inconceivable rapidity.

79 Manners. The porpoise is generally gregarious; this is particularly the case in the time of copulation in the month of August. It is not unusual to see at that time 15 males in pursuit of one female; and so eager are they in the chase, that they are often thrown ashore. The female goes with young 10 months, and brings forth one at a time. At birth the young one is of considerable size, and it constantly follows the mother till it is weaned. When a pregnant female is killed, it has been observed that the tail of the fœtus is seen thrust through the navel of the mother. This is supposed to be occasioned by the spasmodic contraction, produced by the efforts of the mother in the struggles of death.

80 Uses. The flesh of the porpoise has a disagreeable oily taste. It is however used as food by the inhabitants of Lapland and of Greenland. In Greenland they suffer it to undergo some degree of putrefaction to make it tender, and then they prepare it by roasting or boiling. They use the skin, the fat, and the entrails for this purpose. The Dutch and the Danes take the porpoise only for the extraction of the oil.

The porpoise inhabits those places which are sheltered by rocks and bays, and is oftener seen in summer than in winter.

2. Delphinus Delphis, the *Dolphin*, or *Bottle-nosed Whale*.

French, *Dauphin*; German, *Meerschwein, Tummler*; Dutch, *Dolphin Taymelaar*; Norwegian, *Springer*; Iceland, *Leipter*.

The body is nearly oval. The dorsal fin is curved at the top. The snout is flattened and sharp. The teeth are cylindrical and pointed. 81 Characters.

The greatest thickness of the dolphin is at the insertion of the pectoral fins; from which the body gradually diminishes towards the head and tail, and thus has the oval form. The head enlarges at the top like that of the porpoise; but, in the dolphin, it diminishes in thickness, and ends in a flatted beak, like that of a goose. The jaws are of equal length, and furnished on each side with a row of cylindrical teeth, a little pointed at the end, and projecting near one and a half inches above the gum. It would appear that the number of teeth varies according to the age and sex. Klein has reckoned 96 in the upper jaw, and 90 in the under. Mr Pennant, on the contrary, mentions that he saw 19 teeth in the latter, and 21 in the former. Forty-seven teeth have been observed by others in each jaw. 82 Description.

The eyes are placed almost in the same line with the opening of the mouth. The breathing hole is on the top of the head, opposite to the orbit of the eyes. It appears in form of a crescent, the horns of which are directed towards the snout.

The pectoral fins are oval, and inserted at the under part of the breast. The dorsal fin occupies the middle of the body. It is curved backwards at the extremity. The tail fin is divided into two lobes, the one of which folds over the other.

The upper surface of the body is black; the breast is white. From under the eyes on each side passes a white ray, which stretches towards the pectoral fins.

The dolphin is almost always an inhabitant of the open seas, and very rarely approaches the shore. His motions are inconceivably swift; and hence he has been named by the mariners, the *arrow of the sea*.

The length of the dolphin varies from five to nine or ten feet.

The description which has now been given, has little relation to the fanciful accounts which have been detailed of this fish, or to the imaginary representations by the ancient painters and engravers. On the pieces of money which were in circulation in the time of Alexander the Great, and are preserved by Belon, as well as on other medals, the dolphin is represented with 83 Fabulous history.

Classification, &c. with a very large head, a spacious open mouth, and the tail raised above the head.

No animal has been more celebrated by the ancient poets and historians than the dolphin. From the earliest ages he was considered as consecrated to the gods, and honoured as the benefactor of man. Pliny, Ælian, and other ancient authors, speak highly of his attachment to mankind. The younger Pliny has written a charming story of the loves of a dolphin for Hippus; and Ovid relates, with all the beauties of poetry, the story of the musician Arion, who being pursued by pirates and thrown into the sea, was rescued and saved by this kind animal.

Inde (fide majus) tergo delphina recurvo,
Se memorant onere supposuisse novo.
Ille sedens citharamque tenet, pretiumque vehendi
Cantat, et æquoreas carmine mulcet aquas.
Di pia facta vident. Astris delphina recepit
Jupiter; et stellas jussit habere novem.
OVID. Fasti, lib. ii. 117.

But (past belief) a dolphin's arched back
Preserved Arion from his destined wreck.
Secure he sits, and with harmonious strains
Requites his bearer for his friendly pains.
The gods approve: the dolphin heaven adorns,
And with nine stars a constellation forms.

But after all these fabulous accounts of the dolphin by the ancients, and the presages drawn by the modern sailors from their movements, it does not appear that this species of fish is endowed with more sagacity than any other of the cetaceous fishes, or discovers greater attachment to man. What may have been the foundation of these fables, it is not our present object to inquire. It is true, that the dolphin and others of the cetaceous fishes accompany ships for several days together. But this seems to be in search of food, on account of the offals of animal matters that are thrown overboard.

3. DELPHINUS TURSIO.

Greenland, *Nesarnak*; French, *Le Nesarnak*.

84 Characters. The form of the body is conical. The dorsal fin is curved. The snout is compressed above. The teeth are straight and blunt.

85 Description. The greatest thickness of this species is between the dorsal and pectoral fins. From this to the extremity of the tail the body becomes gradually more slender.

The breathing hole, which is placed above the orbits of the eyes, is about 1½ inch in diameter. The anterior part of the head is inclined and rounded, and terminates in a flat beak. The lower jaw is the longest. Both jaws are furnished with 42 cylindrical teeth, which are disposed in a single row.

The pectoral fins are very low, and are of a falciform shape. The dorsal fin rises like an inclined plane, and is incurvated behind. At the posterior base of the latter fin there arises a projection which stretches to the tail. The tail fin is divided into two lobes in form of a crescent.

The upper part of the body is black; the belly is white.

It has been observed by some naturalists, that when this species rises to the surface to respire, a great part of the body appears above water. It inhabits the open seas, and is consequently taken with difficulty. The flesh, the fat, and the entrails, are eaten in the same way as the porpoise.

DELPHINUS ORCA, *the Grampus*.

Plate CXL. fig. 4.

French, *Epaulard*; Norwegian, *Spek-Hugger*; *Hoval-Hund*; Dutch, *Botskop*; Iceland, *Huyding*; Swedes, *L'Opare*.

86 Characters. The body is nearly oval. The dorsal fin is very high. The teeth are conical and slightly curved.

87 Description. The profile of the grampus is oval and oblong. The greatest thickness is about the middle of the trunk, from which it gradually diminishes towards both extremities. The snout is short and round. The lower jaw is broader than the upper. Both jaws are furnished with conical teeth, which are unequal and curved at the top, and are from 20 to 30 in number in each jaw.

The eyes are situated in the same line with the opening of the mouth.

But the most distinguishing mark of the grampus is the dorsal fin, which rises from the middle of the back in the form of a cone, and is nearly four feet in height. The pectoral fins are very broad, and nearly oval. The tail fin is divided into two lobes in the form of a crescent. The penis is three feet in length.

The upper part of the body is black; the belly is white. Sometimes white spots are observed on the head and back.

The grampus is the largest fish belonging to the genus. Some have been seen of 25 feet in length by 12 or 13 in circumference. One of 24 feet long was taken in the mouth of the river Thames in the year 1759.

All naturalists agree in describing the grampus as the most cruel and voracious of the family of the dolphin. Its ordinary food is the seal and some species of flat fish. But it is said that it will attack the porpoise, and even the large whale. The latter, so far from defending himself, is struck with terror, utters dreadful shouts, and, to escape from the enemy, quits the open seas, and retires towards the coasts, which is perhaps the reason that the whale is sometimes thrown ashore. The grampus, however, is often the victim of its voracity. It is at this time that the fishermen watch the opportunity of striking him with the harpoon.

When the emperor Claudius was engaged in the construction of the harbour of Ostia, a grampus, attracted by some skins which had been sunk in a shipwreck, came upon the coast. There he remained for several days; and forming a kind of canal to receive his huge body in the sand, was protected from the agitation of the sea. While in pursuit of his prey, one day, he was driven ashore by the violence of the waves. The back appeared above the surface of the sea, and resembled a ship with its bottom upwards. The emperor caused strong nets to be stretched across the mouth of the harbour to prevent the escape of the fish, in case he should again get into the water. He then advanced in person, accompanied with his pretorian bands, and exhibited a very amusing spectacle to the Romans. The soldiers embarked in boats were ordered to attack him with spears and other missile weapons. One of the boats was filled with water, and sunk

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Classification, &c. sunk in consequence of the fish spouting with great violence.

a. A variety of the grampus is described by the late Mr John Hunter, in the Philosophical Transactions for 1787. It is distinguished particularly by having a very large belly, which diminishes suddenly towards the region of the anus. The dorsal fin reaches nearer the tail. It has the form of a rectangular triangle, and is longer, but less elevated than the first described. The lower part of the body is not perfectly white, but is marked with brown and black spots.

88

5. Delphinus Gladiator, the *Sea-Sword*.

Characters. The form of the body of this species is conical. The dorsal fin resembles a sabre. The teeth are small and sharp.

89 Description. This species comes very near the grampus in the form of the head; but it is chiefly distinguished by the dorsal fin, which is three or four feet high, and about 18 inches broad at the base. It becomes slender toward the summit, and is incurvated towards the tail. This fin seems to be an offensive instrument; for with it they strike and wound the whale. The length is from 23 to 25 feet.

This species is gregarious. They are found together in small bodies, which attack the whale with great fury, and tear off large masses from his body. When he becomes warm and fatigued, he lolls out his tongue, which is instantly seized by the watchful enemy. They even enter the mouth and tear out the tongue entirely, which seems with them to be a delicate morsel. The delphinus gladiator possesses immense strength. They have been known to seize upon a dead whale that was dragged by a number of boats, and carry it to the bottom.

They are found near Spitzbergen, in Davis straits, and on the coasts of New England, and even so far north as the 79° of latitude. They are very fat, and the oil which they yield is esteemed very good.

6. Delphinus Leucas.

Beluga, Pennant's Quadrup.: *Whittfisch*, Anderson's Iceland.

90 Characters. The form of the body is conical. There is no dorsal fin. The teeth are short and blunt.

91 Description. This species has been arranged by some naturalists among the whales, but having teeth in both jaws makes it properly come under this genus. The body resembles a lengthened cone, having the base at the pectoral fins, and the vertex at the tail. The head is short, and ends in an obtuse snout, on the top of which is a protuberance in which is the blow-hole, which terminates in an oblique direction towards the posterior part of the body. The jaws are nearly equal. The lower jaw is furnished with nine small obtuse teeth on each side, which resemble in structure the grinding teeth of quadrupeds. The teeth in the fore part of the jaw are the smallest. In the upper jaw the number of teeth is the same, but they are more pointed and slightly curved.

The eyes are not larger than those of the hog. The opening of the mouth is small, and the tongue is strongly attached to the lower jaw. Behind the eyes is the external opening of the ear, but it is scarcely visible.

The pectoral fins are broad and of an oval figure. The dorsal fin is wanting, but in its place there is an angular protuberance. The tail fin is divided into two rounded lobes. Classification, &c.

The penis of the male is bony, of a white colour, and inclosed in a sheath. The mammæ of the female are placed on each side of the organs of generation.

The whole body is white, and marked in young fishes with brown and blue spots. The skin is an inch thick, and covers a layer of fat of three inches. It is said that the flesh of this species has a reddish colour like that of pork.

It lives on different fishes, particularly the cod and the soal fish. And as the throat is of small capacity, it is sometimes suffocated in attempting to swallow fish of too large size. The female has one young at a time, which at birth is of a greenish colour, but becomes afterwards bluish, and as it advances in age is white. The females are gregarious, and the young follow at their sides, imitating all their motions. This species is often observed following ships, and exhibiting by a thousand different motions an amusing spectacle.

It quits the open sea during the rigour of winter, and enters the bays that are free from ice. It is seldom an object of trade, on account of the little advantage from the fat. Their arrival, however, is considered by the whale fishers as the fortunate presage of an abundant fishery. The length is from 12 to 18 feet.

7. Delphinus Bidentatus.

The body is conical. The dorsal fin is spear-shaped. The snout is slender and flat. There are two sharp teeth in the lower jaw. 92 Characters.

This species in some of its characters resembles the *delphinus tursio*, but in others is so different that it may properly be regarded as a distinct species. The forehead is convex and rounded. The upper jaw is flat, and ends in a beak like that of a duck; but there are only two sharp teeth at the anterior extremity of the lower jaw. The pectoral fins, which are of an oval form and small for the size of the body, are placed opposite to the angles of the mouth. The place of the dorsal fin corresponds to the origin of the tail, is spear-shaped, pointed, and inclines backward. The tail fin is divided into lobes, forming by their union a crescent. The lower part of the body is of a light brown colour, the upper part is brownish black. This species is supposed to be from 30 to 40 feet long. 93 Description.

8. Delphinus Butskopf, *Bottle-headed* or *Beaked Whale*.

The form of the body is conical. The dorsal fin is incurvated towards the tail. The snout is flat and slender. The upper jaw and the palate are furnished with small teeth. 94 Characters.

The body represents a cone whose summit is towards the tail. The head is of a greater height than breadth. The front, which is full and round, becomes suddenly narrow, and ends in a flat beak rounded at the extremity. The breathing-hole is on the top of the head, opposite to the orbit of the eyes; it forms a crescent whose horns are turned towards the tail. This is the characteristic 95 Description.

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Classification, &c. characteristic mark between this and other species of *delphinus*. In place of teeth the surface of the palate and upper jaw are covered with small points, which are unequal and hard. The tongue adheres to the lower jaw, and is notched at the edges. The edge of the upper jaw is also notched.

The eyes are convex as in quadrupeds. They are surrounded with eyelids, and are placed nearly in the middle of the side of the head.

The pectoral fins are attached to the lower part of the breast; they are small in proportion to the size of the fish. The dorsal fin is nearer the tail than the snout: the summit is incurvated backward. The tail-fin is divided into two lobes in form of a sickle.

The whole body excepting the belly is of a leaden colour.

In the *Journal de Physique* for the year 1789, M. Baussard has published an account of two cetaceous fishes which were taken near Honfleur in September of the preceding year. The largest was 23½ feet long, and the smallest 12½. The fishers of Honfleur perceived them at a distance struggling on the strand. When they approached they found the smallest stuck on the sand in shallow water. The mother made many attempts to move her young one into deep water, and not only failed but stuck fast by the head, the heaviest part of the body. The fishermen first took possession of the young one, secured it with ropes; and by their own exertions, aided by a horse and the flowing of the sea, succeeded in bringing it on shore. They then went into the water up to the middle to secure the mother; and having made above 50 wounds with knives on the head and back, and a large wound in the belly, at which the fish seemed to be in great pain, by uttering groans like those of a hog, they were driven off by the violent motion of the tail. A small anchor was then brought, which was introduced into the breathing hole, and a rope was fastened round the tail. The fish finding herself thus entangled, made such violent efforts, that she broke a thick rope, disengaged herself from the anchor, and taking the advantage of the rising tide, escaped and launched into the deep, at the same instant throwing up an immense quantity of water mixed with blood to the height of 12 feet. She was found next day floating on the water quite dead, at the distance of three leagues from Honfleur.

The following are the principal dimensions of the young fish and the mother,

	Young one. Feet.	Inches.	*Mother.* Feet.	Inches.
Total length,	12	6	23	6
Greatest circumference,	8	0	15	7
Distance from the breathing-hole, to the extremity of the snout,	1	11	4	4
Length of the dorsal fin,	1	0	2	0
Height of ditto	0	7	1	3
Length of the pectoral fins,	1	0	2	0
Breadth of ditto,	0	7	1	3
Breadth of the tail fin,	3	2	6	10

M. Bonnaterre, Encycloped. Method.

9. Delphinus Feres.

96 Characters. In this species there is one fin on the back. The head is rounded. The teeth are oval and obtuse.

The head is nearly of the same height as the length. It is very thick at the top, and suddenly diminishing towards the anterior part ends in a short round snout. The jaws are equal; they are covered with membranous lips, and furnished internally with a row of teeth; 20 have been reckoned in each jaw. The form of the teeth constitutes the distinctive character of the species. The large and the small teeth are equal in number. The largest are above an inch long by half an inch broad. The small teeth are only five or six lines in length.

97 Description.

The skeleton of one of this species is preserved in the cabinet of natural history at Frejus in France. The length is 14 feet. The bones of the skull are 1 foot 10 inches long, and 1 foot 5 inches broad.

This species is found in the Mediterranean sea.

Chap. II. *Of the Anatomy and Physiology of Cetaceous Fishes.*

98 Difficulties in acquiring a knowledge of their structure.

It has fallen to the lot of few anatomists to have an opportunity of examining with accuracy the structure of cetaceous fishes. The same difficulties which have retarded the progress of their natural history, operate perhaps still more powerfully in preventing the acquisition of information with regard to their anatomical structure. They are not inhabitants of those parts of the world where this knowledge is in that improved state to render such investigations successful: and when they are accidentally found on the shores of civilized countries, the anatomist, whose skill and dexterity only could be advantageously employed in the examination, is not always at hand, and they are too large to be transported to the dissecting-room, where the nature and structure of the different parts could be patiently traced and faithfully demonstrated. Several of the species of this tribe of fishes have been dissected by the late Mr John Hunter, the detail of which he has given in a paper on the Structure and Economy of Whales, in the Philosophical Transactions for the year 1787, and to this paper we must acknowledge ourselves indebted for the principal part of the anatomical knowledge which we propose to lay before our readers in the present chapter.

99 Distinctive characters.

We have already mentioned the characters which distinguish the whale tribe from fishes in general. They have indeed nothing peculiar to fish, except that they live in the same element, and have the same powers of progressive motion as those fish, which from their nature must move with great velocity. This seems to be the case with all fish which come to the surface of the water, as the whales must do for the purpose of respiration. It has also been observed that they are more closely allied to quadrupeds than to fish. They have in many respects the peculiar structure and economy of parts which belong to this class of animals. They are furnished with lungs, breathe air, and have warm blood.

100 Allied to quadrupeds.

101 Fitted for rapid motion.

This tribe of animals is peculiarly fitted by their external form for dividing the water in progressive motion, and for moving with considerable velocity. And, on account of the uniformity of the element in which they live, the form of their bodies is more uniform than in animals of the same class that live on land.

The

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102 Form of the head; The form of the head is commonly a cone or inclined plane. The spermaceti whale is an exception to this, in which it terminates in a blunt surface. The head is larger in proportion to the body than in quadrupeds, and swells out laterally at the articulation of the lower jaw. This seems to be of advantage to the animal in catching its prey, as there is no motion of the head on the body.

103 of the body. Behind the pectoral fins, at the insertion of which the circumference is greatest, the body gradually diminishes to the spreading of the tail. The body is flattened laterally; and it would appear that the back is sharper than the belly, which is nearly flat.

104 Power of the tail. The progressive motion of the animal is performed by the tail, which moves the broad termination or lobes, operating in the same manner as an oar in sculling a boat. And for the purpose of preventing any obstruction in moving through the water, it may be observed that all the external parts of the class mammalia, that live on land, are either entirely wanting, or are concealed under the skin in cetaceous fishes.

Sect. I. *Of the Bones.*

105 The skeleton gives no idea of the general form. The bones alone, Mr Hunter observes, when properly united into the skeleton, in many animals give the general shape and character. But this is not so decidedly the case in this order of animals. In them the head is immensely large, the neck small, there are few ribs, in many a very short sternum, and no pelvis, with a long spine terminating in a point, so that these bones being merely joined together do not afford any idea of the regular shape of the animal. The different parts of the skeleton are so enclosed, and the projecting spaces between the parts so filled up, that they are altogether concealed, and give to the animal externally an uniform and elegant form.

106 Bones of the head; The great size of the bones of the head leave but a small cavity for the brain. In the spermaceti whale it is not easy to discover where the cavity of the skull lies. This is also the case with the large whalebone and bottle-nose whale. In the porpoise, the skull constitutes the principal part of the head: for the brain is found to be considerably larger in proportion to the size of the animal. The bones of one genus differ very much from those of another. In the spermaceti and bottle-nose whales, the grampus and the porpoise, the lower jaws, especially at the posterior ends, resemble each other; but in others it is very different. The number of particular bones is also observed to vary very much.

107 of the neck and back; *Vertebræ.*—The piked whale has seven vertebræ in the neck, 12 in the back, and 27 to the tail. This makes the whole number 46. In the porpoise the cervical vertebræ are seven in number. There is one common to the neck and back, 14 proper to the back, and 30 to the tail, making in whole 51. The cervical vertebræ of a bottle-nose whale, were the same in number as those of the porpoise. There were 17 in the back and 37 in the tail, which make the whole number 60. Four of the vertebræ of the neck in the porpoise are anchylosed, or have grown together. The atlas in every one of this order of animals that has been examined is the thickest of the vertebræ. It seems to be composed of two. There is no articulation between the first and second vertebræ of the neck to admit of rotatory motion. The vertebræ of the neck are very thin, so that the distance between the head and shoulders is as short as possible.

Sternum or *Breastbone.*—This is very flat in the piked whale, and consists of a single very short bone. The breastbone of the porpoise is considerably longer; it is composed of three bones, which are of some length in the small bottle-nose whale. The first rib of the piked whale, and the three first of the porpoise, are articulated to the sternum. 108 of the breast.

Ribs.—The small bottle-nose whale, dissected by Mr Hunter, had 18 ribs on each side; and the porpoise had 16. Fifteen ribs have been reckoned in the skeleton of the dolphin. A large whalebone whale had 15 ribs on each side, which were 21 feet long and 18 inches in circumference. The spermaceti whales which were thrown ashore on the coast of Brittany in France, had only 8 ribs on each side. They were 5 feet long and 6 inches in circumference. 109 Ribs

The ends of the ribs that have two articulations, in the whole of this tribe, Mr Hunter observes, are articulated with the body of the vertebræ above, and with the transverse processes below, by the angles, so that there is one vertebra common to the neck and back. In the large whalebone whale the first rib is bifurcated, and consequently is articulated with two vertebræ. 110 articulated with two vertebræ.

Pectoral or *lateral fins.*—These are analogous, and somewhat similar in construction to the anterior extremities of quadrupeds. They are composed of a scapula or shoulder-blade, os humeri, ulna, radius, carpus, and metacarpus, which last may include the fingers, the number of bones being such as may be reckoned fingers, although they are included in one general covering. The number of bones in each is different, the fore-finger has five, the middle and ring-finger has seven, and the little finger has four. These bones are not articulated by capsular ligaments as in quadrupeds, but by intermediate cartilages attached to each bone. These cartilages are nearly equal in length to one-half of the bone. This construction gives firmness and a considerable degree of pliability to the whole. 111 Pectoral fins similar to the extremities of quadrupeds.

Teeth.—Of this tribe of animals some have teeth in both jaws, some have them only in one, while there are others which have none at all. The teeth cannot be divided into classes as in quadrupeds. They are all pointed teeth, and are pretty much similar in form and size. Each tooth is a double cone, one part of which is fastened in the jaw, and the other projects above the gum. In some, indeed, the fang is flattened and thin at the extremity; and in others it is curved. 112 Teeth

The formation of the teeth, and their progress afterwards, seems to be different from that of quadrupeds: For they seem to form in the gum, so that they must either extend and sink into the jaw, or the alveoli must rise to enclose them. Mr Hunter thinks this last the most probable, since the depth of the jaw is increased, so that the teeth seem to sink deeper and deeper in it. This mode of formation is observed in jaws that are not fully grown; for, as happens in other animals, the teeth increase in number as the jaw lengthens. 113 formed differently from quadrupeds.

It does not appear that they shed their teeth, or 114 Are not have shed.

Anatomy and Physiology. have new ones formed similar to the old. This indeed seems scarcely possible from the situation in which they are originally formed.

115 Peculiar substance. *Whalebone.*—This is a substance peculiar to the whale. It is of the same nature as horn. It is therefore entirely composed of animal matter, and is extremely elastic. The name of bone is undoubtedly improper, as it has no earthy matter in its composition; but as it has been commonly employed we shall still retain it.

116 Two kinds. There are two kinds of whalebone. One kind is got from the large whale; the other from a smaller species. It is placed in the inside of the mouth, and is attached to the upper jaw. It consists of thin plates of different sizes in different parts of the mouth. The length and the breadth of the whalebone, although not always, in general correspond pretty nearly; those plates that are longest being also the broadest.

117 Arrangement. These plates are arranged in several rows on the outer edge of the upper jaw, similar to the teeth in other animals, and stand parallel to each other, one edge being towards the circumference of the mouth, and the other towards the inside. They are placed at unequal distances in different parts of the mouth. In the piked whale, they are only one-fourth of an inch asunder at the greatest distance. In the great whale the distances are greater.

118 Outer row. The longest plates are in the outer row; and the length is proportioned to the different distances between the different parts of the jaws. Some of them are 14 or 15 feet long, and 12 or 15 inches broad. Towards the anterior and posterior part of the mouth they are very short. They rise for half a foot or more of the same breadth, and afterwards shelve off from the inside till they come nearly to a point at the outer. The exterior of the inner rows are the longest, corresponding to the termination of the declivity of the outer, and become shorter and shorter, till they hardly rise above the gum.

119 Inner row. The inner rows are closer than the outer, rise almost perpendicularly from the gum, are longitudinally straight, and have less declivity than the other. The plates of the outer row make a serpentine line laterally, and in the piked whale the outer edge is the thickest. Round the line made by their outer edge runs a small white bead, which is formed along with the whalebone, and wears down with it; both edges of the smaller plates are of nearly the same thickness. In all

120 Hair. of the plates, the termination is in a kind of hair, as if the plate were divided into innumerable small parts. The exterior plates have the strongest and also longest.

The whole surface of the mouth resembles the skin of an animal covered with strong hair; and under this surface the tongue lies when the mouth is shut. In the piked whale the projecting whalebone remains entirely on the inside of the lower jaw, when the mouth is shut, because the jaws meet everywhere along their surface. Mr Hunter is at a loss to explain how this is effected in large whales, in which the lower jaw is straight, forming a horizontal plane; but the upper jaw being an arch, cannot be hid by the former. He therefore supposes that a broad upper lip reaches to the lower jaw and covers the whole.

The formation of the whalebone is in one respect similar to that of horn, hair, &c. but it has another mode of growth and decay which is peculiar. The plates form upon a thin vascular substance, which does not immediately adhere to the jaw-bone; but which has a more dense vascular substance between. From this substance thin broad processes, corresponding to each plate, are sent out; and on these processes the plate is formed, in the same way as the horn on the bony cone, or the tooth on the pulp. Each plate is necessarily hollow at the growing end, and the first part of the growth takes place on the inside of the hollow. But besides this mode of growth, it receives additional layers on the outside, which are formed on the vascular substance extended along the surface of the jaw. This part also forms upon it a kind of horny substance between each plate, which is very white, rises with the whalebone, and becomes even with the outer edge of the jaw, and the termination of its outer part forms the bead above mentioned. This intermediate substance fills up the space between the plates, as high as the jaw, and is similar to the alveolar processes, keeping them firm in their places. Anatomy and Physiology. 121 Formation peculiar.

As both the whalebone and the intermediate substance are constantly growing, a determined length must be supposed necessary, so that there must be a regular mode of decay established, which does not depend entirely on chance or accidental circumstances. In its growth there seems to be a formation of three parts; one from the rising cone, which is the centre, a second on the outside, and a third being the intermediate substance. These appear to have three stages of duration; for that which forms on the cone, it is supposed, makes the hair; and that on the outside makes principally the plate of the whalebone; and this, when got a certain length, breaks off, leaving the hair projecting, becoming at the termination very brittle; and the third or intermediate substance, by the time it rises as high as the edge of the skin of the jaw, decays and softens away.

The use which has been ascribed to the whalebone, is principally for the retention of the food till it is swallowed; for it is supposed that the fish which are taken by the species of whale having this peculiar construction of the mouth, are small when compared with its size. Plate CXLI. Fig. 3, 4, 5.

SECT. II. *Of the Skin and Muscles.*

The cuticle, or scarf skin, in this order of animals, is similar to that on the sole of the foot in the human species. It seems to be composed of a number of layers, which may be separated by slight putrefaction. Mr Hunter suspects that this arises from a succession of cuticles being formed. The fibres of the cuticle appear to have no particular direction. It has no elasticity, but is easily torn asunder. The internal layer is tough and thick, and in the spermaceti whale, the external surface resembles coarse velvet. The cuticles gives the colour to the animal. In parts that are dark, a dirty coloured substance has been washed away in separating the cuticle from the true skin. This seems to be the *rete mucosum.* 122 Cuticle.

The cutis or true skin in cetaceous fishes is extremely villous in the external surface, corresponding to the rough surface of the cuticle, and forming ridges in some 123 True skin.

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some parts. The villi, which are soft and pliable, float in water, and are observed to be longer or shorter in proportion to the eyes of the animal. In some they are one-fourth of an inch in length, and in all they are very vascular.

The cutis seems to be the termination of the cellular membrane of the body more closely united, having smaller interstices, and becoming more compact. In fat animals the distinction between skin and cellular membrane is small, the gradation from the one to the other being almost imperceptible; for the cells of both membrane and skin being loaded with fat, the whole seems to be one uniform substance. A loose elastic skin would appear to be improper in this tribe of animals; it is therefore always on the stretch by the adipose membrane being loaded with fat. In some places, indeed, where it seems to be necessary, it possesses considerable elasticity, as at the setting on of the fins, and under the jaw, round the opening of the prepuce, the nipples, &c. to allow free motion of these parts, where it is observed that there is more reticular and less adipose membrane.

In the piked whale there is a very singular instance of an elastic cuticular contraction. The whole skin of the fore part of the neck and breast, and as far down as the middle of the belly, is extremely elastic; but it receives an increased lateral elasticity by being ribbed longitudinally. It is not easy to say why this part which covers the thorax should possess so much elasticity, for this part of the body cannot be increased in size.

124 Muscles.

The fleshy or muscular parts of cetaceous fishes resemble that of most quadrupeds. Perhaps it comes nearer to that of a bull or a horse than to that of any other animal. Some of the fleshy parts are very firm; and about the breast and belly they are mixed with tendons.

125 Tendons

The body and tail of this tribe of animals are composed of a series of bones connected together, and moved as in fish; but the movements are produced by long muscles, with long tendons. This renders the body thicker, and the tail at its stem smaller, than any other swimming animal.

The depressor muscles of the tail, which are similar in situation to the psoæ, make two very large ridges on the lower part of the cavity of the belly, rising much higher than the spine, and the lower part of the aorta passes between them. These two large muscles go to the tail, which may be considered as the two posterior extremities united in one.

The muscles of cetaceous animals lose their fibrous structure a very short time after death, and become as uniform a texture as a mass of clay, and even softer. This change no doubt arises from incipient putrefaction, although no evidence of this process being begun is to be had from any offensive smell. This change is most remarkable in the large muscles, as those of the back and the psoæ muscles.

The Tail.—The construction of the tail affords an instance of a singular piece of mechanism. It is composed of three layers of tendinous fibres, which are covered with the cutis and cuticle. Two of these layers are external: the other is internal. The direction of the fibres of the external layers is the same as in the tail, forming a stratum about one-third of an inch thick; but varying, as the tail is thicker or thinner. The middle layer is composed entirely of tendinous fibres, passing directly across between the two external layers, their length being in proportion to the thickness of the tail. This structure gives amazing strength to this part of the animal.

126 very strong.

The substance of the tail is so firm and compact, that the vessels remain in their dilated state, even when they are cut across. This section consists of a large vessel, surrounded by as many small ones as can come in contact with its external surface. The fins are merely covered with a strong condensed adipose membrane.

Sect. III. *Of the Organs of Digestion and Excretion.*

127 Gullet.

In the whale, the œsophagus begins at the fauces, as in other animals. At the beginning it is circular, but is soon divided into two passages by the epiglottis crossing it. Passing down in the posterior mediastinum, to which it is attached by a broad part of the same membrane, its anterior surface makes the posterior part of a cavity behind the pericardium. Having passed through the diaphragm, it enters the stomach, and is lined with a very thick, white, and soft cuticle, which is continued into the first cavity of the stomach. The inner or true coat of the œsophagus is white, and of considerable density, but it is not muscular; for it is thrown into large longitudinal folds, by the contraction of the muscular fibres. This coat is very glandular; many orifices of glands, especially near the fauces, are visible. The œsophagus is larger than it is in quadrupeds, in proportion to the bulk of the animal, but of less size than it usually is in fish. One in the piked whale that was measured, was three inches and a half wide.

128 Stomach and intestines.

The stomach, as in other animals, lies on the left side of the body, and terminates on the pylorus towards the right. The duodenum passes down on the right side, as in the human body, lies on the right kidney, and then passes to the left side, behind the ascending part of the colon and root of the mesentery, comes out on the left side, and getting on the edge of the mesentery, becomes a loose intestine, forming the jejunum. In this course behind the mesentery, it it exposed as in most quadrupeds. The jejunum and ileum pass along the edge of the mesentery downwards, to the lower part of the abdomen. The ileum, near the lower end, makes a turn towards the right side, mounts upwards round the edge of the mesentery, passes a little way on the right, as high as the kidney, and there enters the colon or cæcum. The cæcum, which is about seven inches long, and resembles that of the lion or seal, lies on the lower end of the kidney, considerably higher than in the human body; and this renders the ascending part of the colon short. The colon passes obliquely up the right side, a little towards the middle of the abdomen; and when as high as the stomach, crosses to the left, and acquires a broad mesocolon. It lies here on the left kidney, and in its passage down inclines more and more to the middle line of the body. When it has reached the lower part of the abdomen, it passes behind the uterus, and along the vagina in the female; between the two testicles, and behind the bladder and root of the penis, in the male; bending down, to open on what is called the belly of the animal. In its whole

course

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For the size of the animal, the intestines are not large. In those of 18 or 24 feet long, they are not larger than in the horse; the colon is very short, and has little more capacity than the jejunum and ileum. This is a circumstance common to carnivorous animals. In the piked whale, the length from the stomach to the cæcum is 28½ yards, the length of the cæcum seven inches, and of the colon to the anus, two yards and three quarters.

The teeth, in the ruminating tribe of animals, point out the kind of stomach, cæcum, and colon; but in others, as the horse, lion, &c. the appearances of the teeth only indicate the kind of colon and cæcum. In the cetaceous tribe of fishes, whether they have teeth or not, the stomachs vary little, and the circumstance of cæcum seems not to depend on either teeth or stomach.

The stomach, in all the subjects examined by Mr Hunter, consisted of several bags continued from the
129 Number of stomachs. first on the left, towards the right, where the last terminates in duodenum. The number and size of the stomachs differ considerably. In the porpoise, grampus, and piked whale, there are five; in the bottle-nose whale, seven. The two first stomachs in the porpoise, bottle-nose, and piked whale, are the largest;
130 First. the others are smaller, but not uniformly so.

The first stomach has very much the shape of an egg with the small end downwards, and is lined with a continuation of the cuticle from the œsophagus. In some,
131 Second. the œsophagus enters the upper end of the stomach; in others, it enters posteriorly and obliquely. The second stomach in the piked whale is very large, and rather longer than the first, is of the shape of the Italic letter *S*, and passes out from the upper end of the first on its right side, by nearly as large a beginning as the body of the bag. In the porpoise, where this second stomach begins, the cuticle of the first ends. The inside of the second stomach has unequal rugæ like an irregular honey-comb. In the piked whale the rugæ are longitudinal, and in many places deep, some of them being united by cross bands: in the porpoise the folds are thick, massy, and indented into each other. This stomach opens into the third by a round contracted orifice.

132 Third. The third stomach is the smallest, appears only to be a passage between the second and fourth, has no peculiar internal structure, and terminates in as large an opening as at its beginning. It is from one to five inches
133 Fourth. long. The fourth stomach is less than either the first or second. It seems to be flattened between the second and fifth; and in some, as the porpoise, it is long, and passes in a serpentine course like an intestine. The internal surface is regular and villous, and opens on its
134 Fifth. right side into the fifth. The fifth stomach is round in the piked whale; in the porpoise it is oval: it is small, and terminates in the pylorus without any appearance of a valvular structure. Its coats are thinner than those of the fourth; the internal surface is even, and it is commonly tinged with bile. In some, as the piked whale and the large whalebone whale, there is a cæcum; in others, as the porpoise, grampus, and bottle-nose whale, it is wanting.

The structure of the inner surface of the intestine is very singular. The inner surface of the duodenum of the piked whale has longitudinal rugæ or valves, at some distance from each other, and receiving lateral folds. The inner coat of the ileum and jejunum appears in irregular folds, which may vary according to the action of the muscular coat of the intestine, yet do not seem to depend entirely on this contraction. In some the whole tract of the intestine is thrown into large cells, which are subdivided into smaller. These cells have the appearance of pouches with the mouths downwards, and act like valves when any thing is attempted to be passed in a contrary direction.

Liver.—In this tribe of animals there is a consider- 135 Resembles the human. able degree of uniformity in the liver, which in shape bears a near resemblance to the human liver, but is probably less firm in its texture. The right lobe is the largest and thickest, and there is a large fissure between the two lobes, in which the round ligament passes. Toward the left the liver is much attached to the stomach. The gall-bladder is wanting; but the hepatic duct, which enters the duodenum about seven inches beyond the pylorus, is large.

Pancreas.—The pancreas is a long flat body, hav- 136 Situation. ing its left end attached to the right side of the first cavity of the stomach. It crosses the spine at the root of the mesentery, joins the hollow curve at the duodenum near to the pylorus, adheres to that intestine, and its duct enters that of the liver near the termination in the gut.

Spleen.—The spleen, which is involved in the epi- 137 Small. ploon, is small for the size of the animal. In some of the tribe, as in the porpoise, there are one or two small ones, not larger in size than a nutmeg, and sometimes smaller. They are placed in the epiploon behind the others.

Kidney.—The kidneys in this whole tribe of ani- 138 Conglomerated. mals are conglomerated. They are made up of smaller parts, which are connected only by cellular membrane, blood-vessels, and ducts. The smaller portions are of a conical figure; the apex is placed towards the centre of the kidney, and the base forms the external surface. Each portion is composed of a cortical and tubular substance, the tubular terminating in the apex, which apex makes the mamilla. Each mamilla has an infundibulum, which is long, and at its beginning wide, embracing the base of the mamilla, and becoming smaller. These infundibula at last unite and form the ureter.

Ureters and Bladder.—The ureter comes out of the 139 Small. kidney at the lower end, and passes along to the bladder, which it enters very near to the urethra. The bladder, which is of an oblong shape, is small for the size of the animal. In the female the urethra passes along to the external sulcus or vulva, and opens just under the clitoris, as in the human subject. The *capsulæ renales*, when compared to the human, are small for the size of the animal. They are flat and of an oval figure. They are composed of two substances; of an external substance, which has the direction of its fibres towards the centre; and of an internal substance, which is more uniform and has less of the fibrous appearance.

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Sect. IV. *Of the Organs of Circulation and Respiration.*

140 Heart large.

1. Circulation.—The heart and blood-vessels, especially the veins, are probably larger in proportion to their size than in the quadruped. The heart is enclosed in its pericardium, and is attached to the diaphragm as in the human body. It is composed of two auricles and two ventricles, is flatter than in the quadruped, and adapted to the shape of the chest. The auricles have a greater number of fasciculæ, passing more across the cavity from side to side, than in many other animals; and besides have considerable muscularity and
141 Structure not peculiar.
elasticity. There is nothing peculiar in the structure of the ventricles of the heart, in their valves, in the arteries, or in their distribution, all which have a similarity to other animals whose parts are nearly similar.

142 Blood in great proportion.

Animals of this tribe have a greater proportion of blood than any other yet known; and some arteries are apparently intended as reservoirs, where a great quantity of blood is required in any part. There is a network of arteries, formed of the intercostal arteries, and running between the pleura, ribs, and their muscles. The spinal marrow is surrounded with a net-work of arteries in the same manner, especially where it passes out from the brain, where a thick substance is formed by their ramifications and convolutions.

In examining particular parts which bear any relation to the size of the animal, if we have been accustomed to see them in the middle-sized animals, we must behold them with astonishment in animals like the whale, which so far exceed the common bulk. The heart and aorta of the spermaceti whale, for instance, appear of immense size, when we make this kind of comparison. The latter measures a foot in diameter; and the former was too large to be contained in a wide
143 Circulation astonishing.
tub. Considering the quantity of circulating fluid in so large a vessel, that probably 10 or 15 gallons of blood are thrown out at a single stroke, and the great velocity with which it moves, the mind must be filled with wonder.

144 Veins.

The veins seem to have nothing peculiar in their structure, if we except the veins in the folds on the skin of the breast, as in the piked whale, where, and in similar places, it was necessary to have the elasticity increased.

145 Red globules in great proportion.

The blood of this order of animals is similar to that of quadrupeds. Mr Hunter seems to think that the quantity of red globules is in larger proportion; and he supposes that this increased quantity of red particles may have some effect in aiding to keep up the animal heat; for as they live in a very cold climate, or atmosphere, compared with the heat of their bodies, it is readily carried off, and therefore some help of this kind becomes necessary.

The quantity of blood in this tribe of animals is comparatively greater than in the quadruped, and therefore it is probable that it amounts to more than in any known animal. In them too the red blood is carried to the extreme parts of the body, similar to what happens in the quadruped, but different from fish.

2. Respiration.—Some parts of the organs of respiration in animals that live on land seem to be fitted for a compound action, as for instance the larynx, which is adapted both for respiration, deglutition, and sound; but in the whale tribe it seems to be adapted only for respiration.

Larynx.—The larynx varies much in structure and Varieties. 146
size in the different species. It is composed of the os hyoides, thyroid, cricoid, and two arytenoid cartilages. The os hyoides was larger, while the cartilages were much smaller, in the bottle-nose whale of 24 feet long than in the piked whale of 17 feet. In the bottle-nose the os hyoides is composed of three bones, with two whose ends are attached to it, making five in all. In the porpoise it consists of only one bone slightly bent: it has no attachment to the head, as in many quadrupeds.

The thyroid cartilage, in the piked whale, is broad from side to side, and has two lateral processes which are long, and pass down the outside of the cricoid, near to its lower end, and are joined to it, as in the human subject. The cricoid cartilage is broad and flat, making the posterior and lateral part of the larynx, and is much deeper behind and laterally than before. The two arytenoid cartilages project much, and are united to each other till near their ends; they are articulated on the upper edge of the cricoid, cross the cavity of the larynx obliquely, and make the passage at the upper part a groove between them. In several of the tribe, the epiglottis makes a third part of the passage, and completes the glottis by forming it into a canal. No thyroid gland has been discovered.

Lungs.—The lungs are two oblong bodies, one on 147 Not divided into lobes.
each side of the chest, but are not divided into smaller lobes as in the human subject. They are of considerable length, but not so deep as in the quadruped, from the heart being broad and flat, and filling up the chest. They are increased in size by rising higher up in the chest, and passing farther down on the back. The 148 Very elastic.
lungs are extremely elastic in their substance, and have the appearance and consistence of the spleen of an ox. The branches of the bronchiæ which ramify into the lungs, have the cartilages rounded, which seems to admit of greater motion between them.

The pulmonary cells are smaller than in the quadruped, and communicate with each other, which those of the quadruped do not; for by blowing into one branch of the trachea, the whole lungs may be filled.

The diaphragm has not the same attachments as in 149 Diaphragm
the quadruped; because the ribs in this tribe do not complete the cavity of the thorax. The diaphragm is therefore unconnected forwards to the abdominal muscles, which are very strong, being a mixture of muscular and tendinous fibres. The chest is longest in the direction of the animal at the back, by the diaphragm passing obliquely backwards, and reaching low on the spine. The parts immediately concerned in respiration are very strong. This is particularly the case with the diaphragm. This seems necessary, as the animal must enlarge the chest in so dense a medium as water, the pressure of which must be greater than the counterpressure from the air inspired. And for the same reason, expiration must be easily performed, for the pressure of the water and the natural elasticity of the parts are greater than the resistance of the internal air, so that

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Anatomy and Physiology. that it may be produced without any immediate action of muscles. In these animals the diaphragm seems to be the principal agent in inspiration.

Blow-hole, or passage for the air.—In animals breathing air, the nose is the passage for the air, and the seat of the organ of smelling; but in some of the cetaceous tribe, this sense seems to be wanting; in them, therefore, the nostrils are intended merely for respiration. The membranous portion of the posterior nostrils is one canal; but in the bony part, in most of them, it is divided into two. In those which have it divided, it is in some continued double through the anterior soft parts, and opens by two orifices; but, in others, it unites again in the membranous part, making externally only one orifice, as in the porpoise, grampus, and bottle-nose whale. At its beginning in the fauces, it is a roundish hole, surrounded by a strong sphincter muscle, which grasps the epiglottis: the canal beyond this enlarges, and opens into the two passages in the bones of the head. In the spermaceti whale, in which the canal is single, it is thrown a little to the left side. After these canals emerge from the bones near the external opening, they become irregular, and have sulci passing out laterally, of irregular forms, with corresponding eminences; and the structure of these eminences is muscular and fatty.

150 Nostrils chiefly intended for respiration.

Pl. CXLI. fig. 1, 2. Where there is only one external opening, it is transverse, as in the porpoise, grampus, bottle-nose, and spermaceti whale; but when it is double, it is longitudinal, as in the large whalebone whale, and in the piked whale. These openings form a passage for the air to and from the lungs; for it would be impossible for these animals to breathe through the mouth.

151 Opening well fitted for respiration.

In the whale tribe, the situation of the opening on the upper surface of the head is well adapted for the purpose of respiration; for it is the first part that comes to the surface of the water in the natural progressive motion of the animal. The animals of this order do not live in the medium which they breathe. This requires a particular construction of the organs which conduct the air to the lungs, that the water in which they live may not interfere with the air they breathe. The projecting glottis passes into the posterior nostrils, by which means it crosses the fauces, and divides them into two passages.

The beginning of the posterior nostrils, which answers to the *palatum molle* in the quadruped, has a sphincter which grasps the glottis, by which its situation is rendered still more secure, and the passages through the head, across the fauces and along the trachea, are rendered one continued canal. This union of glottis and epiglottis with the posterior nostril making only a kind of joints, admits of motion, and of a dilatation and contraction of the fauces in deglutition, from the epiglottis moving more in or out of the posterior nostril. This tribe of animals having no projecting tongue, and therefore wanting its extensive motion, and the power of sucking things into the mouth, may perhaps require this peculiarity of construction to render the communication between the air and lungs more perfect. But how far this is the case, in the present state of our knowledge of the structure and economy of these respiratory organs, it is not easy to say.

Sect. V. *Of the Brain and Organs of Sense.*

The brain.—In the different genera of the cetaceous tribe of animals, the brain differs much, and also in the proportion it bears to the bulk of the animal. The porpoise has the largest brain, and thus comes nearest to the human subject. The whole brain is compact. The anterior part projects less forward than in the quadruped; the *medulla oblongata* is less prominent, and lies on the hollow made by the lobes of the cerebellum.

152 Not in proportion to the bulk.

The brain is composed of distinctly marked cortical and medullary substances. The medullary substance is very white; the cortical like the tubular substance of the kidney; and these two substances, seem to be in the same proportion as in the human brain. The lateral ventricles are large. They pass close round the ends of the *thalami nervorum opticorum*. The thalami are large: the *corpora striata* small. Most of the other parts have a great resemblance to similar parts in the human brain.

The substance of the brain is more visibly fibrous than in any other animal. The fibres pass from the ventricles as from a center to the circumference, and continue through the cortical substance. The brain of the piked whale weighed four pounds 10 ounces. 153 Substance fibrous.

The spinal marrow in this tribe of animals is proportionally smaller than in the human species. It is largest in the porpoise where the brain is largest, bearing some proportion to the quantity of brain. But this is not always the case; for in the spermaceti whale, where the brain is small, the spinal marrow is proportionally largest. It terminates about the twenty-fifth vertebra, beyond which is the *cauda equina;* the dura mater is no farther continued. The nerves that go off from the spinal marrow in its course are more uniform in size than in the quadruped; the parts being more equal, and no extremities, except the fins, to be supplied. The structure of the spinal marrow is more fibrous than in other animals; when separated longitudinally, it tears with a fibrous appearance, but when separated transversely, it breaks irregularly. 154 Spinal marrow.

The skull is lined with the dura mater, and in some forms the three processes corresponding to the divisions of the brain, as in the human subject; but in others this division is bony. Where the dura mater covers the spinal marrow, it differs from what takes place in other animals, for it encloses the marrow closely, and the nerves immediately passing out through it at the lower part, as they do at the upper, so that the cauda equina as it forms is on the outside of the dura mater.

The nerves going out from the brain are similar to those of the quadruped, excepting in those that want olfactory nerves, as the porpoise. As the organs of sense are variously formed in different animals, fitted for the different modes of impression, in this tribe the construction is varied according to the economy of the animal. The senses of touch and taste seem to be adapted to every mode; but those of smell, sight, and hearing, probably require to be varied or modified according to circumstances; and according to these circumstances the senses are formed. 155 Nerves.

Sense of touch.—The skin in this tribe of animals appears in general to be well calculated for sensation. 156 Skin the seat of sensation.

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The whole surface is covered with villi, which are so many vessels, and it must be supposed also nerves. Whether this structure be only necessary for acute sensation, or whether it be necessary for common sensation, is not known. But it may be observed, that where the sense of touch is required to be acute, the villi are usually thick and long; and this is probably necessary, because in these parts of the body where the sensations of touch are acute, such parts are covered with a thick cuticle. This is remarkably the case in the ends of our fingers and toes, and in the foot of the hoofed animals. Mr Hunter seems to think that the sense of touch possesses greater acuteness in water.

157 Tongue not merely the organ of taste.

Sense of taste.—The tongue in most animals is not only the organ of taste, but is also intended for mechanical purposes. For this latter purpose it is perhaps less so than in any other animal. In some it has more freedom of motion than in others; and the reason of this is probably the difference in the mode of catching the food and of swallowing. In those with teeth it projects most, which seems less necessary in others which merely open the mouth to receive the food along with the water, or swim upon it. In the porpoise and grampus, the tongue is firm in texture; but in the spermaceti whale it resembles a feather bed. It is composed of muscle and fat; and in some is pointed and serrated on the edges.

158 Wanting in some.

Sense of smelling.—In many of this tribe there is no organ of smell at all; and in those which have such an organ, it is not that of a fish, and therefore, like theirs, it is probably not calculated to smell water. It becomes a matter of difficulty to account for the manner in which such animals smell water, and why others have no such organ, which is supposed to be peculiar to the large and small whalebone whales. Mr Hunter is of opinion that the air retained in the nostril out of the current of respiration, which by being impregnated with the odoriferous particles contained in the water during the act of blowing, is applied to the organ of smell. It might be supposed, he observes, that they would smell the air on the surface of the water by every inspiration as animals do on land; but admitting this to be the case, it will not give them the power to smell the odoriferous particles of their prey in the water at any depth; and as their organ is not fitted to be affected by the application of water, and as they cannot suck water into the nostrils without the danger of its passing into the lungs, it cannot be by its application to this organ that they are enabled to smell. Some have the power of throwing the water from the mouth through the nostril, and with such force as to raise it 30 feet high. This no doubt answers some very important purpose, although not very obvious. Mr Hunter, supposing that smelling the external air could be of no use as a sense, thinks that they do not smell in inspiration; for the organ of smell is out of the direct road of the current of air in inspiration, and it is also out of the current of water when they spout; may it not then be supposed, he asks, that this sinus contains air, and as the water passes in the act of throwing it out, that it impregnates this reservoir of air, which immediately affects the sense of smell? This operation is conjectured to be performed in the act of expiration; because then the water is said to be very offensive. Mr Hunter adds, that if this solution be well founded, those only can spout which have the organ of smell. But as some animals of this order are entirely deprived of this organ, and as the organ in those which have it is extremely small, as well as the nerve which receives the impression, it would appear to be less necessary in them than in those which live in air.

159 Similar to quadrupeds.

Sense of hearing.—The internal ear in general has nearly the same construction as that of quadrupeds. The bones, the cavities, the cartilages, and the nerves are the same, their disposition and arrangement varying in some of the species; and from this there arises a difference of structure in these organs, and perhaps also a difference in the sensation. According to some anatomists, the semicircular canals are wanting in some of this tribe of animals; while they have been described by others. Some have described the form of the vestibulum as in the spermaceti whale, others have denied its existence altogether. It is perhaps owing to their being less easily detected, that they have been supposed not to exist at all. According to the relations of fishermen, the cetaceous tribe have the sense of hearing as acute as that of quadrupeds.

160 Is small.

Sense of seeing.—The organ of light in this tribe seems to have a very close analogy with the same organ in quadrupeds. There is the same relative connection between the choroid coat, the retina, and the crystalline humour. In some circumstances, however, they differ, by which probably the eye in this tribe is better adapted to see in the medium through which the light is to pass. The eye for the size of the animal is small; from which it is conjectured that their power of motion is not great. As no observations have yet been made on the form, size, and density of the different humours of the eye, any thing we could add would be mere conjecture founded on vague analogy.

Sect. VI. *Of the Organs of Generation, &c.*

161 Structure similar to those of ruminating animals.

If the cetaceous tribe of animals come near to fishes in some point of resemblance, they are very different in those of others. This is remarkably the case in the structure of the organs of generation, in which they come nearer in form to those of ruminating animals, than of any other; and this similarity is more striking in the female than in the male; for the situation must vary in the latter on account of external circumstances.

162 Male.

In the male the testicles remain in the situation in which they were formed, as in those quadrupeds in which they never come down into the scrotum. They are situated near the lower part of the abdomen, one on each side, upon the two great depressors of the tail; and at this part they come in contact with the abdominal muscles anteriorly. The vasa deferentia pass directly from the epididymis behind the bladder, or between it and the rectum, into the urethra. The vesiculæ seminales are wanting. The structure of the penis is nearly the same as that of the quadruped. The erectores penis, which have a similar insertion to those of the human subject, as well as the acceleratores, are very strong muscles.

163 Female.

These organs in the female consist of the external opening of the vagina, the two horns of the uterus, Fallopian tubes, fimbriæ, and ovaria. The external opening is a longitudinal slit, whose edges meet in two opposite

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opposite points, forming a kind of sulcus. The vagina passes upwards and backwards in a diagonal direction, respecting the cavity of the abdomen, and then divides into the two horns, one on each side of the loins. These afterwards terminate in the Fallopian tubes, to which the ovaria are attached. The inside of the vagina is smooth for about one-half of its length, and then begins to form something similar to valves projecting towards the mouth of the vagina, each like an *os tincæ*. These are from six to nine in number. These hardly go quite round where they first begin to form, but the last make complete circles; and at this place the vagina becomes smaller, and continues gradually to decrease in width to its termination. From the last projecting part the passage is continued up to the opening of the two horns: and at this place the inner surface forms longitudinal rugæ, which stretch into the horns.

The Fallopian tubes, at their termination in the uterus, are for some inches remarkably small, they then begin to dilate suddenly; and this dilatation increases, till at the mouth they are five or six inches in diameter. Through their whole length they are full of longitudinal rugæ. The ovaria are oblong bodies about five inches in length; one end is attached to the end of the Fallopian tube, and the other to the horn of the uterus. They are irregular in the external surface, and have no capsule but what is formed by the Fallopian tube.

In what position the act of copulation is performed, does not seem to be precisely ascertained. The Greenland fishermen say, that they are then erect in the water, the heads being above the surface, and embracing each other with the fins. M. de St Pierre, during the course of a voyage to the isle of France, asserts, that he saw them several times in this position. Others as confidently affirm, that the female throws herself on her back; but it would appear, that this position must interfere with the act of respiration, which cannot be for any length of time suspended; and, therefore, that it is less probable.

164 Bring forth one at a time, once in two years.

It is conjectured, that the female admits the male only once in two years, and that the time of gestation is nine or ten months. It is probable, too, that having only two nipples, they bring forth only a single young one at a time.

165 Mammæ.

The glands for the secretion of milk, or the breasts, are two, one on each side of the middle line of the belly at its lower part. The posterior ends, from which the nipples proceed, are on each side of the opening of the vagina in small furrows. They are flat bodies lying betweent he external layer of fat and the abdominal muscles, and are of considerable length, but only one-fourth of that in breadth. There is a large trunk which runs through the whole length of the gland, and appears to serve the purpose of a reservoir for the milk. Into this trunk the lateral and smaller ducts enter, some with the course of the milk, some in a contrary direction. The trunk terminates in a projection externally, which incloses the nipple.

166 Process of sucking.

It seems difficult at first sight to conceive in what way the process of sucking is performed; so that both the mother and the young one may at the same time respire freely. According to the relations of the Greenland fishermen, the mother throws herself on her side, and the young one then seizes the nipple. In this position, the smallest motion of the body permits the mother or the young one to enjoy the advantage of respiration. The art of sucking must be different from that of land animals, for in them it is performed by drawing the air from the mouth backward into the lungs, which the fluid follows by the pressure of the external air on its surface; but, in the cetaceous tribe, the lungs have no connection with the mouth. The operation of sucking must therefore be performed by the action of the mouth itself, and by its having the power of expansion.

The milk of the whale is supposed to be very rich. 167 Milk rich.
In the one which was taken near Berkeley with its young one, the milk was tasted by Mr Jenner and Mr Ludlow. By their account, it had the richness of cows milk to which cream had been added.

The young whale, according to Dudley, continues to suck for a year. They are then called *short-heads* by the fishermen, and are extremely fat, some yielding 50 tons of fat. The mothers, at the same period, are very lean. At the age of two years, they are called *stunts*, because they are supposed to be dull after being weaned. The quantity of fat which they then yield, is from 24 to 28 tons. After this period, they come under the denomination of *skull-fish*, when their age can only be guessed at by the length of hair at the terminations of the whalebone.

168 Affection for its young.

The affection and attachment which the whale discovers for its young, have been much celebrated by naturalists. Perhaps it is magnified by the comparison between the whale and fishes living in the same element, the care of whose offspring is totally disregarded by the parent, and left, which indeed is all that is necessary, to the influence of heat and air to bring forth from the ova or spawn deposited by the mother. This attachment is probably, after all, not more remarkable than in other animals which suckle their young, and bring forth a small number, or only one at a time.

Sect. VII. *Of the Food of the Whale; the Size, Abode, Fat, &c.*

169 Different kinds of fish.

Food.—The food of the whole cetaceous tribe is supposed by naturalists to be fish, each probably having some particular kind. Some hundreds of the beaks of cuttle-fish were found by Mr Hunter, in the stomach of the bottle-nose whale; in the stomach of the piked-whale, bones of different fish, but particularly those of the dog-fish; and, in the grampus, the tail of a porpoise.

Considering the capacity of the œsophagus, we must conclude, that they do not swallow fish so large in proportion to their size as many fish do; for it is observed, that fish often attempt to swallow more at a time than what the stomach will hold; so that part must remain in the œsophagus till the rest is digested.

170 Of the large whale.

The food of the large whalebone whale is supposed to be small fish, sometimes crab-fish and shell-fish. It may appear strange, that so large an animal should be able to find a quantity of food sufficiently great for its subsistence, and to preserve with it such a covering of fat as they are generally found to have. But this wonder ceases, when it is considered that the very food they

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they seek after, is found in the greatest abundance in those regions which they usually inhabit. In the economy of the whalebone whale, this substance, from which it derives its name, seems to be of particular use; for as it appears that they live on small fish, which they probably receive into the mouth in great numbers, it was necessary that there should be some contrivance to retain them in the mouth till they are swallowed; and this purpose is fully answered by the whalebone.

171 Northern whale.

The northern whale, or the north-caper, lives on mackerel, herrings, cod fish, and tunny fish. Horrebow mentions, that the Icelanders found in the stomach of an individual of this species, which came on shore in pursuit of its prey, no less than 600 living cod-fish, besides a great number of pilchards, and some aquatic birds. This account is probably exaggerated, at least with regard to the number of fish in the stomach being alive. The other species belonging to this genus usually feed on the herring, the arctic salmon, and the sand-eel.

172 Narhwal.

The narhwal, or unicorn whale, is said to live chiefly on the different species of actinia. It is unprovided with teeth to seize its prey; but, according to some naturalists, it can employ the long tooth which proceeds from the upper jaw to entangle these fishes; and having collected them in this manner to the edge of the lips, it sucks them into the mouth and destroys them, by constantly stretching the tongue along the lips.

173 Spermaceti whale.

The spermaceti whales pursue the seal, the dolphin, and the pike-headed whale. The large spermaceti whale pursues, with great avidity, the shark, which is said to be his ordinary food; and this animal, otherwise so formidable, is seized with such a panic at the sight of this terrible enemy, that he conceals himself in the mud, or under the sand; sometimes seeing himself so assailed on all sides, he darts across the rocks, and strikes them with such force and violence as to occasion his own death. This terror, according to Fabricius, is so strongly impressed, that the shark, which is so greedy of the carcases of the other cetaceous fishes, dares not even approach the dead body of the large spermaceti whale.

174 Blackheaded spermaceti whale.

The physeter microps is said to prey chiefly on the seal. When the seals are in number together, and find themselves attacked by their enemy, they make a precipitate retreat. Some gain the shore; while others climb on a piece of ice; and then, if the whale be alone, he conceals himself under the ice, and waits till the seal return to the water, when he seizes his prey. But if several whales have joined in the pursuit, as frequently happens, it is said they surround the mass of ice, and overturn it in the water.

175 Dolphin.

The dolphin genus feed on cod fish, flat fish, such as the turbot, and many other kinds of fish of moderate size. The grampus is the boldest, the strongest, and the most voracious of any belonging to this tribe of animals. It is agreed by almost all naturalists, that the grampus will even attack the great whale, and put him to flight, which is said to be the reason that they are sometimes thrown ashore on our coasts.

176 Sixty feet.

Size of the whale.—The whale is now rarely seen to exceed 60 feet in length, by 36 feet in circumference. A whale, which landed in the island of Corsica in 1620, was one of the largest which has been known for some centuries. It measured 100 feet in length. But although this be an enormous bulk, it falls far short of the magnitude of the whale, as it has been described by ancient naturalists, existing in their time. But probably these relations will gain little faith, even from the most credulous of the present day, in which Pliny speaks of the whale being 960 feet long; and in another place, the same naturalist says, that Juba writes to C. Cæsar, the son of Augustus, that some whales of 600 feet in length, and 360 in circumference, had entered the rivers of Arabia.

177 Formerly larger.

But whatever credit is to be given to these stories, there is little doubt that the whales in the northern ocean were formerly of much greater bulk than they now are: and the reason seems to be, that being less disturbed when this fishery was less frequented, they arrived at a greater age, and consequently acquired a greater size. 178 Reason.

179 More frequent in the ocean formerly.

Abode of the whale.—According to the testimony of the ancient naturalists, the whale was more frequently seen in the ocean than at present; for, on account of being disturbed by the numerous fleets traversing the ocean, they have retired to the regions of the north, where they are less exposed to the noise of the mariners, less harassed by the fishermen, and enjoy that tranquillity which is no longer to be found in their former haunts.

180 Chiefly in the northern seas.

The large whalebone whale is most frequently found in the Greenland seas, Davis straits, and the coasts of Spitzbergen, Iceland, and Norway; on the coasts of Labrador, in the gulf of St Lawrence, and round Newfoundland. This whale is also found among the Philippine islands, near Socotora, an island on the coast of Arabia Felix, and on the coasts of Ceylon. The whale also frequents the Chinese seas; and, if the reports of voyagers are to be implicitly admitted, is found there of an immense size. The usual retreat of the spermaceti whale is the northern ocean, towards Davis straits, the North Cape, and the coasts of Finmark. Of all the cetaceous fish, this indeed seems to lead the most wandering life. In the year 1787, this whale was discovered in great numbers in an extensive bay in the southern peninsula of Africa, at the distance of 40 leagues from the Cape of Good Hope.

The dolphin family is found in all seas; in the ocean, the Mediterranean, the gulf of Messina, and the Adriatic sea, from whence they go into the lagoons of Venice, and to the coasts of Galicia. On the coasts of Cochin China very considerable fisheries are established, which produce a great quantity of oil.

181 Largest fishes in northern regions.

We may conclude, that, in general, the great whale and the unicorn fish usually frequent the seas towards the poles, between the 68th and 79th degrees of latitude; and that the other families are found diffused more or less in the seas of more temperate regions. It would appear, from this account of the places which are the ordinary haunt of the whale, that the productions of nature are disposed somewhat in a contrary order; since we find all the large terrestrial animals, such as the elephant and rhinoceros, in countries within the torrid zone; while the huge inhabitants of the ocean have fixed their abode in the polar regions. 182 Largest land animals in the torrid zone.

Migration

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Migration of the whale.—Although the abode of the whale be generally determined and fixed, yet particular causes force them to leave their usual and natural haunts. The season of their amours, a furious storm, the pursuit of a harassing enemy, the want of food, or excessive cold, often oblige them to migrate. Sometimes they appear solitary, sometimes in considerable numbers, according to the nature of the causes which have disturbed and driven them from their ordinary retreats. According to the information of voyagers who have visited these regions, the great whale every year, in the month of November, leaves Davis straits, enters the river St Lawrence, and there brings forth her young, between Camourasca and Quebec; and from thence, in the month of March following, they regularly return to the polar seas.

183 Causes of.

It appears, that the whale constantly remains in the northern ocean, and never leaves it but when the female is to bring forth, or when they are driven away by an enemy. In this last case they are most commonly found solitary, at least not more than the male and female, or the mother and the young one.

The spermaceti whales, however, seem frequently to change their habitation, and to roam about in strange seas. This appears from considerable numbers having been thrown ashore or left dry by the retreating tide at different times. In the year 1690, 200 of this species were landed near Cairston in the Orkneys; and, in the year 1784, 31 large spermaceti whales came on shore on the west coast of Audierne in Lower Brittany in France.

184 Blackheaded whale.

Enemies of the whale.—The greatest and most terrible enemy of the small whale is the physeter microps, or black-headed spermaceti whale. As soon as he perceives the pike-headed whale, the porpoise, and some others, he darts upon them, and tears them to pieces with his crooked fangs.

185 Unicorn-fish.

It is said, that there exists a continual and settled enmity between the unicorn-fish and the great whale; and that they never meet without engaging in combat, in which the whale receives so many severe, and often deadly wounds, as often to occasion its death. When the unicorn-fish strikes its tooth or horn into the side of ships, it is supposed that it is through mistake, taking the vessel for its enemy, the whale.

186 White bear

The white bear, so common in Greenland and Spitzbergen, is extremely fond of the flesh of the cetaceous and other fishes. He remains constantly on the watch for his prey, on a mass of ice, or on the sea shore; and as soon as he perceives it, he throws himself into the water, and plunges to attack it. The large and the small whales are equally the objects of his eager pursuit; but he is not successful till after they have lost a great deal of blood from the wounds which he has inflicted, or they have been exhausted with fatigue.

187 Saw-fish.

Between the saw-fish and the whale there exists a constant warfare. It is related by all the fishermen, that the whale and saw-fish, whenever they meet, join in combat, and that the latter is always the aggressor. Sometimes two or more individuals combine to attack a single whale; and it is inconceivable with what fury they make the attack. The whale, whose only defence is his tail, endeavours to strike his enemy with it; and a single blow would prove mortal. But the saw-fish, with astonishing agility, shuns the dreadful stroke, bounds into the air, and returns upon his huge adversary, plunging the rugged weapon, with which he is furnished, into his back. The whale is still more irritated by this wound, which only becomes fatal when it penetrates the fat. The engagement ceases not but with the death of one of the combatants. Martens relates an account of one of these combats between the Iceland whale (Balæna Glacialis) and the saw-fish. It seemed to be extremely dangerous to approach the field of battle. It was therefore at some distance, that he saw them pursuing and striking each other, dealing such violent blows that the water rose in foam as if agitated by a storm. He was prevented from seeing the issue of the struggle by the weather becoming thick and hazy; but he was informed by the sailors, that such combats were frequent; that they generally kept at a distance till the whale was vanquished; and that the saw-fish, only eating the tongue, relinquished the rest of the body, which they take possession of.

Forskal informs us, that the Arabians believe that some species of the scarus, a fish found in the Red sea, enter the blow-holes of the whale, and destroy it with their sharp spines; and, in confirmation of this fact, it is mentioned, that one of these fishes was found in the blow-hole of a dead whale.

188 Birds.

The whale is even harassed with aquatic birds, which alight in great numbers on its back, in search of the testaceous animals and small insects, which have made it their habitation. And, like most other animals, the whale is tormented with a species of louse, peculiar to itself, which adheres so strongly to the skin, that it may sooner be torn asunder than be made to let go its hold. The fins, the lips, the parts of generation, and other parts of the body, which are most protected from friction, are chiefly infested with this insect. The bite is extremely painful, and they are most troublesome in that season when the whale is in heat.

189 Not so old as formerly.

Age of the whale.—If the time necessary for the growth or increase of the body were in proportion to the period of life, there could be little doubt of the whale being, of all animals known, the most remarkable for longevity. It is well known, that the whales which were taken when this fishery first became an object of trade, that is, between 200 and 300 years ago, were of much greater bulk than they are found to be in the present day. The largest now taken rarely exceed 60 feet long; while, at that time, some reached the astonishing size of 100 in length. The reason of this difference of size seems to be, that, when the fishery first commenced, whales which had probably reached their utmost growth were frequently met with. These, on account of being the largest, were constantly harassed, pursued, and destroyed; so that none which have attained their full growth are now to be found in those seas resorted to by the fishermen. From this circumstance, that no large whales are now to be seen in the places which they commonly frequent, it is concluded, that the period of the life of the whale is very long; and that they cannot arrive at the huge size for which the first whales were so remarkable, since they are not permitted to live undisturbed the requisite length of time to attain that bulk. According to Buffon, a whale may live 1000 years, since a carp has been known to reach the age of 200. But,

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But, reasoning from analogy, with regard to the structure and economy of the whale, we have seen in many instances, by no means holds; and it is perhaps equally inapplicable to the growth and age of this order of animals.

190 Oil. *The fat* or *oil of cetaceous fishes.*—The fat of this order of animals is usually called *oil*. It is the most fluid of animal fats, for it does not coagulate in our atmosphere. It is found in considerable quantity, principally on the outside of the muscles, and immediately under the skin; and is rarely to be met with in any of the cavities, or in the interstices of the muscles. This substance is enclosed in a reticular membrane, apparently composed of fibres passing in all directions, which seem to confine its extent, and allow it little or no motion on itself; for the whole, when distended, forms almost a solid body. In some of the animals of this order there is a different distribution of the fat. Under the head or neck of the bottle-nose whale, it is confined in large cells which admit of motion. In some this reticular membrane is very fine, in others it is coarse and strong, and it varies in different parts of the same fish. In the porpoise, spermaceti, and large whalebone whale, it is very fine; in the grampus and small whalebone whale, it is coarse. In all of them it is finest on the body, becoming coarser as it reaches and covers the fins and tail, which latter is composed of fibres without any fat.

The internal fat is the least fluid in this order of animals. It is nearly of the consistence of hogs lard. The external fat is the common train-oil. It is the adipose covering from all of the whale kind, which is brought home in square pieces called *flitches*; and this, which is commonly known under the name of *blubber*, after being boiled, yields the oil by expression, leaving

191 Of two kinds. the cellular membrane. When these flitches or masses of fat become putrid, there issue two kinds of oil. The one is pure; but the other seems to have a considerable mixture of other animal matters, which, from the state of putridity, are readily dissolved in the purer oil, and form a kind of butter. It feels unctuous to the touch, and ropy, coagulates with cold, swims on water, and the pure oil separates and rises to the top. The substance which remains after all the oil is extracted, is almost entirely convertible into glue, and is sold to be applied to the same purposes.

192 In every part of the body. *Spermaceti.*—The substance called *spermaceti* is found in every part of the body, mixed with the common fat of the animal; but to this it bears a small proportion. In the head this substance is also mixed with the common fat; but here the proportions of the two substances are reversed: the spermaceti is by far in greatest quantity. And, from this circumstance of its being found in such abundance, in what, from a slight view, would appear to be the cavity of the skull, it has been by some supposed to be the brain.

193 Most abundant in the head. The two kinds of fat in the head are contained in cells or in cellular membrane, similar to what takes place in other animals; but, besides these, there are larger cells, or ligamentous parts going across, the better to support the vast load of oil of which the bulk of the head is principally composed. There are two places in the head in which this oil lies. These are situated along the upper and lower part of it, and are divided by the nostrils and a great number of tendons which pass from the nose and the different parts of the head. The cells which are of the smallest size, and are the least ligamentous, are observed to contain the purest spermaceti. These cells resemble those which contain the fat in other parts of the body nearest the skin, and they lie above the nostril, along the upper part of the head, immediately under the skin and common cellular membrane. The spermaceti, which lies above the roof of the mouth, or between it and the nostril, is more intermixed with a ligamentous cellular membrane; and it is contained in chambers whose partitions are perpendicular. Near the nose these chambers are smallest; but they become larger towards the back part of the head, and in these last the spermaceti is purest. About the nose Mr Hunter discovered a great number of vessels which had the appearance of a plexus of veins, some of which were as large as a finger. They were loaded with spermaceti and oil, and some of them had corresponding arteries. He thinks it probable that they were lymphatics, and that their contents were absorbed from the cells of the head; for many of these cells or chambers were found empty.

The numerous useful purposes to which the common oil of the whale and the spermaceti are applied, the latter sometimes in medicine, and both in many of the arts and in domestic economy, are to well known to be particularly pointed out.

Ambergris.—This substance, the origin of which was long a matter of doubt and uncertainty among naturalists, is now pretty well ascertained to be the production of some of the cetaceous tribe of animals. By some it was supposed to be the excrement of the whale, and by others, that it was the dung of birds. According to some, it is composed of honey and wax, consolidated by the heat of the sun and the action of sea water; while, in the opinion of others, it is a bituminous substance, which flows from the bowels of the earth into the waters of the ocean, where it becomes hard and firm. 194 Doubts and opinions of its origin.

But, in the opinion of later naturalists, it is a substance which has an origin and formation similar to that of musk, and is a production of the spermaceti whale. This opinion has been rendered more probable by the same substance having been found in some whales of this species, and particularly in one which came on shore on the coast of Bayonne in France, in 1741. In the latter it was found in rounded masses from three to 12 inches in diameter, which weighed from $1\frac{1}{2}$ lb. to 20lb. It was contained in an oval bag from three to four feet long, and from two to three feet broad, which was suspended immediately above the testicles. This bag terminated in two tubes, one of which becoming narrower, reached to the penis; the other proceeded from the kidneys, and terminated in the other extremity. The bag was almost entirely filled with a yellow-coloured fluid, not quite so thick as oil, exhaling a similar but stronger odour than the masses of ambergris which floated in it. Each mass was composed of concentric layers. The number of masses found in one bag never exceeded four. One was found which weighed 20lb.; but there was no other in the same bag. It has been supposed that the ambergris is only found in old whales, and in the males. Some naturalists think that this substance is an oily concretion 195 The production of the spermaceti whale.

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Anatomy and Physiology. tion which exhales the odour of the fluid in which it is formed; and that the bag which contains these fragrant masses is the urinary bladder.

But if this be the usual mode in which ambergris is produced, it appears difficult to account for the large masses which are found floating in the waters of the ocean in different parts of the world, as among the islands in the torrid zone, and in the Indian and African seas.

According to the information collected by Dr Swediaur, and which the reader will find more fully detailed under the word AMBERGRIS, it appears that it is generally considered by the New England fishermen as a production of the spermaceti whale. Sometimes they find it floating in the sea; and when this happens they search for the whale, supposing that it has been voided by this animal. Sometimes they cut it out from a swelling or protuberance on the belly of the dead whale. And from all the information which Dr Swediaur could obtain, he concludes, that ambergris is generated in the bowels of the spermaceti whale (*Physeter Macrocephalus*, Lin.), and that it is there mixed with the beaks of the *sepia octopodia*, which is the principal food of this whale.
196 Supposed to be indurated fæces. He therefore considers this substance to be the fæces of the animal preternaturally indurated, mixed with the indigestible relics of the food. See AMBERGRIS.

Later information has verified some part of the doctor's opinion, as well as some of the conjectures of earlier naturalists. Mr Coffin, master of a ship employed in the southern whale fishery, brought home, in the year 1791, 362 ounces of ambergris taken from the body of a female spermaceti whale on the coast of Guinea. Part was found floating in the sea, and part was seen coming from the anus while the people were employed in cutting up the blubber. More was found in the intestines, and the rest in a bag communicating with them. This whale was lean, sickly, and old, and yielded but a small proportion of oil. When the spermaceti whale is struck, she generally voids her excrement; and, if she does not, it is conjectured that she has no ambergris. Mr Coffin supposes, that the production of this substance is either the cause or the effect of some disease, as he thinks it is most likely to be found in sickly fish, as was the case with the fish which
197 Probably a preternatural substance. yielded him so large a quantity. Perhaps it may be found by future and more accurate investigation to be a natural production of the animal, secreted to answer some important purpose in its economy; and that it is preternaturally increased in quantity, either by the excessive or the diminished action of the vital powers in age or disease, and then it is excreted, or discovered in the body of the fish after death.

198 Used as a perfume. Ambergris is one of the most fragrant perfumes; and for this purpose, it is chiefly employed in this as well as in most other countries. In Asia, and in some parts of Afica, it is also used in medicine and cookery. It is bought up in considerable quantities by the pilgrims who travel to Mecca, by whom it is supposed to be used in fumigations in religious ceremonies, in the same manner as the burning frankincense or other fragrant perfumes makes part of the religious rites of other countries.

CHAP. III. *Of the Whale Fishery.*

Whale Fishery.

199 Power of man in subduing the largest animals.

NOTHING, perhaps, displays in a more striking manner the power and dexterity of man than the facility and success with which he conquers and destroys the most enormous and the most formidable of the animated productions of nature. The elephant and the whale, the largest animals known, the one seemingly secure in the midst of the huge icy mountains of the polar regions, and the other roaming at pleasure in the almost inaccessible wilds and deep woods of the torrid zone, yield to his power, or fall beneath his all-subduing arm. The swiftest and the most ferocious, as well as the most sagacious, and the most cunning and artful, escape not the toils and snares which he contrives, or the deadly aim of the instruments of his invention.

Whether man was originally urged by necessity, as is most probable, to attack so huge a monster as the whale, or whether it was indirectly to gratify the artificial demands of luxury that he first attempted and still continues to persevere in an occupation so full of of danger and fatigue, it must be allowed to be one of the boldest and most daring enterprises that can be conceived. And indeed were it not quite familiar to us, we should still behold with dread and astonishment so feeble a creature as man preparing to attack this monster of the deep, whose strength, were it properly directed, no power could resist; nor would our wonder be diminished, when we find that he seldom fails to succeed in the attempt. But knowledge is power; and the triumphs of intellectual power are equally conspicuous, in accommodating the most unwieldy and most unmanageable parts either of the inanimate or animated creation to the supply and gratification of human wants and desires, in guiding through the trackless ocean the ship from which the spear is launched for the destruction of the whale, or in digging from the bowels of the earth the metal with which the compass and the harpoon are constructed.

200 Norwegians first acquainted with this fishery.

So early as the 9th century, in the time of Alfred the Great, it appears that the Norwegians were acquainted with the whale fishing. This prince received an account of the discoveries of a Norwegian about the North Cape, in which he speaks of his having been as far north as the places to which the whale-hunters resort; which is considered as a proof of its antiquity; although it is supposed that it was pursued merely on account of the oil, the use of the whalebone not being then known *.

* Anderson's Hist. of Comm. i. 84.

201 Biscayans most expert.

But the people who are recorded in history as having prosecuted this fishery with success, were the Biscayans. The spermaceti whale, as well as the whalebone whale, were at that time frequently seen in these latitudes. The first attempts were made in the bay of Biscay, and in the gulf of Gascony. Ships were fitted out, instruments were constructed, and an establishment was formed for carrying on the fishery. It was observed that the whale only appeared at certain seasons of the year, which led the new fishers to suppose that his residence in other seas was more permanent. And discovering that they retreated towards the polar regions, ships were fitted out and manned with

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Whale Fishery.

with the most experienced seamen, to pursue them northward. At this time the Biscayans carried on this trade, both for the sake of the oil and the whalebone.

202 The English first engage in it.

Towards the end of the 16th century, the English first engaged in the whale fishery. But at this time they were so little acquainted with it, that "the request of an honest merchant, by letter to a friend of his, to be advised and directed in the course of killing the whale," is recorded by the historians of that age. The answer was, that a ship of two hundred tons must be fitted out, and provided with all kinds of proper utensils and instruments. But it appears to have been necessary to send to *Biskaie for men skilful in catching the whale and ordering of the oil, and one cooper skillful to set up the staved cask.*

Hakluyt's Voyage, 414.

In the year 1594, some English ships made a voyage to Cape Breton, at the entrance of the bay of St Lawrence, some for the morse fishing, and others for the whale fishing. This seems to have been among their first attempts in this trade. The fishing proved unsuccessful; but they found in an island 800 whale fins or whalebone, part of the cargo of a Biscayan ship wrecked there three years before, which they put on board and brought home. This was the first time that this substance was imported into England.

203 Whalebone first introduced.

204 Ships fitted out from Hull.

The town of Hull, in 1598, first fitted out ships from England for the Greenland whale fishery, a branch of trade which has since become very considerable, and has frequently received the protection and encouragement of the legislature. A premium of six shillings for each ton of oil, and five shillings for each ton of whalebone, was at first granted by government in 1672. But this encouragement appearing insufficient for the success of the fishery, or the enterprise being considered too great for the stock of individuals, a company was incorporated in 1692, and established by royal authority, with peculiar privileges. Their capital amounted to 40,000l. sterling. The subscriptions in a few years increased to 82,000l. sterling; but in 1701 the company was dissolved, and the trade made free to all adventurers.

205 Premium granted.

206 Company established.

207 English very successful.

The English were now become the most successful adventurers in this fishery. By their skill, their industry, and perseverance, and the aid and encouragement granted by the legislature, they carried on the whale fishery on more advantageous terms than the Biscayans, the first adventurers, whose efforts became less enterprising, as their success was more precarious. In the year 1730, they fitted out for this fishery only 33 ships; about the year 1735, the number was diminished to ten or twelve; and continuing to decrease till the war in 1744, the trade was finally abandoned.

208 New English Company.

The English still persevered in the trade, a new company was established, and a fund of 50,000l. sterling was provided, with power to the company to make all necessary and proper regulations. And for the farther encouragement of the fishery, a duty of 17l. or 18l. sterling was imposed on the ton of all oil imported, and a premium or bounty, to the same amount, was paid for every ton of oil exported which was the produce of the national fishery. Other encouragements were also given; rewards were bestowed on the most successful; the sailors employed in the trade were exempted from the impress service; adventurers were indemnified for all losses which they sustained in their first enterprise; and they were granted the privilege of providing, duty free, all those articles which were needed in this fishery, and were the subjects of taxation.

209 Fishery encouraged.

Still farther to encourage and extend the fishery, which now had become an important national concern, parliament granted in 1779 a premium to five ships which should bring home the greatest quantity of oil: for the first greatest quantity, 500l. sterling; for the next, 400l.; and for the third, fourth, and fifth, 300l. 200l. and 100l. sterling.

210 Fishery in North America.

In North America, while that continent was subject to Britain, the whale fishery was carried on to a very considerable extent. A society was established at New York, and numbers of ships were equipped for this trade in different parts of the colonies, by enterprising adventurers, and it has been long extremely successful and lucrative.

211 Advantages of the fishery.

The advantages derived to the nation from the whale fishery, are no doubt very considerable. Beside being an excellent nursery for hardy seamen, it is the foundation of great commercial concerns, by introducing articles which become the sources of an important trade. In this view it has often been an object of legislative discussion, and has often experienced the liberal encouragement and protection of government. According to a law passed in favour of ships employed in this trade, every British vessel of 200 tons or upwards, bound to the Greenland seas, on the whale fishery, if found to be duly qualified agreeable to the act, obtained a licence from the commissioners of the customs to proceed on such voyage; and on the ship's return, the master and mate declaring on oath that they were on such voyage, that they used all their endeavours to take whales, and that all the whale-fins, blubber, oil, &c. imported in their ship, were taken by their crew in those seas, there was allowed 40s. for every ton according to the admeasurement of the ship.

212 Regulations.

It was afterwards found, however, that so great a bounty was neither necessary to the success of the trade nor expedient with regard to the public. In 1786, therefore, the acts conferring the said emoluments being upon the point of expiring, the subject was brought under the consideration of parliament; and it was proposed to continue the former measures, but with a reduction of the bounty from 40s. to 30s. In proposing this alteration, it was stated, "that the sums which this country had paid in bounties for the Greenland fishery amounted to 1,265,461l.; that, in the last year, we had paid 94,858l.; and that, from the consequent deduction of the price of the fish, the public at present paid 60 per cent. upon every cargo. In the Greenland fishery there were employed 6000 seamen, and these seamen cost government 13l. 10s. per man per annum, though we were never able to obtain more than 500 of that number to serve on board our ships of war. Besides, the vast encouragement given to the trade had occasioned such a glut in the market, that it was found necessary to export considerable quantities; and thus we paid a large share of the purchase money, for foreign nations, as well as for our own people, besides supplying them with the materials of several important manufactures." This proposition was opposed by several members, but was finally carried; and the propriety of the measure became very soon

213 State of the trade in England.

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Whale Fishery. soon apparent. At that time (1786) the number of ships employed from England in the whale fishery to Davis straits and the Greenland seas amounted to 139; besides 15 from Scotland. The proposed alteration took place the following year (1787); and notwithstanding the diminution of the bounty, the trade increased; the number of ships employed the same year from England amounting to 217, and the next year (1788) to 222. Their cargoes consisted of 5989 tons of clean oil; 7654 tons of whalebone, beside 13,386 seal skins.

214 Southern whale fishery, For some years British capital has been employed in a southern whale fishery; and this has also been a very lucrative branch of trade. This fishery was first prosecuted with vigour about the commencement of the American war. In the year 1785, 18 ships which produced 29,000l. sterling were employed in it. Two years afterwards the number of ships was doubled, and the returns increased in a much greater proportion, which is a proof of the flourishing state of the trade. The number of ships in 1787 was 38, and the produce amounted to 107,000l. sterling.

215 carried on by Americans settled in Milford Haven. Some American families, when the war broke out in that country, emigrated to Nova Scotia, where they proposed to carry on the whale fishery; but being discouraged from particular circumstances, on the invitation of the honourable Mr Greville, they settled at Milford in Milford Haven, and fitted out a ship, which had a very successful voyage. The number of ships soon increased to four, and at present (1803), that number is doubled, so that 8 ships are now employed in the southern whale fishery from this port, with a capital afloat of no less than 80,000l. sterling. This fact is stated by Mr Barrow in his Travels in Southern Africa; and "I mention it (says he), as a striking instance to show the importance of the South sea fishery, and as a proof that, contrary to the generally received opinion, it may be carried on with skill and management, and without the adventitious aid of trading, so as fully to answer the purpose of those who are properly qualified to embark in the undertaking. For where men, by industry in their profession, rise from small beginnings into affluence, such profession may be followed with a greater certainty of success than many others which appear to hold out more seducing prospects. The American fishermen never set out with a capital, but invariably work themselves into one; and the South sea fishery from England may succeed on the same principle, as the above example clearly shews, under every disadvantage, when properly conducted.

216 Partially encouraged. "It is difficult to point out the grounds of justice or policy in giving tonnage bounties to the Greenland fishery, and only premiums to successful adventurers in the southern fishery. A voyage to Greenland is four months, the outfit of which is covered by the tonnage bounty, and if wholly unsuccessful, the same ship can make a second voyage the same year to some of the ports of the Baltic. A voyage to the South sea is from 12 to 18 months, and must depend solely on the success in fishing. A Greenland ship sets out on a small capital, and builds on a quick return; but a South sea whaler must expend a very considerable capital in making an outfit, for which he can reckon on no returns for at least 18 months. Hence the usual practice of sending them out in the double capacity of fishers and contraband traders, in order that the loses they may sustain by ill success in fishing may be made good by smuggling. Whale Fishery.

"If by extending the fishery we should be enabled to supply the continent of Europe, two objects should never be out of the view of the legislature—the exemption from duty of all the produce of the fisheries, and particularly spermaceti, which, if manufactured into candles, and subject only to the same duty as tallow candles, would produce much more to the revenue than when taxed as it now is, as wax. I have heard it asserted that the extension of the premium system, by doubling its present amount, which never could exceed 30,000l. a-year, would be adequate encouragement to supply the home-market with spermaceti and black whale oil, and that the bonding of foreign oil in Great Britain would throw the whole agency of American fishery on England with greater advantage to both countries than by any other system.

217 Cape of Good Hope a convenient station "But when we consider that the home market is necessarily secured to British subjects by high duties on foreign oil, we should also consider that every means to lessen the charges of outfit should strengthen our adventure in this lucrative branch of trade. Among others that would seem to have this tendency, are the facilities that might be afforded by the happy position of the Cape of Good Hope. If at this station was established a kind of central depot for the southern whale-fishery, it might, in time, be the means of throwing into our hands exclusively the supply of Europe with spermaceti oil. To the protection of the fisheries on the east and west coasts of southern Africa, the Cape is fully competent, and the fisheries on these coasts would be equally undisturbed in war as in peace. From hence they would, at all times, have an opportunity of acquiring a supply of refreshments for their crews, and of laying in a stock of salt provisions at one-fourth part of the expence of carrying them out from England."

218 Dutch early engaged in the fishery. The Dutch were very early engaged in the Greenland whale-fishery, which soon became one of the most important objects of their trade. In 1611 a company was established at Amsterdam for carrying on the whale-fishery on the coasts of Spitzbergen and Nova Zembla. This branch of trade has in general succeeded better with the Dutch than with any other nation. The principal reason which has been assigned for this success is the greater economy and frugality of this people, in this as in all their concerns, by which they are able to undersell others in oil and whalebone. The mode of fitting out all their ships is also mentioned as a cause of their prosperity in this fishery. The ship-builder, the rope-maker, the baker, the brewer, and other tradesmen, employed in fitting out these ships, commonly take a share in the voyage. When it proves fortunate, they are double gainers; but when it is unsuccessful, the loss which they sustain is probably not greater than if they had merely furnished the articles without having a chance of the profit; and in this respect have the advantage of mere merchants. It is observed by De Witt that this fishery, since it fell into the hands of individuals, has seldom failed to be profitable; but while it was monopolized by the Dutch Greenland company, the profit was inconsiderable. Some idea may be formed of the extent to which the Dutch have carried this trade, by stating that

219 Extent of their fishery.

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Whale Fishery.

that for a period of 46 years preceding the year 1722, 5886 ships were employed in it, and in this period they took 32,907 whales. Each whale, at an average, valued at 500l. makes the total amount above 16 millions sterling.

The following table affords at one view a brief record of the Dutch whale fishery from 1661 to 1788. The number of ships employed for each year, and the number of whales taken, are stated in separate columns.

220 Ships employed, and produce of it, from 1661 to 1788.

A LIST *of the Number of Ships from* HOLLAND, *which were employed in the* GREENLAND *and* DAVIS STRAITS WHALE FISHERY *since* 1661.

N. B. *The* DUTCH *sent Ships to* DAVIS STRAITS *for the first time in* 1719.

Years	Ships.	Fish	Years	Ships.	Fish.
1661	133	452½	1708	122	533⅛
1662	149	862	1709	126	192¼
1663	202	932⅛	1710	137	62
1664	193	782	1711	117	631
1665	War with England, no Ships out.		1712	108	373¼
1666			1713	93	237½
1667			1714	108	1291
1668	155	573	1715	134	698½
1669	138	1013½	1716	153	535
1670	148	792	1717	179	392⅛
1671	158	1088⅛	1718	139	280¼
1672	War with England, no Ships out.		1719	211	346
1673			1720	228	455 17/24
1674			1721	260	733 2/7
1675	147	900½	1722	254	1101½
1676	145	182⅙	1723	233	314
1677	145	785⅓	1724	232	358
1678	120	1118¼	1725	226	530½
1679	126	792	1726	218	244
1680	151	1373	1727	202	402⅛
1681	175	876	1728	182	363⅛
1682	195	1444	1729	184	229⅓
1683	242	1338⅛	1730	186	248¾
1684	233	1153½	1731	164	298¼
1685	209	1283 7/16	1732	176	314⅙
1686	189	664 1/7	1733	184	360¼
1687	194	621½	1734	186	327
1688	214	340½	1735	185	496¾
1689	160	241⅛	1736	191	857½
1690	117	785	1737	196	504½
1691	2	war with France.	1738	195	472
			1739	192	728¼
1692	32	56⅛	1740	187	665⅛
1693	90	175	1741	178	312¼
1694	63	161 5/16	1742	173	358½
1695	97	187⅝	1743	185	937
1696	122	428	1744	187	1494
1697	131	1279	1745	184	568¾
1698	139	1483⅛	1746	180	1036
1699	151	775⅛	1747	164	776¼
1700	173	913⅝	1748	94	278⅙
1701	208	2071⅛	1749	157	619¼
1702	224	687 7/16	1750	158	990½
1703	107	644	1751	162	330 5/16
1704	130	652⅙	1752	159	546¼
1705	157	1678	1753	166	639⅝
1706	151	966⅛	1754	171	672 11/12
1707	131	126	1755	181	720½

Years	Ships.	Fish.	Years	Ships.	Fish.
1756	186	568½	1773	134	444½
1757	180	423⅙	1774	130	450
1758	159	371½	1775	129	105
1759	155	464	1776	123	509
1760	154	454	1777	116	427¾
1761	161	357½	1778	111	306½
1762	165	189¾	1779	105	168¼
1763			1780	82	476
1764	161	224	1781	War with England, no ships ou.	
1765	165	477	1782		
1766	167	189⅓	1783	55	330
1767	165	179⅙	1784	62	198
1768	160	600⅓	1785	65	300
1769	152	1127	1786	67	479
1770	150	523	1787	67	239½
1771	150	143⅓	1788	69	190
1772	131	768⅛			

This table is interesting, as it shews us the precarious nature of this fishery. But it would have been still more valuable, if some other circumstances had been stated, such as the nature of the seasons when the fishery was less successful; whether the preceding winter was unusually long or severe; whether the short summer of these regions was not remarkable for extremes or sudden changes of heat and cold, sudden changes and variations of the wind, the prevalence of particular winds; or other facts which might enable us to trace the causes of the extraordinary failure and success of the fishery.

221 Attempt of the French to revive it.

The French made an attempt to revive this branch of trade in 1784. Six ships fitted out at Dunkirk at the expence of the late king, made some successful voyages both in the northern and southern whale fishery. The advantages of the trade were obvious, and the French government was eager to improve them. In the year 1786, some of the inhabitants of the island of Nantucket, near Halifax in North America, were invited to settle at Dunkirk to carry on the fishery. Several families accepted the invitation, and to encourage them to prosecute the trade, they were permitted to enjoy peculiar privileges and immunities. Ships were sent out to different seas, and had prosperous voyages. But this trade, as well as every other branch of French commerce, has probably been completely interrupted by the late revolution, and the particular circumstances in which that nation has been with regard to foreign powers.

223 Other nations engage in it.

Besides the nations which we have mentioned, who have been most deeply concerned in this fishery, the inhabitants of other countries have also embarked in it. Some ships were equipped at Embden in 1768 by order of the king of Prussia; the Swedish government in 1774 granted to a company established at Gottenburgh the exclusive privilege of the Davis straits and Greenland fishery for 20 years; and Denmark in 1775 attempted to take a share in the benefits of that fishery, which many of the nations of Europe, more enterprising or more industrious, had long successfully enjoyed on the shores of the Danish dominions.

224 Time of the fishery.

The whale fishery commences in May. It is about this time that the whales are seen in great numbers between

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Whale Fishery.

between the 76th and 79th degrees of north latitude; and at a distance they exhibit the appearance of the smoke rising from the chimneys of a great town by the water which is thrown into the air by their spouting or blowing. The fishery continues for the months of June and July, when it must be abandoned whether it has been successful or unprosperous; because it is necessary to be clear of the ice by the end of August. The ships return home at farthest in the month of September. But if the fishery happen to begin early in May, and prove abundant, they sometimes return in June or July.

225 Mode of taking the whale by Europeans.

We shall now conclude this article with a short account of the different modes that are practised in taking the whale. The following is employed in the Greenland fishery by Europeans. Every ship is provided with six boats, to each of which belong six men for rowing the boat, and a harpooner, whose business it is to strike the whale with his harpoon. Two of these boats are kept constantly on the watch at some distance from the ship, fastened to pieces of ice, and are relieved by others every four hours. As soon as a whale is perceived, both the boats set out in pursuit of it, and if either of them can come up before the whale finally descends, which is known by his throwing up his tail, the harpooner discharges his harpoon at him. There is no difficulty in choosing the place where the whale is to be struck, as some have asserted: for these animals only come up to the surface in order to breathe, or *blow*, as the fishermen term it, and therefore always keep the soft and vulnerable part of their bodies above water. A late improvement was made in the method of discharging the harpoon; namely, by shooting it out of a kind of swivel or musquetoon: but it does not appear, that since this improvement was made the whale fishing ships have had better success than before. As soon as the whale is struck, the men set up one of their oars in the middle of the boat as a signal to those in the ship. On perceiving this, the watchman alarms all the rest with the cry of *fall! fall!* upon which all the other boats are immediately sent out to the assistance of the first.

The whale finding himself wounded, swims off with prodigious velocity. Sometimes he descends perpendicularly, and sometimes goes off horizontally at a small depth below the surface. The rope which is fastened to the harpoon is about 200 fathoms long, and properly coiled up, that it may freely be given out as there is a demand for it. At first the velocity with which this line runs over the side of the boat is so great, that it is wetted to prevent its taking fire: but in a short time the strength of the whale begins to fail, and the fishermen, instead of letting out more rope, strive as much as possible to pull back what is given out already, although they always find themselves necessitated to yield at last to the efforts of the animal, to prevent its sinking the boat. If he runs out the 200 fathoms of line contained in one boat, that belonging to another is immediately fastened to the end of the first, and so on; and there have been instances where all the rope belonging to the six boats has been necessary, though half that quantity is seldom required. The whale cannot stay long below water, but again comes up to blow; and being now much fatigued and wounded, stays longer above water than usual. This gives another boat time to come up with him, and he is again struck with a harpoon. He again descends, but with less force than before; and when he comes up again, is generally incapable of descending, but suffers himself to be wounded and killed with long lances which the men are provided with for that purpose. He is known to be near death when he spouts up the water deeply tinged with blood.

The whale being dead, is lashed alongside the ship. They then lay it on one side, and put two ropes, one at the head, and the other in the place of the tail, which, together with the fins, is struck off as soon as he is taken, to keep these extremities above water. On the off-side of the whale are two boats, to receive the pieces of fat, utensils, and men, that might otherwise fall into the water on that side. These precautions being taken, three or four men, with irons at their feet to prevent slipping, get on the whale, and begin to cut out pieces of about three feet thick and eight long, which are hauled up at the capstan or windlass. When the fat is all got off, they cut off the whalebone of the upper jaw with an axe. Before they cut, they are all lashed to keep them firm; which also facilitates the cutting, and prevents them from falling into the sea; when on board, five or six of them are bundled together, and properly stowed; and after all is got off, the carcase is turned adrift, and devoured by the white bears, who are very fond of it. In proportion as the large pieces of fat are cut off, the rest of the crew are employed in slicing them smaller, and picking out all the lean. When this is prepared, they stow it under the deck, where it lies till the fat of all the whales taken during the fishery is on board; then cutting it still smaller, they put it up in tubs in the hold, cramming them full and close. At the end of the season they return home, where the fat is boiled and pressed to give out the oil.

226 By the people of Kamtschatka.

But a different method is practised by the rude inhabitants of the different nations on the coasts of the Frozen ocean. On some parts of the sea coasts of Kamtschatka, the return of the fishing season is celebrated with a grand festival and great rejoicings in their subterraneous winter habitations, in which many superstitious ceremonies are performed. In one part of the ceremonies dogs are sacrificed with beating of drums and other rude musical instruments. The priests who attend and conduct the festival, transport with great solemnity and pomp a figure of a whale, made of wood, from the summer habitation to the winter cottage. As the ceremonies proceed, the whole company assembled shout with a great noise, that the whale has made its escape from the cottage to the sea; and they pretend even to show the traces of the whale, in its course, as if it had really made its way through the opening in the cottage. These ceremonies being ended, the men prepare their nets, and embark in their canoes. The nets are set at the openings of bays, where fish, which are the food of the whale, are abundant, and in the pursuit of which entering the bays he is taken. When this is observed by the people in the canoes, they approach and secure their prize with ropes and straps of leather. This event is again celebrated by their wives and children on shore with dancing, singing, and other demonstrations of joy. But after the whale is sufficiently secured, he is not brought on shore

227 Their previous ceremonies,

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Whale-Fishery. shore till another ceremony is performed. They put on their best clothes, and with similar solemnity, transport the image of the whale in wood from the winter to a new summer habitation. A lamp is there lighted up, and an attendant is appointed to watch and keep it burning from the spring to the autumn. The whale is then cut up, and furnishes for a long time what is considered by the natives of those regions a very delicate food.

228 By the people of the Kurile islands. Among the Kurile islands, which are situated near the southern extremity of the peninsula of Kamtschatka, the whales are most abundant about the beginning of autumn. At that time the inhabitants embark in their canoes, and search for them in places where they generally find them asleep on the surface of the water. When they are so fortunate as to find one in this situation, they approach with the least possible noise; and, when they have come within the proper distance, they pierce him with poisoned arrows. And although these wounds seem extremely slight, they are said in a short time to occasion great pain. The whale thus wounded moves about furiously, blows with great violence, and soon dies.

229 Of Iceland. We have already mentioned the mode of taking the whale which is practised by the Icelanders, in giving the natural history of the *balæna glacialis*, or Iceland whale. It is, according to Anderson, by throwing blood into the sea, when they get between the whale and the shore. They then endeavour to drive him towards the shore; but the whale finding himself pursued, attempts to regain the ocean, and approaching the blood, is alarmed; and rather than swim across it, returns towards the land, where he is often thrown on shore. But this is contradicted by Horrebow, who says, that the usual method of killing the whale in Iceland is with the harpoon.

230 Of Greenland. When the whale returns to the coasts of Greenland, the fishermen put on their large skin coats, and furnish themselves with a large knife, and a stone to sharpen it. They provide also harpoons, spears, and arrows, with a number of large skins of the sea-dog inflated. Thus equipped, they launch their canoes, and embark with their wives and children. The harpoon which they generally employ is pointed with bone, or a sharp stone. Some indeed have harpoons of iron, which they procure from the Danes by barter for the oil or fat of the whale. The scarcity of wood and iron makes these articles extremely valuable to Greenlanders, and has excited their ingenuity to avoid the risk of losing them. For this purpose an inflated bladder of the skin of the sea-dog is attached to the harpoon, so that in case it should not reach the whale when they attempt to strike, it may float on the water, and be recovered. Thus equipped they launch out into the ocean in their small canoes, and, with great intrepidity, attack the largest whales. They approach them, says Anderson, with astonishing boldness, and endeavour to fix, by means of their harpoon, which they throw at his body, some of the skins inflated with air. For, notwithstanding the enormous bulk of this animal, two or three of these skins, by the resistance which they make to the water, on account of their diminished specific gravity, greatly impede his attempts at plunging into the deep. Having by this means succeeded in arresting his progress, they approach nearer; and, with their lances, pierce his body, till he become languid and feeble with the loss of blood, and at last dies. The fishermen then plunge into the sea with their skin-jackets filled with air, and swim to their prize; and, floating on the surface of the water, they cut off with their knives from every part of the whale the fat or blubber, which is thrown into the canoes. And, notwithstanding the rudeness and imperfection of their instruments, their dexterity is such, that they can extract from the mouth the greatest, or at least the best part of the whalebone.

But the mode of fishing the whale, the boldest and most astonishing, is that which is practised by the Indians on the coast of Florida. When a whale appears, they fasten to their bodies two pieces of wood and a mallet; and these instruments, with their canoe, constitute the whole of their fishing equipage. When they approach the whale, they throw themselves into the water, swim directly towards him, and have the address to get upon his neck, taking care to avoid the stroke of his fins or tail. When the whale first spouts, the Indian introduces one of the pieces of wood into the opening of one of the blow-holes, and drives it home with the mallet. The whale thus attacked, instantly plunges, and carries the Indian along with him, who keeps fast hold of the animal. The whale, which has now only one blow-hole, soon returns to the surface of the water to respire: and, if the Indian succeeds in fixing the other piece of wood into the second blow-hole, the whale again descends to the bottom, but a moment after reappears on the surface, where he remains motionless, and immediately expires by the interruption of the function of respiration. 231 Astonishing mode by the Floridan Indians.

EXPLANATION OF PLATES.

Plate CXL.—Fig. 1. The large whalebone or Greenland whale, is from 40 to 60 feet long, and more than one half the length in circumference at the thickest part. This whale is taken on account of the oil and the whalebone. 232 Plates explained.

Fig. 2. The narhwal or unicorn-fish, yields a small quantity of oil, but it is said to be of a superior quality. The horns or teeth are much valued, and are in some respects preferable to ivory. They are from 9 to 10 feet long. The flesh is greatly esteemed by the inhabitants of Greenland.

Fig. 3. The large spermaceti whale, which is taken on account of the oil, and also on account of the more valuable substance, spermaceti, which is found chiefly in cells within the skull. The figure here given is taken from one of the 31 which came on shore in 1784, near Audierne in France. The length was 44 feet.

Fig. 4. The grampus. This figure was taken from one caught at the mouth of the Thames in 1759. It was 24 feet long.

Plate CXLI.—Fig. 1. and 2. exhibit a view of the course of the blow-hole in the cetaceous fishes.

Fig. 1. shews the blow-hole of the whalebone and spermaceti whale. In the whalebone whale it is double, and the course of it is marked by the dotted line ABCD. It is single in the spermaceti whale, and marked by the dotted lines AEFD.

Fig. 2. shews that of the monodon and delphinus. That of the monodon, which is single, is shewn by the dotted line ABCD, terminating at the back part of the

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Fig. 1.

BALŒNA MYSTICETUS, LARGE WHALE-BONE WHALE.

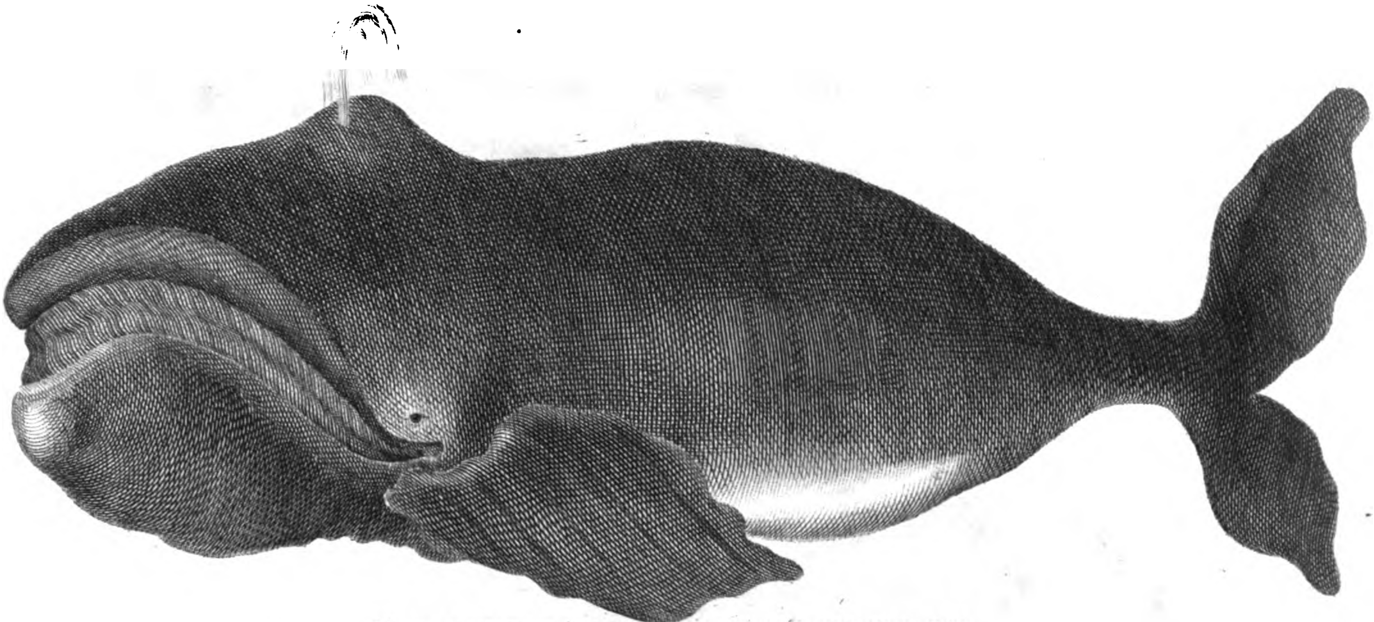


Fig. 2. MONODON MONOCEROS NARHWAL, or UNICORN FISH.

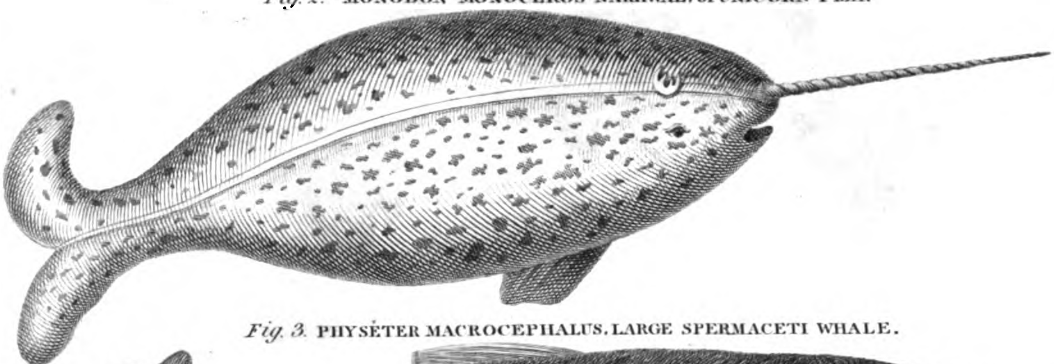


Fig. 3. PHYSÉTER MACROCEPHALUS, LARGE SPERMACETI WHALE.

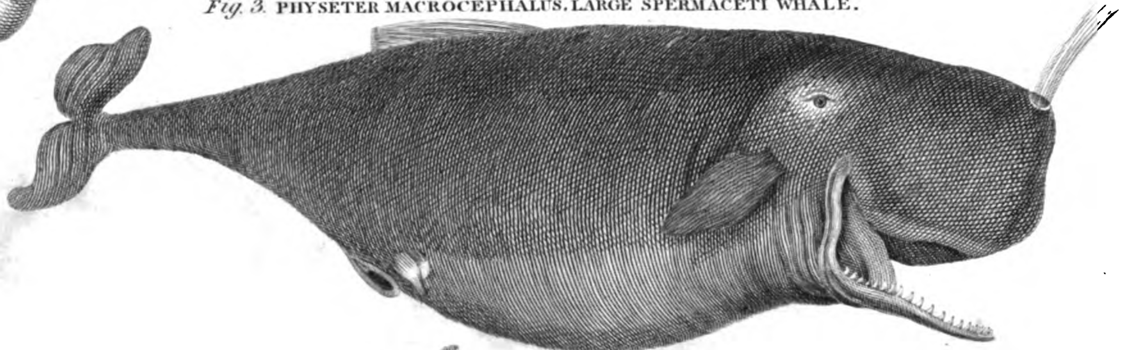
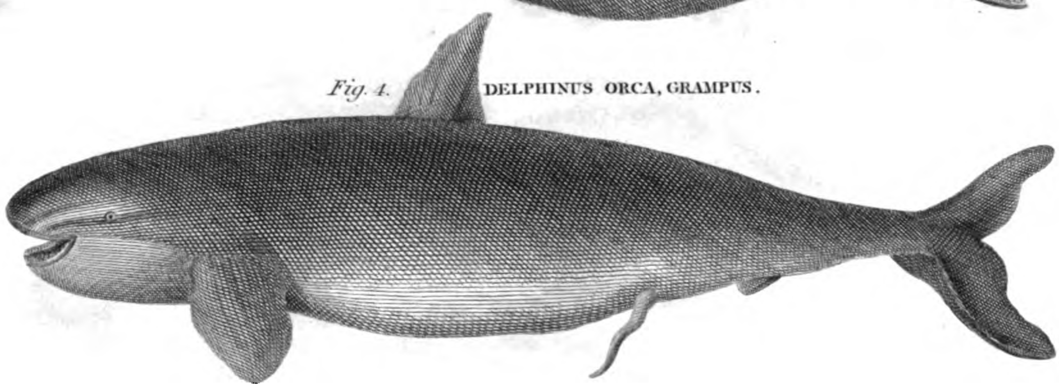


Fig. 4. DELPHINUS ORCA, GRAMPUS.



A. Wilson Sculpt.

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Fig. 1.
BLOWHOLE OF THE WHALEBONE AND SPERMACETI WHALE.

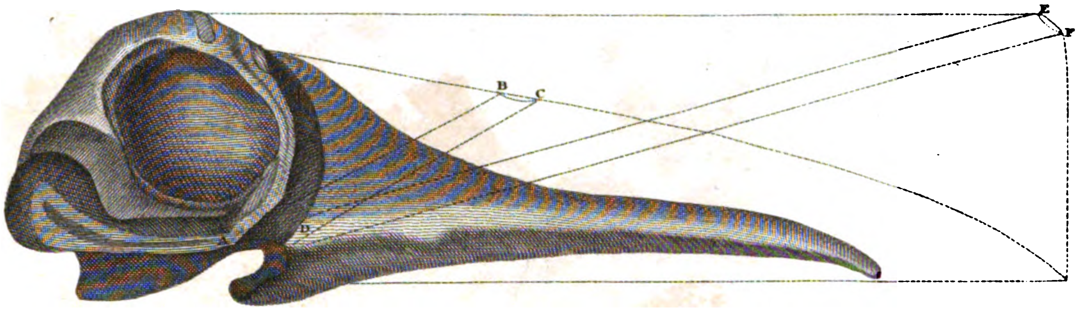


Fig. 2.
BLOWHOLE OF THE UNICORN FISH AND DOLPHIN.

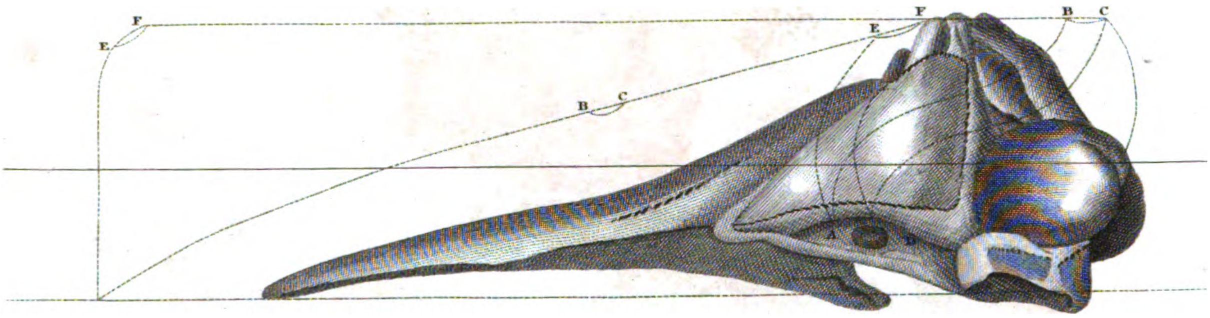


Fig. 3.
PERPENDICULAR VIEW OF THE WHALEBONE.

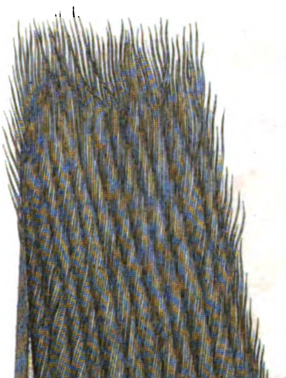


Fig. 4.
LATERAL VIEW.

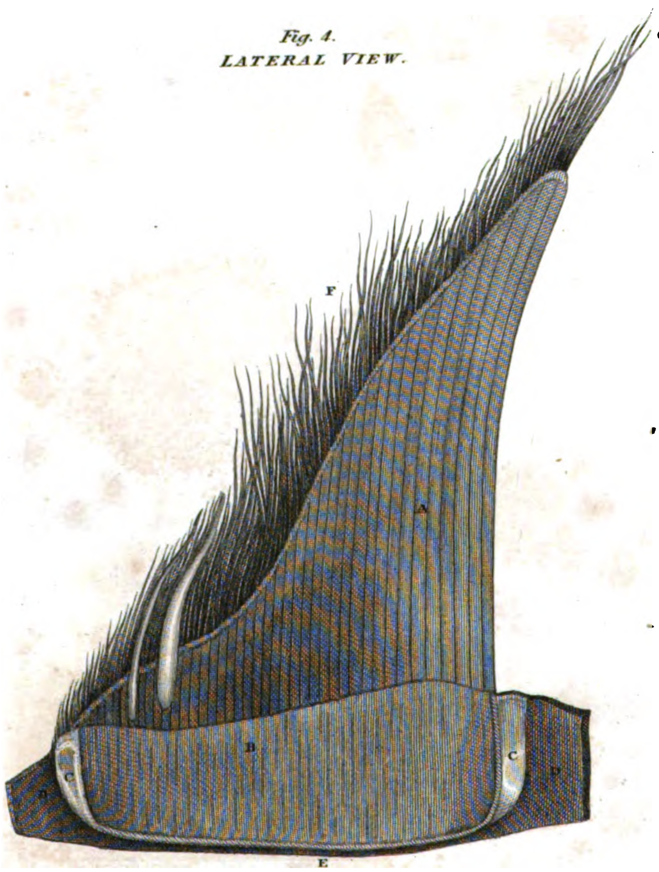
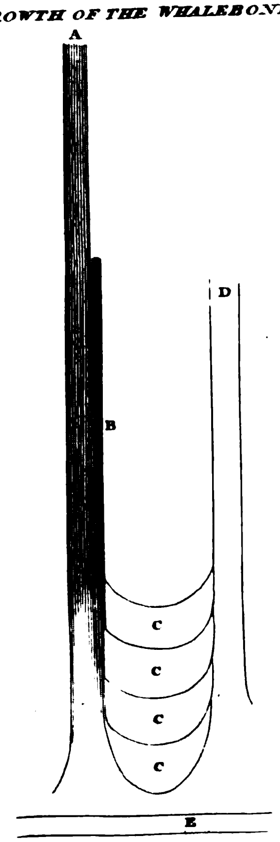


Fig. 5.
GROWTH OF THE WHALEBONE.



A. Wilson sculp.

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Whale Fishery.

the head; and that of the class delphinus by the dotted line AEFD, terminating at the top of the head.

Fig. 3. A perpendicular section of several plates of whalebone in their natural situation in the gum. The inner edges or shortest terminations are removed, and the cut edges seen from the inside of the snout. A, the upper part, shews the distance of the plates from each other. C, the lower part, shews the white substance on which they grow, and the basis on which they stand.

Fig. 4. A side view of one of the plates of whalebone. A, the part which projects beyond the gum, B, the portion which is sunk in the gum. CC, a white substance which surrounds the whalebone, forming there a projecting bead, and also passing between the plates to form their external lamellæ. DD, the part analogous to the gum. E, a fleshy substance covering the jaw-bone, on which the inner lamella of the plate is formed. F, the termination of the whalebone in the hair.

Fig. 5. An outline to shew the mode of growth of the plates, and of the white intermediate substance. A, the middle layer of the plate, which is formed upon a pulp or cone that passes up in the centre of the plate. The termination of this layer forms the hair. B, one of the outer layers, which is formed from the intermediate white substance. CCCC, the intermediate white substance, the laminæ of which are continued along the middle layer, and form the substance of the plate of whalebone. D, the outline of another plate of whalebone. E, the basis on which the plates are formed which adheres to the jaw-bone.

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Cette ‖ Ceuta.

CETTE, a maritime town of France, in Languedoc, seated at the place where the canal of Languedoc begins, between Montpelier and Agde, on the bay of Maguelona, in the Mediterranean sea. Population in 1815, 8000. E. Long. 3. 15. N. Lat. 43. 25.

CETUS, in *Astronomy*, the whale; a large constellation of the southern hemisphere, under Pisces, and next the water of Aquarius. The stars in the constellation Cetus, in Ptolemy's catalogue, are twenty-two; in Tycho's twenty-one; in Hevelius's forty-five; in the Britannic catalogue ninety-seven.

Cetus is represented by the poets as the sea monster which Neptune, at the suit of the nymphs, sent to devour Andromeda for the pride of her mother, and which was killed by Perseus. In the mandible of Cetus is a variable star which appears and disappears periodically, passing through the several degrees of magnitude, both increasing and diminishing, in about 333 days. See Astronomy.

CEVA, a strong town of Piedmont in Italy, seated on the river Tanero, with a strong fort, and containing 5000 inhabitants. E. Long. 3. 8. N. Lat. 44. 20.

CEVENNES, mountains of Languedoc in France, remarkable for the frequent meetings of the Protestants there as a place of security against the tyranny of their governors. In Queen Anne's reign there was an attempt made to assist them by an English fleet in the Mediterranean; but to no purpose, for the French had occupied the passages.

CEUTA, a maritime town of Barbary in Africa, and in the kingdom of Fez, seated on the straits of Gibraltar, opposite that place, in W. Long. 6. 25. N. Lat. 36. 35. John king of Portugal took it from the Moors in 1415, but it now belongs to Spain. In 1697 it sustained a vigorous siege by the Moors.

Ceuta, Ceylon.

CEYLON, a large island in the East Indies, which lies between 6° and 10° north latitude: and between 78° and 82° east longitude. It is situated at the entrance of the bay of Bengal, by which it is bounded on the north. On the north-west it is separated from the Coromandel coast by the gulf of Manaar, a narrow strait full of shoals, and impassable by large ships; and is distant about 60 leagues from Cape Comorin, the southern part of the peninsula of India. Its circumference is computed to be about 900 miles; and its length from Point Pedro at the northern extremity to Donderhead at the southern is about 300 miles. Its breadth is very unequal, being in some parts only from 40 to 50 miles, while in others it extends to 60, 70, and even 100.

The appearance of the eastern coast is bold and rocky, and a few reefs of rocks run out into the sea on the south-east between Point de Galle and Batocolo. The deep water on the eastern shores admits the approach of the largest vessels in safety; and if that side of the island be the least fertile, its other defects are amply compensated by the harbours of Trincomalee and Batocolo. The north and north-west coast from Point Pedro to Columbo is flat, and everywhere indented with inlets of the sea. The largest of them extends almost quite across the island from Mullipatti to Jafnapatam on the north-west point of the island; and forms the peninsula of Jafnapatam. Several of these inlets form small harbours.

The interior of the island abounds with steep and lofty mountains, covered with thick forests, and full

of

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Ceylon.

of almost impenetrable jungles. The woods and mountains completely surround the dominions of the king of Candy, and seem destined by nature to defend him against those foreign enemies, whose superior skill and power have deprived him of the open tracts on the sea-coast. The most lofty range of mountains divides the island nearly into two parts, and so completely separates them from each other, that both the climate and seasons on either side are essentially different. These mountains also obstruct completely the effect of the monsoons, which set in periodically from opposite sides of them; so that not only the opposite sea-coast, but the whole country in the interior, suffers very little from these storms.

The monsoons in Ceylon are connected with those on the Coromandel and Malabar coasts; but they set in much sooner on the western than the eastern side of the island. On the west side, where Columbo lies, the rains prevail in the months of May, June, and July, the season when they are felt on the Malabar coast. This monsoon is usually extremely violent, being accompanied with dreadful storms of thunder and lightning, together with vast torrents of rain, and violent south-west winds. During its continuance, the northern parts of the island are very little affected, and are even generally dry. In the months of October and November, when the opposite monsoon sets in on the Coromandel coast, it is the north of Ceylon which is affected, and scarcely any impression of it is felt in the southern parts.

These monsoons pass slightly over the interior, and seldom occasion any considerable inconvenience. But this part of the island is not altogether freed from the dreadful storms which so terribly ravage the tropical climates. During its own periodical season, which happens in March and April, the rain pours down in torrents, and the thunder and lightning are terrible.

From the situation of this island, so near the equator, the days and nights are nearly of equal length; the variation during the two seasons not exceeding 15 minutes. The seasons are more regulated by the monsoons than the course of the sun; for although the island lies to the north of the line, the coolest season is during the summer solstice, while the western monsoon prevails. Their spring commences in October; and the hottest season is from January to the beginning of April. The heat, during the day, is nearly the same throughout the whole year; the rainy season, however, renders the nights much cooler, from the dampness of the earth, and the prevalence of winds during the monsoons. The climate, upon the whole, is much more temperate than on the continent of India. This temperate climate, however, is chiefly confined to the coast where the sea-breezes have room to circulate. In the interior of the country, owing to the thick and close woods, and the hills which crowd upon each other, the heat is in many degrees greater than on the sea-coast, and the climate often extremely sultry and unhealthy.

The principal harbours in the island for large ships are Trincomalee and Point de Galle; they also come to anchor, and at certain seasons of the year moor securely, in the roads of Columbo. There are several other inferior ports round the island, which afford shelter to the smaller coasting vessels.

The two principal rivers are the Malivagonga and the Mulivaddy. The former takes its rise among the hills to the south-east of Candy, and nearly surrounds that city. After a variety of circuitous windings among the mountains, it at last discharges itself into the sea at Trincomalee. This river is so deep as to be fordable only towards the source; but the rocks, which everywhere break its course, prevent it from being navigated. The Mulivaddy rises from the foot of a very high mountain, known to Europeans by the name of Adam's Peak, and situated about sixty miles to the north-east of Columbo. This river falls into the sea by several branches: the largest of these empties itself about three miles from the fort of Columbo, after having nearly surrounded a large tract of the level country, of which it forms a peninsula.

Besides the rivers with which Ceylon abounds, there are many lakes and canals communicating with them, particularly in the neighbourhood of Columbo and Nigumbo. They are often of considerable extent, and of great utility to the inhabitants in their neighbourhood, who have thus an opportunity of readily transporting their several articles of trade; and it is by this means also that the towns on the coast are supplied with the greatest abundance of fresh-water fish.

The internal communications by land through the island have scarcely passed the first stage of improvement. Along the sea-coasts indeed there are roads and stations for travellers: but these roads are in many places rugged and steep.

The soil in general is sandy, with a small mixture of clay. In the south-west parts, particularly about Columbo, there is a great deal of marshy ground, very rich and productive. This tract, however, is chiefly occupied with cinnamon plantations, and the rest of the island, in its present state of cultivation, does not produce a sufficient quantity of rice for the consumption of its inhabitants.

Ceylon was originally divided into a number of distinct petty kingdoms, separated by the several rivers and mountains which are dispersed over the face of the island, and subject each to its own independent sovereign. In process of time, however, the whole country was reduced under the dominion of the king of Candy, and divided by him into a few great provinces, from which several of the numerous titles he still retains were derived. These provinces were Candy, Coitu, Matura, Dambadar, and Sittivacca, which included the rich districts on the west coast. The chief of these provinces was Candy, situated in the centre of the island, and honoured with the royal residence. The king holds his court there to this day; and though all the other provinces have been more or less encroached upon, no part of Candy has ever been reduced to permanent subjection under a foreign power. The great divisions of the island now are reduced to two; the one comprehending those parts under the dominion of Europeans, and the other those which still remain to the natives.

Little was known of the island of Ceylon previous to the arrival of the Portuguese in 1505, who were admitted by the king of the country in a friendly manner, and received from him an annual tribute for their protection against external invasion, particularly against the attacks of the Arabs, who had long harassed and oppressed

Ceylon. oppressed the Ceylonese. The inhabitants at that time, as at present, consisted of two distinct races, the Bedahs, who lived in the forests, particularly in the northern parts, and the Cinglese, who inhabited the sea coast. Columbo, now the European capital at Ceylon, was at that time the royal residence. Cinnamon was even then the chief product and staple commodity of the country. Two hundred and fifty thousand pounds weight were annually delivered by the king to the Portuguese in name of tribute. The inhabitants suffered great cruelties and oppression under the Portuguese, and were glad of an opportunity of throwing off the yoke and putting themselves under the protection of the Dutch. In 1632, a strong armament was sent out by the latter to act in concert with the native prince; and after a bloody struggle, the Portuguese were at last expelled from the island. Columbo surrendered to the Dutch arms in 1656, and this terminated the dominion of the Portuguese in the island. In the year 1795, the island was reduced by a body of British troops. Subsequently to that period the native princes in the interior have been subdued.

The chief towns in Ceylon are Trincomalee and Columbo. Trincomalee lies in latitude 8° 30′. It runs in a north-east direction along one branch of the bay. The country around it is mountainous and woody; the soil uncultivated and rather barren, and the whole appearance wild.

Trincomalee, from its situation and construction, is naturally strong. It occupies more ground than Columbo, but contains a much smaller number of houses, and those inferior in size and appearance to those which are to be met with in several towns on the south-west coast. The circumference of Trincomalee, within the walls, is about three miles; within this space is also included a hill or rising point, immediately over the sea, and covered with brushwood.

The fort is strong, and commands the principal bays; and, in particular, the entrance into the grand harbour, or inner bay, which affords at all seasons, and in every variety of weather, a secure shelter to ships of all descriptions, being land-locked on all sides, and sufficiently deep and capacious to receive any number of the largest vessels.

This harbour, from its nature and situation, is that which stamps Ceylon one of our most valuable acquisitions in the East Indies. As soon as the violent monsoons commence, every vessel which is caught by them in any other part of the bay of Bengal, is obliged immediately to put to sea to prevent inevitable destruction. At these seasons Trincomalee and Bombay alone, of all the ports on the different coasts of the peninsula of India, are capable of affording a safe retreat. The incalculable advantages to be derived from such a harbour, are increased by its proximity and easy access to our settlements in the bay of Bengal.

Columbo is the capital of Ceylon and the seat of government. Although Trincomalee, on account of its situation and harbour, be of more consequence to this nation to retain, yet Columbo in every other respect is greatly superior. The number of its inhabitants is much greater; its fort and black town are much larger; the country where it is situated is far more fertile, and the rich district depending upon it much wider, being not less than 20 leagues in length, and 10 in breadth. It is situated in the west, or rather towards the south-west part of the island, in about 7° north latitude and 78° east longitude from London.

The plan of Columbo is regular. It is nearly divided into four equal quarters by two principal streets, which cross each other, and extend the whole length of the town. To these, smaller ones run parallel, with connecting lanes between them. At the foot of the ramparts on the inside is a broad street or way, which goes round the whole fort, and communicates with the bastions and soldiers barracks; and also affords, at the different angles, open spaces for their private parading.

Besides the European inhabitants of Ceylon, the natives are quite distinct from each other in manners and civilization. The Cinglese, who inhabit the low lands and parts contiguous to the coasts, live entirely under the dominion of whatever European nation has been able to acquire possession of that part of the island. The nature of the country they inhabit indeed leaves them hardly any alternative but unconditional submission, unless they could either meet the Europeans in open battle, or consent to quit their plentiful fields for the barren mountains of the interior.

They are a quiet, inoffensive people; exceedingly grave, temperate, and frugal. Their bodies partake of the indolence of their minds, and it is with reluctance they are roused to any active exertion. When, however, they are obliged to apply themselves to any work, such as agriculture, they are capable of undergoing a great deal of labour.

The milder virtues form the most prominent features of the Cinglese character. They are gentle, charitable, and friendly, and have scarcely any of the false, treacherous, and designing arts which are often found among the Candians. With much less smoothness and courteousness of face and manner than the latter, they have much sincerer hearts. On examining the countenances and carriage of these two classes of Ceylonese, it is easy to perceive the difference arising from the respective circumstances in which they are placed. The countenance of the Candian is erect, his look haughty, his mein lofty, and his whole carriage marked by the pride of independence.

The looks of the Cinglese even denote a degree of effeminacy and cowardice, which excites the contempt of the Candians; although the latter, with all their boasted spirit, can never venture to attack an European but by the same method as the Cinglese, and are equally cautious in waiting the convenient moment of assaulting him from the bushes, in which they have concealed themselves.

The most singular part of the inhabitants of Ceylon are the Bedahs or Vaddahs. The origin of the Bedahs or Vaddahs, who inhabit the deepest recesses of the Ceylonese forests, has never been traced, as no other race can be found in the eastern world which corresponds with them. Conjecture has, indeed, been busy on the occasion, as it usually is where real information is wanting. The Bedahs are generally supposed to have been the aboriginal inhabitants of the island, who, upon being overwhelmed by their Cinglese invaders, preferred the independence of savages to a tame submission. A current tradition, however,

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ever, assigns them a different origin. It is related that they were cast away on the island, and chose to settle there; but refusing, upon a certain occasion, to assist the king in his wars against some foreign enemies, they were driven out from the society of the natives, and forced to take up their abode in the most unfrequented forests. Some imagine that the Bedahs are merely a part of the native Candians, who chose to retain their ancient savage freedom, when their brethren of the plains and valleys submitted to the cultivation of the earth, and the restraints of society. This opinion rests entirely on those Bedahs, who are most known, speaking a broken dialect of the Cinglese. It is, however, by no means ascertained that this is the universal language of the Bedahs; nor is any account of their origin supported by the slightest shadow of proof.

Among the animals of Ceylon, and at the head of the class of quadrupeds, is the elephant, which is considered as superior to those found in any other part of the world. The oxen are of very small size, scarcely exceeding that of calves of a year old. They are of that species which have the hump on the shoulder; but are inferior in quality, as well as in size, to any found on the Indian continent. The beef is sometimes of a good quality, and forms the chief food of the European soldiers. Buffaloes are found in great numbers in the island, both in a wild and tame state. They are wild and untractable; and even when tamed and trained to the draught, for which, being stronger and larger than the oxen, they are well adapted, they retain a good deal of their original manners. A variety of deer and elks are found in Ceylon; especially the gazelle, a very small species, about the size of our hare, which is caught by the natives and brought to market in cages, where they are sold for about 1s. a piece. Hares, similar to the European, abound in every part of the island; a small species of tyger, the tyger cat, the leopard, the jackal, porcupines, racoons, squirrels, and sometimes, but rarely, the hyena, and the bear, are found in Ceylon. Birds, insects, serpents, and other reptiles, such as are usually to be met with in the larger islands of the Indian ocean, or on the neighbouring continent, are common on this island.

Ceylon abounds in all the vegetables and fruits which are found within the tropical regions. But among the vegetable productions of Ceylon, the most valuable, and what may be reckoned the staple commodity of the island, is the cinnamon.

The principal woods, or gardens, as they are called, where the cinnamon is procured, lie in the neighbourhood of Columbo. The grand garden near the town is so extensive as to occupy a tract of country from 10 to 15 miles in length, and stretching along from the north-east to the south of the district. Nature has here concentrated both the beauty and the riches of the island. Nothing can be more delightful to the eye than the prospect which stretches around Columbo. The low cinnamon trees which cover the plain allow the view to reach the groves of evergreens, interspersed with tall clumps, and bounded everywhere with extensive ranges of cocoa-nut and other large trees. The whole is diversified with small lakes and green marshes, skirted all around with rice and pasture fields. In one part the intertwining cinnamon trees appear completely to clothe the face of the plain; in another, the opening made by the intersecting footpaths just serve to shew that the thick underwood has been penetrated.

The soil best adapted for the growth of the cinnamon is a loose white sand. Such is the soil of the cinnamon gardens around Columbo, as well as in many parts around Nigumbo and Caltura, where this spice is found of the same superior quality. Of late years little is procured from the interior; and what is brought thence is coarser and thicker in the appearance, and of a hot pungent taste.

As this spice constitutes the wealth of Ceylon, great pains are taken to ascertain its quality, and to propagate the choicest kinds. The prime sort, and that which grows in the gardens around Columbo, is procured from the *laurus cinnamomum*. This is a tree of a small size, from four to ten feet in height: the trunk is slender, and like several of our shrubs, a number of branches and twigs shoot out from it on every side. The wood is soft, light, and porous, in appearance much resembling that of our osier; and when barked it is chiefly fit for fuel, to which use it is commonly converted. It is, however, sometimes sawed into planks, and manufactured into caddies and other pieces of furniture; but its scent does not secure it from the attacks of the worms.

The cinnamon tree produces a species of fruit resembling an acorn, but not so large, which ripens about the latter end of autumn, and is gathered by the natives for the purpose of extracting the oil. The process they employ is to bruise the fruit, boil it, and skim off the oil: this they use for their hair and body on great occasions, and also for burning in their lamps. When mixed with cocoa-nut oil, it gives extremely good light. The kings of Candy use it for this purpose, and formerly commanded their subjects to bring them a certain quantity as a yearly tribute. When any ambassadors are sent to these princes, they always burn this oil during the time of audience.

The pearl-fishery in the bay of Condatchy, during the season, exhibits one of the most interesting scenes in Ceylon. The banks, where it is carried on, extend several miles along the coast from Manaar southward, off Arippo, Condatchy, and Pomparipo. The principal bank is opposite to Condatchy, and lies out at sea about 20 miles. The first step, previous to the commencement of the fishery, is to have the different oyster banks surveyed, the state of the oysters ascertained, and a report made on the subject to government. If it has been found that the quantity is sufficient, and that they are arrived at a proper degree of maturity, the particular banks to be fished that year are put up for sale to the highest bidder, and are usually purchased by a black merchant. Government sometimes judges it more advantageous to fish the banks on its own account, and to dispose of the pearls afterwards to the merchants. When this plan is adopted, boats are hired for the season on account of government, from different quarters; the price varies considerably, according to circumstances; but is usually from 500 to 800 pagodas for each boat.

As neither the season, nor the convenience of the persons attending, would permit the whole of the banks to be fished in one year, they are divided into three or four different portions, which are fished one portion annually in succession. The different portions are completely distinct, and are set up separately to sale, each

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Ceylon. each in the year in which it is to be fished. By this means a sufficient interval is given to the oysters to attain their proper growth; and as the portion first used has generally recovered its maturity by the time the last portion has been fished, the fishery becomes almost regularly annual, and may thus be considered as yielding a yearly revenue. The oysters are supposed to attain their completest state of maturity in seven years; for, if left too long, it is said that the pearl becomes so large and inconvenient to the fish, that it throws it out of the shell.

The fishing season commences in February, and ends about the beginning of April. The period allowed to the merchant to fish the banks is six weeks, or two months at the utmost; but there are several interruptions, which prevent the fishing days from exceeding more than about thirty. If it happens to be a very bad season, and many stormy days intervene during the period allotted, the purchaser of the fishery is often allowed a few days more as a favour.

During the season, all the boats regularly sail and return together. A signal gun is fired at Arippo, about ten o'clock at night, when the whole fleet sets sail with the land breeze. They reach the banks before daybreak; and at sunrise commence fishing. In this they continue busily occupied till the sea breeze, which rises about noon, warns them to return to the bay. As soon as they appear within sight, another gun is fired, and the colours hoisted, to inform the anxious owners of their return. When the boats come to land, their cargoes are immediately taken out, as it is necessary to have them completely unloaded before night. Whatever may have been the success of their boats, the owners seldom wear the looks of disappointment; for, although they may have been unsuccessful one day, they look with the most complete assurance of better fortune to the next; as the Brahmins and conjurors, whom they implicitly trust in defiance of all experience, understand too well the liberality of a man in hopes of good fortune, not to promise them all they can desire.

Each of the boats carries 20 men, with a tindal or chief boatman, who acts as pilot. Ten of the men row and assist the divers in re-ascending. The other ten are divers; they go down into the sea by five at a time; when the first five come up the other five go down, and by this method of alternately diving, they give each other time to recruit themselves for a fresh plunge.

In order to accelerate the descent of the divers, large stones are employed; five of these are brought in each boat for the purpose; they are of a reddish granite, common in this country, and of a pyramidal shape, round at top and bottom, with a hole perforated through the smaller end sufficient to admit a rope. Some of the divers use a stone shaped like a half-moon, which they fasten round the belly when they mean to descend, and thus keep their feet free.

The people are accustomed to dive from their very infancy, and fearlessly descend to the bottom in from four to ten feet fathom water, in search of the oysters. The diver, when he is about to plunge, seizes the rope to which one of the stones we have described is attached, with the toes of his right foot, while he takes hold of a bag of net-work with those of his left; it being customary among all the Indians to use their toes in working or holding as well as their fingers, and such is the power of habit that they can pick up even the smallest thing from the ground with their toes as nimbly as an European could do with his fingers. The diver thus prepared, seizes another rope with his right hand, and holding his nostrils shut with the left, plunges into the water, and by the assistance of the stone speedily reaches the bottom. He then hangs the net round his neck, and with much dexterity, and all possible dispatch, collects as many oysters as he can while he is able to remain under water, which is usually about two minutes. He then resumes his former position, makes a signal to those above by pulling the rope in his right hand, and is immediately by this means drawn up and brought into the boat, leaving the stone to be pulled up afterwards by the rope attached to it. Ceylon.

The exertion undergone during this process is so violent, that upon being brought into the boat, the divers discharge water from their mouth, ears, and nostrils, and frequently even blood. But this does not hinder them from going down again in their turn. They will often make from 40 to 50 plunges in one day; and at each plunge bring up about 100 oysters. Some rub their bodies over with oil, and stuff their ears and noses to prevent the water from entering; while others use no precautions whatever. Although the usual time of remaining under water does not much exceed two minutes, yet there are instances known of divers who could remain four and even five minutes. The longest instance ever known was that of a diver who came from Anjango in 1797, and who absolutely remained under water full six minutes.

The boat-owners and merchants are very apt to lose many of the best pearls while the boats are on their return to the bay from the banks, as the oysters when alive and left for some time undisturbed frequently open their shells of their own accord; a pearl may then be easily discovered, and the oyster prevented by means of a bit of grass or soft wood from again closing its shell, till an opportunity offers of picking out the pearl. Those fellows who are employed to search among the fish also commit many depredations, and even swallow the pearls to conceal them; when this is suspected, the plan followed by the merchants is to lock the fellows up, and give them strong emetics and purgatives, which have frequently the effect of discovering the stolen goods.

As soon as the oysters are taken out of the boats, they are carried by the different people to whom they belong, and placed in holes or pits dug in the ground to the depth of about two feet, or in small square places cleared and fenced round for the purpose; each person having his own separate division. Mats are spread below them to prevent the oysters from touching the earth; and here they are left to die and rot. As soon as they have passed through a state of putrefaction, and have become dry, they are easily opened without any danger of injuring the pearls, which might be the case if they were opened fresh, as at that time to do so requires great force. On the shell being opened, the oyster is minutely examined for the pearls: it is usual even to boil the oyster, as the pearl, though commonly found in the shell, is not unfrequently contained in the body of the fish itself.

The pearls found at this fishery are of a whiter colour than those got in the gulf of Ormus on the Arabian

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bian coast, but in other respects are not accounted so pure or of such an excellent quality; for though the white pearls are most esteemed in Europe, the natives prefer those of a yellowish or golden cast. Off Tutucoreen, which lies on the Coromandel coast, nearly opposite to Condatchy, there is another fishery; but the pearls found there are much inferior to the two species now mentioned, being tainted with a blue or grayish tinge.

In preparing the pearls, particularly in drilling and stringing them, the black people are wonderfully expert. The instrument they employ in drilling is a machine made of wood, and of a shape resembling an obtuse inverted cone, about six inches in length, and four in breadth, which is supported upon three feet, each 12 inches long. In the upper flat surface of this machine, holes or pits are formed to receive the larger pearls, the smaller ones being beaten in with a little wooden hammer. The drilling instruments are spindles of various sizes according to that of the pearls; they are turned round in a wooden head by means of a bow-handle to which they are attached. The pearls being placed in the pits which we have already mentioned, and the point of the spindle adjusted to them, the workman presses on the wooden head of the machine with his left hand, while his right is employed in turning round the bow-handle. During the process of drilling, he occasionally moistens the pearl by dipping the little finger of his right hand in a cocoa-nut filled with water, which is placed by him for that purpose; this he does with a dexterity and quickness which scarcely impedes the operation, and can only be acquired by much practice.

They have also a variety of other instruments, both for cutting and drilling the pearls. To clean, round, and polish them to that state in which we see them, a powder made of the pearls themselves is employed. These different operations in preparing the pearls occupy a great number of the black men in various parts of the island. In the black town of Columbo, in particular, many of them may every day be seen at this work.

Putallom is remarkable for its salt-pans. This place, before the arrival of Europeans on the island, supplied the natives with salt; and on account of its convenient situation, was pitched upon by the Dutch for manufacturing the salt with which they supplied the king of Candy's dominions, according to the articles of their treaty with him. The salt-pans are formed by an arm of the sea which overflows part of the country between Putallom and Calpenteen. A very large quantity of salt was manufactured here by the Dutch; they looked upon it as of the highest importance to their interests in the island, and the most formidable weapon which it was in their power to employ against the native king, as it was impossible for him to procure any but through their means. The Dutch enacted severe laws to prevent individuals from manufacturing or trading in this article, the government taking upon itself the management of the works and the care of supplying both its own subjects and the Candians. In order to keep a constant check on the latter, the Dutch were careful not to allow them too great a quantity at once; and whatever remained at Putallom after supplying the demands of each year they destroyed, that it might not be seized upon by surprise. But this manufacture has been of late greatly neglected. See CEYLON, SUPPLEMENT.

CHACE. See CHASE.

CHACO, a large country of South America, situated between 19° and 37° S. Lat. It belongs to the Spaniards, by whom it was conquered in 1536. It is not naturally fruitful; but abounds in gold mines, which are so much the more valuable that they are easily worked. The works are carried on by about 8000 blacks, who deliver every day to their masters a certain quantity of gold; and what they can collect above this belongs to themselves; as well as what they find on those days that are consecrated to religion and rest, upon condition that during the festival they maintain themselves. This enables many of them to purchase their liberty; after which they intermarry with the Spaniards.

CHADCHOD, in Jewish antiquity. Ezekiel mentions *chadchod* among the several merchandises which were brought to Tyre. The old interpreters, not very well knowing the meaning of this term, continued it in their translation. St Jerome acknowledges that he could not discover the interpretation of it. The Chaldee interprets it pearls; others think that the onyx, ruby, carbuncle, crystal, or diamond, is meant by it.

CHÆRONEA, in *Ancient Geography*, the last town, or rather the last village, of Bœotia, towards Phocis; the birth-place of Plutarch; famous for the fatal defeat of the confederate Greeks by Philip of Macedon. This place was considered by Philip as well adapted to the operations of the Macedonian phalanx; and the ground for his encampment, and afterwards the field of battle, were chosen with equal sagacity; having in view on one side a temple of Hercules, whom the Macedonians regarded as the author of their royal house, and the high protector of their fortune; and on the other the banks of the Thermodoon, a small river flowing into the Cephissus, announced by the oracles of Greece as the destined scene of desolation and woe to their unhappy country. The generals of the confederate Greeks had been much less careful to avail themselves of the powerful sanctions of superstition. Unrestrained by inauspicious sacrifices, the Athenians had left the city at the exhortation of Demosthenes, to wait no other omen but the cause of their country. Regardless of oracles, they afterwards advanced to the ill-fated Thermodoon, accompanied by the Thebans, and the scanty reinforcements raised by the islands and states of Peloponnesus which had joined their alliance. Their army amounted to 30,000 men, animated by the noblest cause for which men can fight, but commanded by the Athenians Lysicles and Chares; the first but little, and the second unfavourably known; and by Theagenes the Theban, a person strongly suspected of treachery; all three creatures of cabal and tools of faction, slaves of interest or voluptuousness, whose characters (especially as they had been appointed to command the only states whose shame, rather than virtue, yet opposed the public enemy) are alone sufficient to prove that Greece was ripe for ruin.

When the day approached for abolishing the tottering independence of those turbulent republics, which their own internal vices, and the arms and intrigues of Philip,

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Philip, had been gradually undermining for 22 years, both armies formed in battle array before the rising of the sun. The right wing of the Macedonians was headed by Philip, who judged it proper to oppose in person the dangerous fury of the Athenians. His son Alexander, only 19 years of age, but surrounded by experienced officers, commanded the left wing, which faced the Sacred Band of the Thebans. The auxiliaries of either army were posted in the centre. In the beginning of the action, the Athenians charged with impetuosity, and repelled the opposing divisions of the enemy; but the youthful ardour of Alexander obliged the Thebans to retire, the Sacred Band being cut down to a man. The young prince completed their disorder, by pursuing the scattered multitude with his Thessalian cavalry.

Meantime the Athenian generals, too much elated with their first advantage, lost the opportunity to improve it; for having repelled the centre and right wing of the Macedonians, except the phalanx, which was composed of chosen men, and immediately commanded by the king, they, instead of attempting to break this formidable body by attacking it in flank, pressed forward against the fugitives, the insolent Lysicles exclaiming in vain triumph, "Pursue, my brave countrymen! let us drive the cowards to Macedon." Philip observed this rash folly with contempt; and saying to those round him, "Our enemies know not how to conquer," commanded his phalanx, by a rapid evolution, to gain an adjacent eminence, from which they poured down, firm and collected, on the advancing Athenians, whose confidence of success had rendered them totally insensible to danger. But the irresistible shock of the Macedonian spear converted their fury into despair. Above a thousand fell, two thousand were taken prisoners; the rest escaped by a precipitate and shameful flight. Of the Thebans more were killed than taken. Few of the confederates perished, as they had little share in the action, and as Philip, perceiving his victory to be complete, gave orders to spare the vanquished, with a clemency unusual in that age, and not less honourable to his understanding than his heart; since his humanity thus subdued the minds, and gained the affections of his conquered enemies.

According to the Grecian custom, the battle was followed by an entertainment; at which the king, presiding in person, received the congratulations of his friends, and the humble supplications of the Athenian deputies, who craved the bodies of their slain. Their request, which served as an acknowledgment of their defeat, was readily granted; but before they availed themselves of the permission to carry off their dead, Philip, who with his natural intemperance had protracted the entertainment till morning, issued forth with his licentious companions to visit the field of battle; their heads crowned with festive garlands, their minds intoxicated with the insolence of wine and victory; yet the sight of the slaughtered Thebans, which first presented itself to their eyes, and particularly the sacred band of friends and lovers, who lay covered with honourable wounds on the spot where they had been drawn up to fight, brought back these insolent spectators to the sentiments of reason and humanity. Philip beheld the awful scene with a mixture of admiration and pity; and, after an affecting silence, denounced a solemn curse against those who basely suspected the friendship of such brave men to be tainted with criminal and infamous passions.

But this serious temper of mind did not last long; for having proceeded to that quarter of the field where the Athenians had fought and fallen, the king abandoned himself to all the levity and littleness of the most petulant joy. Instead of being impressed with a deep sense of his recent danger, and with dutiful gratitude to Heaven for the happiness of his escape, and the importance of his victory, Philip only compared the boastful pretensions with the mean performances of his Athenian enemies; and, struck by this contrast, rehearsed, with the insolent mockery of a buffoon, the pompous declaration of war lately drawn up by the ardent patriotism and too sanguine hopes of Demosthenes. It was on this occasion that the orator Demades at once rebuked the folly, and flattered the ambition of Philip, by asking him, Why he assumed the character of Thersites when fortune assigned him the part of Agamemnon?

Whatever might be the effect of this sharp reprimand, it is certain that the king of Macedon indulged not, on any future occasion, a vain triumph over the vanquished. When advised by his generals to advance into Attica, and to render himself master of Athens, he only replied, "Have I done so much for glory, and shall I destroy the theatre of that glory?" His subsequent conduct corresponded with the moderation of this sentiment. He restored without ransom the Athenian prisoners; who, at departing, having demanded their baggage, were also gratified in this particular; the king pleasantly observing, that the Athenians seemed to think he had not conquered them in earnest. Soon afterwards he dispatched his son Alexander, and Antipater, the most trusty of his ministers, to offer them peace on such favourable terms as they had little reason to expect. They were required to send deputies to the isthmus of Corinth, where, to adjust their respective contingent of troops for the Persian expedition, Philip purposed assembling early in the spring a general convention of all the Grecian states: they were ordered to surrender the isle of Samos, which actually formed the principal station of their fleet, and the main bulwark and defence of all their maritime or insular possessions; but they were allowed to enjoy, unmolested, the Attic territory, with their hereditary form of government.

CHÆROPHYLLUM, Chervil. See Botany *Index*.

CHÆTODON. See Ichthyology *Index*. This fish is a native of the East Indies, where it frequents the sides of the sea and rivers in search of food; from its singular manner of obtaining which it receives its name. When it spies a fly sitting on the plants that grow in shallow water, it swims to the distance of four, five, or six feet; and then, with a surprising dexterity, it ejects out of its tubular mouth a single drop of water, which never fails striking the fly into the water, where it soon becomes its prey.

CHAFF, in *Husbandry*, the husks of the corn, separated by screening or winnowing it. It signifies also the rind of corn, and straw cut small for the use of cattle.

Chaff-cutter, a machine for making chaff to feed horses.

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horses.—The advantages of an easy and expeditious method of cutting straw into chaff, by an engine which could be used by common labourers, have been long acknowledged; and various attempts have been made to bring such an engine to perfection. But the objections to most of them have been their complicated structure, their great price, and the noise they make in working; all which incoveniences seem to have been lately removed by an invention of Mr James Pike, watchmaker at Newton Abbot in Devonshire. Of his engine, which is of a simple and cheap construction, the following description, and figure referred to, are extracted from the Transactions of the Society of Arts, for 1787.

The engine is fixed on a wooden frame, which is supported with four legs, and on this frame is a box for containing the straw, four feet six inches long, and about ten inches broad; at one end is fixed across the box two rollers inlaid with iron, in a diagonal line, about an eighth of an inch above the surface; on the ends of these rollers are fixed two strong brass wheels, which take one into the other. On one of these wheels is a contract wheel, whose teeth take in a worm on a large arbor; on the end of this arbor is fixed a wooden wheel, two feet five inches diameter and three inches thick; on the inside part of this wheel is fixed a knife, and every revolution of the wheel the knife passes before the end of the box and cuts the chaff, which is brought forward between the rollers, which are about two inches and a half asunder; the straw is brought on by the worm taking one tooth of the wheel every round of the knife; the straw being so hard pressed between the rollers, the knife cuts off the chaff with so great ease, that 22 bushels can be cut within the hour, and makes no more noise than is caused by the knife passing through the chaff.

Plate CXXXVII. *A* is the box into which the straw is put. *B*, the upper roller, with its diagonal projecting ribs of iron, the whole moving by the revolution of the brass wheel *C* on the axis of which it is fixed. *D*, a brass wheel, having upon it a face wheel, whose teeth take into the endless screw on the arbor *E*, while the teeth on the edge of this wheel enter between those on the edge of the wheel *C*. On the axis of the wheel *D* is a roller, with iron ribs similar to *B*, but hid within the box. *E*, the arbor, one of the ends of which being made square and passing through a mortise in the centre of the wooden wheel *F*, is fastened by a strong screw and nut; the other end of this arbor moves round in a hole within the wooden block *G*. *H*, the knife, made fast by screws to the wooden wheel *F*, and kept at the distance of nearly three quarters of an inch from it by means of a strip of wood of that thickness, of the form of the blade, and reaching to within an inch of the edge. *I*, the handle mortised into the outside of the wooden wheel *F*.

CHAFFER, in *Zoology*, a species of beetle. See SCARABÆUS, ENTOMOLOGY *Index*.

CHAFFERCONNERS, in commerce, printed linens manufactured in the Great Mogul's dominions. They are imported by the way of Surat, and are of the number of those linens prohibited in France.

CHAFFERY, in the iron works, the name of one of the two principal forges. The other is called the *finery*. When the iron has been brought at the finery into what is called an ancony, or square mass, hammered into a bar in its middle, but with its two ends rough, the business to be done at the chaffery is the reducing the whole to the same shape, by hammering down these rough ends to the shape of the middle part.

CHAFFINCH, the English name of a species of FRINGILLA. See ORNITHOLOGY *Index*.

CHAGRE, a fort of America, in the province of Darien, at the mouth of a river of the same name. It has been taken several times by the Buccaneers, and last of all by Admiral Vernon in 1740. W. Long. 82. 7. N. Lat. 9. 50.

CHAIN (*Catena*) a series of several rings or links, fitted into one another.

There are chains of divers matters, sizes, forms, and for divers uses.—Ports, rivers, streets, &c. are closed with iron chains; rebellious cities are punished by taking away their chains and barriers.

The arms of the kingdom of Navarre are, *Chains Or, in a field of Gules*. The occasion hereof is referred to the kings of Spain leagued against the Moors; who, having gained a celebrated victory against them in 1212, in the distribution of the spoils the magnificent tent of Miralmumin fell to the king of Navarre, as being the first that broke and forced the chains thereof.

A Gold Chain is one of the ornaments or badges of the dignity of the chief magistrates of a city, as the mayor of London, the provost and bailies of Edinburgh, &c.—Something like this obtained among the ancient Gauls: the principal ornament of their persons in power and authority was a gold chain, which they wore on all occasions; and even in battle, to distinguish them from the common soldiers.

CHAIN also denotes a kind of string, of twisted wire; serving to hang watches, tweeser cases, and other valuable toys upon. The invention of this piece of curious work is owing to the English; whence, in foreign countries, it is denominated the *English chain*. These chains are usually either of silver or gold, some of gilt copper; the thread or wire of each kind to be very fine.—For the fabric, or making of these chains, a part of the wire is folded into little links of an oval form; the longest diameter about three lines; the shortest one. These, after they have been exactly soldered, are again folded into two; and then bound together or interwoven, by means of several other little threads of the same thickness; some whereof, which pass from one end to the other, imitate the warp of a stuff; and the others, which pass transverse, the woof. There are at least four thousand little links in a chain of four pendants; which are by this means bound so equally, and withal so firmly together, that the eye is deceived, and takes the whole to consist of one entire piece.

CHAIN is also a kind of measure in France, in the trade of wood for fuel. There are chains for wood by tale, for wood by the rope, for faggots, for cleft wood, and for round sticks. There are also chains for measuring the sheaves of all sorts of corn, particularly with regard to the payment of tithes; for measuring pottles of hay, and for measuring horses. All these are divided into feet, inches, hands, &c. according to the use they are designed for.

CHAIN,

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CHAIN, in surveying, is a measure, consisting of a certain number of links of iron wire, usually a hundred; serving to take the dimensions of fields, &c. This is what Mersenne takes to be the arvipendium of the ancients.

The chain is of various dimensions, as the length or number of links varies: that commonly used in measuring land, called Gunter's chain, is in length four poles or perches; or sixty-six feet, or a hundred links; each link being seven inches $\frac{92}{100}$. Whence it is easy to reduce any number of those links to feet, or any number of feet to links.

This chain is entirely adapted to English measure; and its chief convenience is in finding readily the numbers contained in a given field. Where the proportions of square feet and acres differ, the chain, to have the same advantage as Gunter's chain, must also be varied. Thus, in Scotland, the chain ought to be of 74 feet, or 24 Scotch ells, if no regard be had to the difference between the Scotch and English foot; but if regard be had to this difference, the Scotch chain ought to consist of 74¼ English feet, or 74 feet four inches and ⅘ of an inch. This chain being divided into an hundred links, each of these will be $\frac{928}{1000}$ inches.

That ordinarily used for large distances, is in length 100 feet; each link one foot. For small parcels, as gardens, &c. is sometimes used a small chain of one pole, or 16 feet and a half length; each link one inch $\frac{98}{100}$.

Some in lieu of chains use ropes; but these are liable to several irregularities, both from the different degrees of moisture, and of the force which stretches them. Schwenterus, in his Practical Geometry, tells us, he has observed a rope sixteen feet long reduced to fifteen in an hour's time, by the mere falling of a hoar-frost. To obviate these inconveniences, Wolfius directs, that the little strands whereof the rope consists be twisted contrariwise, and the rope dipped in boiling hot oil, and when dry, drawn through melted wax. A rope thus prepared will not get or lose any thing in length, even though kept under water all day.

CHAIN-Pump. See PUMP.

CHAIN-Shot, two bullets with a chain between them. They are used at sea to shoot down yards or masts, and to cut the shrouds or rigging of a ship.

Top CHAIN, on board a ship, a chain to sling the sail yards in time of battle, in order to prevent them from falling down when the ropes by which they are hung happen to be shot away or rendered incapable of service.

Plate CXXXVII. *CHAIN Wales*, or *Channels*, of a ship, (*porteboissoirs*,) are broad and thick planks projecting horizontally from the ship's outside, abreast of and somewhat behind the masts. They are formed to extend the shrouds from each other, and from the axis or middle line of the ship, so as to give a greater security and support to the masts, as well as to prevent the shrouds from damaging the gunwale, or being hurt by rubbing against it. Every mast has its chain wales, which are either built above and below the second deck ports in a ship of the line; they are strongly connected to the side by knees, bolts, and standards, besides being confined thereto by the chains, whose upper ends pass through notches on the outer edge of the chain wales, so as to unite with the shrouds above.

CHAINS, in *Ship-Building*, are strong links or plates of iron, the lower ends of which are bolted through the ship's side to the timbers.

Hanging in CHAINS, a kind of punishment inflicted on murderers. By stat. 25 Geo. II. c. 37. the judge shall direct such to be executed on the next day but one, unless Sunday intervene, and their bodies to be delivered to the surgeons to be dissected and anatomized; and he may direct them afterwards to be hung in chains. During the interval between sentence and execution, the prisoner shall be kept alone, and sustained only with bread and water. The judge, however, hath power to respite the execution, and relax the other restraints of the act.

CHAIN Island, an island lately discovered by Captain Wallis in the South sea. It seemed to be about five miles long and as much broad, lying in the direction of north-west and south-east. It appeared to be a double range of woody islands joined together by reefs, so as to compose one island of an oval figure, with a lake in the middle. The trees are large, and from the smoke that issued from the woods, it appeared to be inhabited. W. Long. 145. 54. S. Lat. 17. 23.

CHAJOTLI, or CHAYOTI, a Mexican fruit of a round shape, and similar in the husk with which it is covered to the chesnut, but four or five times larger, and of a much deeper green colour. Its kernel is of a greenish white, and has a large stone in the middle, which is white, and like it in substance. It is boiled, and the stone eaten with it. This fruit is produced by a twining perennial plant, the root of which is also good to eat.

CHAIR (*Cathedra*), was anciently used for the pulpit, or suggestum, whence the priest spoke to the people.

It is still applied to the place where professors and regents in universities deliver their lectures, and teach the sciences to their pupils; thus, we say, the professor's chair, the doctor's chair, &c.

Curule CHAIR, was an ivory seat placed on a car, wherein were seated the prime magistrates of Rome, and those to whom the honour of a triumph had been granted.

Sedan CHAIR, a vehicle supported by poles, wherein persons are carried; borne by two men. There are 200 chairs allowed by act of parliament; and no person is obliged to pay for a hackney chair more than the rate allowed by the act for a hackney coach driven two-third parts of the said distance. 9 Ann. c. 23. § 8. Their number is since increased by 10 Ann. c. 19. and 12 Geo. I. c. 12. to 400. See *Hackney COACHES*.

CHAIR is also applied by the Romanists to certain feasts, held anciently in commemoration of the translation of the see, or seat, of the vicarage of Christ, by St Peter.

The perforated chair, wherein the new elected pope is placed, F. Mabillon observes, is to be seen at Rome; but the origin thereof he does not attribute, as is commonly done, to the adventure of Pope Joan; but says there is a mystery in it; and it is intended,

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tended, forsooth, to explain to the pope those words of Scripture, that *God draws the poor from out of the dust and mire.*

CHAIRMAN, the president, or speaker of an assembly, company, &c. We say, the chairman of a committee, &c.

CHAISE, a sort of light open chariot, or calash.

Aurelius Victor relates, that Trajan first introduced the use of post-chaises; but the invention is generally ascribed to Augustus; and was probably only improved by Trajan and succeeding emperors.

CHALAZA, among naturalists, a white knotty sort of a string at each end of an egg, formed of a plexus of the fibres of the membranes, whereby the yolk and white are connected together.

CHALCAS. See BOTANY *Index*.

CHALCEDON, or CALCEDON, anciently known by the names of *Procerastis* and *Colbusa;* a city of Bithynia, situated at the mouth of the Euxine, on the north extremity of the Thracian Bosphorus, over against Byzantium. Pliny, Strabo, and Tacitus, call it *The city of the Blind;* alluding to the answer which the Pythian Apollo gave to the founders of Byzantium, who, consulting the oracle relative to a place where to build a city, were directed to choose that spot, which lay opposite "to the habitation of the blind;" that is, as was then understood, to Chalcedon; the Chalcedonians well deserving that epithet for having built their city in a barren and sandy soil, without seeing that advantageous and pleasant spot on the opposite shore, which the Byzantines afterwards chose.—Chalcedon, in the Christian times, became famous on account of the council which was held there against Eutyches. The emperor Valens caused the walls of this city to be levelled with the ground, for siding with Procopius, and the materials to be conveyed to Constantinople, where they were employed in building the famous Valentinian aqueduct. Chalcedon is at present a poor place, known to the Greeks by its ancient name, and to the Turks by that of *Cadiaci*, or "the Judges' Town."

CHALCEDONY, in *Natural History*, a genus of the semipellucid gems. They are of an even and regular, not tabulated structure; of a semi-opaque crystalline basis, and variegated with different colours, but those ever disposed in form of mists or clouds, and, if nicely examined, found to be owing to an admixture of various coloured earths, but imperfectly blended in the mass, and often visible in distinct moleculæ. It has been doubted by some whether the ancients were at all acquainted with the stone we call *chalcedony;* they having described a Chalcedonian carbuncle and emerald, neither of which can at all agree with the characters of our stone; but we are to consider that they have also described a Chalcedonian jasper, which seems to have been the very same stone as they describe by the word *turbida*, which extremely well agrees with our chalcedony.

There are four known species of the chalcedony. 1. A bluish white one. This is the most common of all, and is found in the shape of our flints and pebbles, in masses of two or three inches or more in diameter. It is of a whitish colour, with a faint cloud of blue diffused all over it, but always in the greatest degree near the surface. This is a little less hard than the oriental onyx. The oriental chalcedonies are the only ones of any value; they are found in vast abundance on the shores of rivers in all parts of the East Indies, and frequently come over among the ballast of the East India ships. They are common in Silesia and Bohemia, and other parts of Europe also; but with us are less hard, more opaque, and of very little value. 2. The dull milky-veined chalcedony. This is a stone of little value; and is sometimes met with among our lapidaries, who mistake it for a kind of nephritic stone. It is of a somewhat yellowish white or cream colour, with a few milk-white veins. This is principally found in New Spain. 3. The third is a brownish, black, dull, and cloudy one, known to the ancients by the name of smoky jasper, or jaspis capnitis. This is the least beautiful stone of all the class: it is of a pale brownish white, clouded all over with a blackish mist, as the common chalcedony is with a blue. It is common both in the East and West Indies, and in Germany; but is very little valued, and is seldom worked into any thing better than the handles of knives. 4. The yellow and red chalcedony is greatly superior to all the rest in beauty; and is in great repute in Italy, though very little known among us. It is naturally composed of an admixture of red and yellow only, on a clouded crystalline basis; but is sometimes found blended with the matter of common chalcedony, and then is mixed with blue. It is all over of the misty hue of the common chalcedony. This is found only in the East Indies, and there not plentifully. The Italians make it into beads, and call these *cassidonies;* but they are not determinate in the use of the word, but call beads of several of the agates by the same name. All the chalcedonies readily give fire with steel, and make no effervescence with aquafortis.

CHALCIDENE, or CHALCIDICE, in *Ancient Geography*, an inland country of Syria, having Antiochia or Seleucia to the west, Cyrrhestica to the north, to the south Apamene and Cœlosyria, and to the east Chalybonites; being so called from its principal city Chalcis. This province, one of the most fruitful in Syria, was seized by Ptolemy the son of Mennæus, during the troubles of Syria, and by him made a separate kingdom. Ptolemy himself is styled by Josephus and Hegesippus only prince of Chalcis, but his son Lysanias is honoured both by Josephus and Dio with the title of king. Upon the death of Antiochus Dionysius king of Syria, Ptolemy attempted to make himself master of Damascus and all Cœlosyria; but the inhabitants having an utter aversion to him on account of his cruelty and wickedness, chose rather to submit to Aretas king of Arabia, by whom Antiochus and his whole army had been cut off. He opposed Pompey on his entering Syria; but was by him defeated, taken prisoner, and sentenced to death; which, however he escaped by paying a thousand talents, and was left also in possession of his kingdom. After Aristobulus king of Judea had been poisoned by the friends of Pompey, and Alexander his son beheaded at Antioch, he sent Philippion his son to Ascalon, whither the widow of Aristobulus had retired with her other children, to bring them all to Chalcis; proposing, as he was in love with one of the daughters named Alexandra, to maintain them in his own kingdom in a manner suitable to their rank; but Philippion likewise being

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ing in love with Alexandra, married her on the way; for which presumption Ptolemy put him to death on his return, and then took her to wife. On account of this affinity, he supported to the utmost of his power Antigonus the younger son of Aristobulus, who took the field at the head of a considerable army, but on his entering Judea was entirely defeated by Herod. Ptolemy soon after died, and was succeeded by his son Lysanias, who, espousing the cause of the Asmonæan family with great warmth, promised to Barzapharnes who commanded the Parthian troops in Syria, and to Pacorus the king's son, a thousand talents and five hundred women, provided they should put Antigonus in possession of the kingdom of Judea, and depose Hyrcanus. He was not long after put to death by Mark Antony, at the instigation of Cleopatra; who, in order to have his dominions, accused him falsely of having entered into an alliance with the Parthians.

CHALCIDIC, Chalcidicum, or Chalcedonium, in the ancient architecture, a large magnificent hall belonging to a tribunal or court of justice. Festus says, it took its name from the city Chalcis; but he does not give the reason. Philander will have it to be the court or tribunal where affairs of money and coinage were regulated; so called from χαλκος, *brass*, and δικη, *justice*. Others say, the money was struck in it; and derive the word from χαλκος, and οικος, *house*. In Vitruvius, it is used for the auditory of a basilica: in others of the ancient writers for a hall or apartment where the heathens imagined their gods to eat.

CHALCIDICE, in *Ancient Geography*, an eastern district of Macedonia, stretching northwards between the Sinus Toronæus and Singiticus. Formerly a part of Thrace, but invaded by Philip of Macedon. Named from the city Chalcis near Olynthus.

CHALCIDIUS, a famous Platonic philosopher in the third century, who wrote a commentary, which is esteemed, on the Timæus of Plato. This work has been translated from the Greek into Latin.

CHALCIS, in *Ancient Geography*, a city of Chalcidice. See Chalcidice. Another of Ætolia, near the mouth of the river Evenus, on the Ionian sea, at the foot of a cognominal mountain; and therefore called by some *Hypochalcis*. Another of Eubœa, (Strabo), on the Euripus, the country of Lycophron the poet, one of the seven which formed the constellation Pleiades. Now *Negroponte*. E. Long. 24. 30. N. Lat. 38. 30. A fourth, the capital of Chalcidene in Syria; distinguished by the name *ad Belum*, a mountain or a river; and *ad Libanum*, from its situation (Pliny).

CHALCITIS, one of the divisions or districts of Mesopotamia, to the south of Anthemusia, the most northern district, next to Armenia, and situated between Edessa and Carræ. *Chalcitis* (Pliny), an island opposite to Chalcedon.

CHALCONDYLAS, Demetrius, a learned Greek, born at Constantinople, left that city after its being taken by the Turks, and afterwards taught Greek in several cities in Italy. He composed a Greek grammar; and died at Milan in 1513.

Chalcondylas, *Laonicus*, a famous Greek historian of the 15th century, was born at Athens; and wrote an excellent history of the Turks, from Ottoman, who reigned about the year 1300, to Mahomet II. in 1453.

CHALDEA, in *Ancient Geography*, taken in a larger sense, included Babylonia; as in the prophecies of Jeremiah and Ezekiel. In a restricted sense, it denoted a province of Babylonia, towards Arabia Deserta; called in Scripture *The land of the Chaldeans*. Named from Chaled the fourth son of Nabor. See Babylonia.

CHALDEE language, that spoken by the Chaldeans or people of Chaldea. It is a dialect of the Hebrew.

Chaldee Paraphrase, in the rabbinical style, is called Targum. There are three Chaldee paraphrases in Walton's Polyglot; viz. that of Onkelos, that of Jonathan son of Uzziel, and that of Jerusalem.

CHALDRON, a dry English measure, consisting of thirty-six bushels, heaped up according to the sealed bushel kept at Guildhall, London; but on shipboard, twenty-one chaldrons of coals are allowed to the score. The chaldron should weigh two thousand pounds.

CHALICE, the cup or vessel used to administer the wine in the sacrament, and by the Roman Catholics in the mass.

The use of the chalice, or communicating in both kinds, is by the church of Rome denied to the laity, who communicate only in one kind, the clergy alone being allowed the privilege of communicating in both kinds.

CHALK (*Creta*), is a white earth found plentifully in Britain, France, Norway, and other parts of Europe, said to have been anciently dug chiefly in the island of Crete, and thence to have received its name of *Creta*. They have a very easy way of digging chalk in the county of Kent in England. It is there found on the sides of hills; and the workmen undermine it so far as appears proper; then digging a trench at the top, as far distant from the edge as the undermining goes at bottom, they fill this with water, which soaks through in the space of a night, upon which the whole flake falls down at once. In other parts of the kingdom, chalk generally lies deeper, and they are forced to dig for it at considerable depths, and draw it up in buckets.

Chalk is of two kinds; hard, dry, and firm, or soft and unctuous; both of which are adapted to various purposes. The hard and dry kind is much the properest for burning into lime; but the soft and unctuous chalk is the best for using as a manure for lands. Chalk, whether burnt into lime or not, is in some cases an excellent manure.

Pure chalk melts easily with alkali and flint into a transparent colourless glass. With alkaline salts it melts somewhat more difficultly, and with borax somewhat more easily than with flint or sand. It requires about half its weight of borax and its whole weight of alkali to fuse it. Sal mirabile, and sandiver, which do not vitrify at all with the crystalline earths, form, with half their weight of chalk, the first a yellowish black, the latter a greenish glass. Nitre, on the other hand, one of the most active fluxes for flint, does not perfectly vitrify with chalk. This earth notably promotes the vitrification of flint; a mixture of the two requiring less alkali than either of them separately. If glass made from flint and alkali is further saturated with the flint, so as to be incapable of bearing

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bearing any further addition of that earth without becoming opaque and milky, it will still in a strong fire take up a considerable proportion, one-third or one-fourth of its weight, of chalk, without injury to its transparency: hence chalk is sometimes made use of in compositions for glass, as a part of the salt may then be spared. Chalk likewise has a great effect in melting the stony matters intermixed with metallic ores, and hence might be of use in smelting ores; as indeed limestone is used for that purpose. But it is remarkable, that chalk, when deprived of its fixed air, and converted into limestone, loses much of its disposition to vitrify. It is then found to melt very difficultly and imperfectly, and to render the glass opaque and milky.

Chalk readily imbibes water; and hence masses of it are employed for drying precipitates, lakes, earthy powders that have been levigated with water, and other moist preparations. Its economical uses in cleaning and polishing metalline or glass utensils are well known. In this case it is powdered and washed from any gritty matter it may contain, and is then called *whiting*.—In medicine it is one of the most useful absorbents, and is to be looked upon simply as such. The astringent virtues which some have attributed to it have no foundation, unless in as far as the earth is saturated with an acid, with which it composes a saline concrete manifestly subastringent. For the further properties of chalk, see CHEMISTRY *Index*.

Black CHALK, a name given by painters to a species of earth with which they draw on blue paper, &c. It is found in pieces from two to ten feet long, and from four inches to twenty in breadth, generally flat, but somewhat rising in the middle, and thinner towards the edges, commonly lying in large quantities together. While in the earth, it is moist and flaky: but being dried, it becomes considerably hard and very light, but always breaks in some particular direction; and if attentively examined when first broken, appears of a striated texture. To the touch it is soft and smooth, stains very freely, and by virtue of its smoothness makes very neat marks. It is easily reduced into an impalpable soft powder, without any diminution of its blackness. In this state it mixes easily with oil into a smooth paste; and being diffused through water, it slowly settles in a black slimy or muddy form; properties which make its use very convenient to the painters, both in oil and water colours. It appears to be an earth quite different from common chalk, and rather of the slaty bituminous kind. In the fire it becomes white with a reddish cast, and very friable, retaining its flaky structure, and looking much like the white flaky masses which some sorts of pitcoal leave in burning. Neither the chalk nor these ashes are at all affected by acids.

The colour shops are supplied with this earth from Italy or Germany; though some parts of England afford substances nearly, if not entirely, of the same quality, and which are found to be equally serviceable both for marking and as black paints. Such particularly is the black earth called *killow*, said by Dr Merret, in his *Pinax Rerum Britannicarum*, to be found in Lancashire, and by Mr Da Costa, in his History of Fossils, to be plentiful near the top of Cay-Avon, a high hill in Merionethshire.

Red CHALK, an earth much used by painters and artificers, and common in the colour shops. It is properly an indurated clayey ochre, and is dug in Germany, Italy, Spain, and France, but in greatest quantity in Flanders. It is of a fine, even, and firm texture; very heavy, and very hard; of a pale red on the outside, but of a deep dusky chocolate colour within. It adheres firmly to the tongue, is perfectly insipid to the taste, and makes no effervescence with acids.

CHALK *Land*. Barley and wheat will succeed very well on the better sort of chalky land, and oats generally do well on any kind of it. The natural produce of this sort of land in weeds, is that sort of small vetch called the *tine-tare*, with poppies, may-weed, &c. Sainfoil and hope-clover will generally succeed tolerably well on these lands; and where they are of a better sort, the great clover will do. The best manure is dung, old rags, and the sheep dung left after folding them.

CHALK-*Stones*, in *Medicine*, signify the concretions of calcareous matter in the hands and feet of people violently afflicted with the gout. Leeuwenhoek has been at the pains of examining these by the microscope. He divides them into three parts. The first is composed of various small parcels of matter looking like white grains of sand; this is harder and drier, and also whiter, than the rest. When examined with large magnifiers, those are found to be composed of oblong particles laid closely and evenly together: though the whole small stones are opaque, these component parts of them are pellucid, and resemble pieces of horse-hair cut short, only that they are somewhat pointed at both ends. These are so extremely thin, that Mr Leeuwenhoek computes that 1000 of them placed together would not amount to the size of one hair of our heads. The whole stones in this harder part of the chalk are not composed of these particles, but there are confusedly thrown in among them some broken parts of other substances, and in a few places some globules of blood and small remains of other juices. The second kind of chalky matter is less hard and less white than the former, and is composed of fragments or irregular parts of those oblong bodies which compose the first or hardest kind, and these are mixed among tough and clear matter, and interspersed with the small broken globules of blood discoverable in the former, but in much greater quantity. The third kind appears red to the naked eye; and, when examined with glasses, is found to be a more tough and clammy white matter, in which a great number of globules of blood are interspersed; these give it the red appearance it has.

CHALLENGE, a cartel or invitation to a duel or other combat *. A challenge either by word or letter, or to be the bearer of such a challenge, is punishable by fine and imprisonment on indictment or information.

* See *Duel*.

CHALLENGE, among hunters. When hounds or beagles, at first finding the scent of their game, presently open and cry, they are said to challenge.

CHALLENGE, in the *Law of England*, is an exception made to jurors †; and is either in civil or criminal cases.

† See the article *Trial*.

1. In *civil* cases challenges are of two sorts; challenges to the array, and challenges of the poll.

Challenge.

1. Challenges to the array are at once an exception to the whole panel, in which the jury are arrayed, or set in order by the sheriff in his return; and they may be made upon account of partiality or some default in the sheriff or his under-officer who arrayed the panel. Also, though there be no personal objection against the sheriff, if yet he arrays the panel at the nomination, or under the direction of either party, this is good cause of challenge to the array. Formerly, if a lord of parliament had a cause to be tried, and no knight was returned upon the jury, it was a cause of challenge to the array; also by the policy of the ancient law, the jury was to come *de vicineto*, from the neighbourhood of the vill or place where the cause of action was laid in the declaration: and therefore some of the jury were obliged to be returned from the hundred in which such vill lay; and, if more were returned, the array might be challenged from defect of hundreders. For, living in the neighbourhood, these were supposed to know beforehand the characters of the parties and witnesses; and therefore they better knew what credit to give to the facts alleged in evidence. But this convenience was over-balanced by another very natural and almost unavoidable inconvenience; that jurors, coming out of the immediate neighbourhood, would be apt to intermix their prejudices and partialities in the trial of right. And this the law was so sensible of, that it for a long time has been gradually relinquishing this practice; the number of necessary hundreders in the whole panel, which in the reign of Edward III. was constantly six, being in the time of Fortescue reduced to four; afterwards by statute 26 Eliz. c. 6. to two; and at length, by statute 4 and 5 Anne, c. 16. it was entirely abolished upon all civil actions, except upon penal statutes, and upon those also by the 24 Geo. II. c. 18. the jury being now only to come *de corpore comitatus*, from the body of the country at large, and not *de vicineto*, or from the particular neighbourhood. The array by the ancient law may be also challenged, if an alien be party to the suit, and upon a rule obtained by his motion to the court for a jury *de medietate linguæ*, such a one be not returned by the sheriff pursuant to the statute 28 Edward III. c. 13. enforced by 8 Hen. VI. c. 29. which enacts, that where either party is an alien born, the jury shall be one half denizens and the other aliens (if so many be forthcoming in the place), for the more impartial trial; a privilege indulged to strangers in no other country in the world; but which is as ancient in England as the time of King Ethelred, in whose statute *de monticolis Walliæ* (then aliens to the crown of England), c. 3. it is ordained, that "duodeni legales homines, quorum sex Walli et sex Angli erunt, Anglis et Wallis jus dicunto."

2. Challenges to the polls, *in capita*, are exceptions to particular jurors; and seem to answer to the *recusatio judicis* in the civil and canon laws; by the constitutions of which a judge might be refused upon any suspicion of partiality. By the laws of England also, in the times of Bracton and Fleta, a judge might be refused for good cause; but now the law is otherwise, and it is held that judges or justices cannot be challenged. For the law will not suppose a possibility of bias or favour in a judge who is already sworn to administer impartial justice, and whose authority greatly depends on that presumption and idea. And, should the fact at any time prove flagrantly such, as the delicacy of the law will not presume beforehand, there is no doubt but that such misbehaviour would draw down a heavy censure from those to whom the judge is accountable for his conduct. But challenges to the polls of the jury (who are judges of fact) are reduced to four heads by Sir Edward Coke: *propter honoris respectum; propter defectum; propter affectum;* and *propter delictum*. 1. *Propter honoris respectum;* as, if a lord of parliament be impannelled on a jury, he may be challenged by either party, or he may challenge himself. 2. *Propter defectum;* as, if a juryman be an alien born, this is defect of birth; if he be a slave or bondman, it is defect of liberty, and he cannot be a *liber et legalis homo*. Under the word *homo* also, though a name common to both sexes, the female is however excluded, *propter defectum sexus:* except when a widow feigns herself with child in order to exclude the next heir, and a supposititious birth is suspected to be intended; then upon the writ *de ventre inspiciendo*, a jury of women is to be impannelled to try the question whether with child or not. But the principal deficiency is defect of estate sufficient to qualify him to be a juror, which depends upon a variety of statutes*. 3. Jurors may be challenged *propter affectum*, for suspicion of bias or partiality. This may be either a principal challenge, or to the favour. A *principal* challenge is such, where the cause assigned carries with it, *prima facie*, evident marks of suspicion either of malice or favour; as, that a juror is of kin to either party within the ninth degree; that he has an interest in the cause; that there is an action depending between him and the party; that he has taken money for his verdict, &c. which if true cannot be overruled; for jurors must be *omni exceptione majores*. Challenges *to the favour* are where the party hath no principal challenge; but objects only some probable circumstances of suspicion, as acquaintance, and the like; the validity of which must be left to the determination of *triors*, whose office is to decide whether the juror be favourable or unfavourable. 4. Challenges *propter delictum*, are for some crime or misdemeanour that affects the juror's credit, and renders him infamous: As for a conviction of treason, felony, perjury, or conspiracy; or if for some infamous offence, he hath received judgment of the pillory or the like.

* See Blackst. Comment. iii. 362.

II. In *criminal* cases, challenges may 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 in civil causes. For it is here at least as necessary as there, that the sheriff or returning officer be totally indifferent; that, where an alien is indicted, the jury should be *de medietate*, or half foreigners, if so many are found in the place (which does not indeed hold in treasons, aliens being very improper judges of the breach of allegiance; nor yet in the case of Egyptians under the statute 22 Hen. VIII. c. 10.); that on every panel there should be a competent number of hundreders; and that the particular jurors should be *omni exceptione majore*, not liable to objections either *propter honoris respectum, propter defectum, propter affectum*, or *propter delictum*.

Challenges

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Challenges on any of the foregoing accounts are styled challenges *for cause;* which may be without stint in both civil and criminal trials. But in criminal cases, 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 tenderness and humanity to prisoners for which our 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.

This privilege of peremptory challenges, though granted to the prisoner, is denied to the king by the statute 33 Edward I. stat. 4. which enacts, that the king shall challenge no jurors without assigning a cause certain, to be tried and approved by the court. However, it is held that the king need not assign his cause of challenge till all the panel is gone through, and unless there cannot be a full jury without the persons so challenged. And then, and not sooner, the king's counsel must show the cause, otherwise the juror shall be sworn.

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 the number of 35; that is, one under the number of three full juries. For the law judges, that 35 are fully sufficient to allow the most timorous man to challenge through mere caprice; and that he who peremptorily challenges a greater number, or three full juries, has no intention to be tried at all. And therefore it deals with one who peremptorily challenges above 35, and will not retract his challenge, as with one who stands mute or refuses his trial; by sentencing him to the *pein forte et dure* in felony, and by attainting him in treason. And so the law stands at this day with regard to treason of any kind. But by statute 22 Hen. VIII. c. 14. (which, with regard to felonies, stands unrepealed), no person arraigned for felony can be admitted to make more than 20 peremptory challenges.

CHALONS-SUR-SAONE, a ancient town of France, in Burgundy, and capital of the Chalonnois, with a citadel and bishop's see. It is seated on the river Saone, in E. Long. 5. 7. N. Lat. 46. 47.

Chalons-sur-Marne, a large episcopal town of France, in Champagne. It carries on a considerable trade in shalloons and other woollen stuffs. It is seated between two fine meadows on the rivers Marne, Mau, and Nau, in E. Long. 4. 37. N. Lat. 48. 57.

CHALONER, Sir Thomas, a statesman, soldier, and poet, descended from a good family in Denbigh in Wales, was born at London about the year 1515. Having been educated in both universities, but chiefly at Cambridge, he was introduced at the court of Henry VIII. who sent him abroad in the retinue of Sir Henry Knevet, ambassador to Charles V. and he had the honour to attend that monarch on his fatal expedition against Algiers in 1541. Soon after the fleet left that place, he was shipwrecked on the coast of Barbary in a very dark night: and having exhausted his strength by swimming, he chanced to strike his head against a cable, which he had the presence of mind to catch hold of with his teeth; and, with the loss of several of them, was drawn up by it into the ship to which he belonged. Mr Chaloner returned soon after to England, and was appointed first clerk of the council, which office he held during the rest of that reign. On the accession of Edward VI. he became a favourite of the duke of Somerset, whom he attended to Scotland, and was knighted by that nobleman after the battle of Musselburgh, in 1547. The protector's fall put a stop to Sir Thomas Chaloner's expectations, and involved him in difficulties. During the reign of Queen Mary, being a determined Protestant, he was in some danger; but having many powerful friends, he had the good fortune to escape. On the accession of Queen Elizabeth, he appeared again at court; and was so immediately distinguished by her majesty, that she appointed him ambassador to the emperor Ferdinand I. being the first ambassador she nominated. His commission was of great importance; and the queen was so well satisfied with his conduct, that soon after his return, she sent him in the same capacity to Spain; but Sir Thomas was by no means satisfied with this instance of her majesty's confidence: the courts of England and Spain being at this time extremely dissatisfied with each other, he foresaw that his situation would be very disagreeable, and so it proved; but Elizabeth must be obeyed. He embarked for Spain in 1561, and returned to London in 1564, in consequence of a request to his sovereign, in an elegy written in imitation of Ovid. After his return, he resided in a house built by himself in Clerkenwell close, where he died in the year 1565, and was buried in St Paul's. Sir William Cecil assisted as chief mourner at his funeral.

So various were the talents of Sir Thomas Chaloner, that he excelled in every thing to which he applied himself. He made a considerable figure as a poet. His poetical works were published by William Malim, master of St Paul's school, in 1579. His capital work was that "Of restoring the English republic, in ten books," which he wrote when he was ambassador in Spain. It is remarkable, that this great man, who knew how to transact as well as write upon the most important affairs of states and kingdoms, could descend to compose a *dictionary for children*, and to translate from the Latin a book *Of the office of Servants*, merely for the utility of the subjects.

Chaloner, *Sir Thomas*, the younger, though inconsiderable as an author, deserved to be recorded as a skilful naturalist, in an age wherein natural history was very little understood in this or any other country; and particularly as the founder of the alum works in Yorkshire, which have since proved so exceedingly advantageous

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vantageous to the commerce of this kingdom. He was the only son of Sir Thomas Chaloner mentioned in the last article, and was born in the year 1559. Being very young at the time of his father's death, the lord treasurer Burleigh, taking charge of his education, sent him to St Paul's school, and afterwards to Magdalen college in Oxford, where, like his father, he discovered extraordinary talents for Latin and English poetry. About the year 1580, he made the tour of Europe, and returned to England before 1584; for in that year, we find him a frequent attendant in the court of Queen Elizabeth. About this time he married the daughter of Sir William Fleetwood, recorder of London. In 1591 he was knighted; and, some time after, discovered the alum mines on his estate at Gisborough, near the river Tees in Yorkshire (A).

Towards the latter end of the queen's reign, Sir Thomas visited Scotland; and returning to England in the retinue of King James I. found such favour in the sight of his majesty, that he was immediately appointed governor to Prince Henry, whom he constantly attended, and, when his royal pupil visited Oxford, was honoured with the degree of master of arts. How he was employed after the death of the prince is not known. Some years before that event, he married a second wife, the daughter of Mr William Blount of London, by whom he had some children. He died in the year 1615, and was buried at Chiswick in Middlesex. His eldest son William was created a baronet in 18th of James, anno 1640. The title was extinct in 1681. He wrote, 1. Dedication to Lord Burleigh of his father's poetical works, dated 1579. 2. The virtue of nitre, wherein is declared the sundry cures by the same effected. Lond. 1584, 4to.

CHALYBEAT, in *Medicine*, an appellation given to any liquid, as wine or water, impregnated with particles of iron or steel. See MINERAL WATERS.

CHALYBES, in *Ancient Geography*, an ancient people of the Hither Asia. Their situation is differently assigned: Strabo placing them in Paphlagonia, to the east of Synope; Apollonius Rhodius and Stephanus, on the east of the Thermodon, in Pontus; called *Halizones*, by Homer. They either gave their name to, or took it from, their iron manufactures (Xenophon, Val. Flaccus), their only support, their soil being barren and ungrateful, (Dionysius Periegetes).

CHAM, or KHAN, the title given to the sovereign princes of Tartary.

The word, in the Persian, signifies *mighty lord;* in the Sclavonic, *emperor*. Sperlingius, in his dissertation on the Danish term of *majesty*, *koning*, *king*, thinks the Tartarian *cham* may be well derived from it; adding, that in the north they say *kan*, *konnen*, *kunge*, *koning*, &c. The term *cham* is also applied, among the Persians, to the great lords of the court, and the governors of provinces.

CHAM, in *Geography*, a town of the Bavarian palatinate, situated on a river of the same name, about 25 miles north-east of Ratisbon. E. Long. 13. N. Lat. 49. 15.

CHAMA, in *Zoology*, a genus of shell fish belonging to the order of vermes testaceæ. The shell is thick, and has two valves; it is an animal of the oyster kind. Linnæus enumerates 14 species, principally distinguished by the figure of their shells.

CHAMADE, in *War*, a certain beat of a drum, or sound of a trumpet, which is given the enemy as a signal to inform them of some propositions to be made to the commander, either to capitulate, to have leave to bury their dead, make a truce, or the like. Menage derives the word from the Italian *chiamata*, of *clamare*, "to cry."

CHAMÆDRYS. See VERONICA, BOTANY *Index*.

CHAMÆPITHYS. See TEUCRIUM, BOTANY *Index*.

CHAMÆROPS. See BOTANY *Index*.

This plant the Americans call *thatch*, from the use to which the leaves are applied.—Under the name of palmetto, however, Mr Adanson describes a species of palm which grows naturally at Senegal, whose trunk rises from 50 to 60 feet in height: from the upper end of the trunk issues a bundle of leaves, which, in turning off, form a round head: each leaf represents a fan of five or six feet in expansion, supported by a tail of the same length. Of these trees some produce male flowers, which are consequently barren; others are female, and loaded with fruit, which succeed each other uninterruptedly almost the whole year round. The fruit of the large palmettos, Mr Adanson affirms to be of the bigness of an ordinary melon, but rounder; it is enveloped in two skins, as tough as leather, and as thick as strong parchment; within the fruit is yellowish, and full of filaments, fastened to three large kernels in the middle. The negroes are very fond of this fruit, which, when baked under the ashes, is said to taste like a quince.

CHAMANIM, in the Jewish antiquities, is the Hebrew name for that which the Greeks call *Pyreia* or *Pyrateria;* and St Jerome in Leviticus has translated *simulachra*, in Isaiah, *delubra*. These chamanim were, according to Rabbi Solomon, idols exposed to the sun upon the tops of houses. Abenezoa says they were portable chapels or temples made in the form of chariots, in honour of the sun. What the Greeks call Pyreia were temples consecrated to the sun and fire, wherein a perpetual fire was kept up. They were built upon eminences; and were large enclosures without

(A) Sir Thomas, during his residence in Italy, being particularly fond of natural history, spent some time at Pozzoli, where he was very attentive to the art of producing alum. This attention proved infinitely serviceable to his country, though of no great benefit to himself or his family, his attempt being attended with much difficulty and expence. It was begun about the year 1600, in the reign of Queen Elizabeth; but was not brought to any degree of perfection till some time in the reign of Charles I. by the assistance of one Russel a Walloon, and two other workmen brought from the alum works at Rochelle. By one of the arbitrary acts of Charles, it was then deemed a mine royal, and granted to Sir Paul Pindar. The long parliament adjudged it a monopoly, and justly restored it to the original proprietors.

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out covering, where the sun was worshipped. The Guebres, or worshippers of fire, in Persia and the East Indies, have still these Pyreia. The word *chamanim* is derived from *chaman*, which signified to warm or burn.

CHAMARIN, a word which occurs in several places of the Hebrew Bible, and is generally translated the *priests of the idols*, or the *priests clothed in black*, because *chamar* signifies "black," or "blackness." St Jerome, in the second book of Kings, renders it *aruspices*. In Hosea and Zephaniah, he translates it *æditui* or church-wardens. But the best commentators are of opinion, that by this word we are to understand the priests of the false gods, and in particular the worshippers of fire: because they were, as they say, dressed in black; or perhaps the Hebrews gave them this name in derision, because, as they were continually employed in taking care about the fuel, and keeping up the fire, they were always as black as smiths or colliers. We find priests, among those of Isis, called *melanephori*, that is to say, that wear black; but whether this may be by reason of their dressing in black, or whether it were because they wore a certain shining black veil in the processions of this goddess, is not certain. *Camar*, in Arabic, signifies the "moon." Isis is the same deity. Grotius thinks the Roman priests, called *camilli*, came from the Hebrew *chamarin*. Those among the heathens who sacrificed to the infernal gods were dressed in black.

CHAMBER, in building, a member of a lodging, or piece of an apartment, ordinarily intended for sleeping in; and called by the Latins *cubiculum*. The word comes from the Latin *camera*; and that, according to *Nicod*, from the Greek *καμαρα*, *vault* or *curve*; the term *chamber* being originally confined to places arched over.

A complete apartment is to consist of a hall, antichamber, *chamber*, and cabinet.

Privy CHAMBER. Gentlemen of the privy chamber are servants of the king, who are to wait and attend on him and the queen at court, in their diversions, &c. Their number is forty-eight, under the lord chamberlain, twelve of whom are in quarterly waiting, and two of these lie in the privy chamber.

In the absence of the lord chamberlain, or vice chamberlain, they execute the king's orders: at coronations, two of them personate the dukes of Aquitain and Normandy; and six of them, appointed by the lord chamberlain, attend ambassadors from crowned heads to their audiences, and in public entries. The gentlemen of the privy chamber were instituted by Henry VII.

CHAMBER, in policy, the place where certain assemblies are held; also the assemblies themselves. Of these some are established for the administration of justice, others for commercial affairs.

Of the first kind are, 1. Star chamber, so called because the roof was painted with stars; the authority, power, and jurisdiction of which, are absolutely abolished by the statute 17 Car. I. 2. Imperial chamber of Spire, the supreme court of judicatory in the empire, erected by Maximilian I. This chamber has a right of judging by appeal; and is the last resort of all civil affairs of the states and subjects of the empire, in the same manner as the aulic council of Vienna. Nevertheless it is restrained in several cases: it takes no notice of matrimonial causes, these being left to the pope; nor of criminal causes, which either belong to particular princes of towns in their respective territories, or are cognizable by all the states of the empire in a diet. By the treaty of Osnaburg, in 1648, fifty assessors were appointed for this chamber, whereof 24 were to be Protestants, and 26 Catholics; besides five presidents, two of them Protestants, and the rest Catholics. 3. Chamber of accounts, a sovereign court in France, where accounts are rendered of all the king's revenues, inventories and avowals thereof registered, oaths of fidelity taken, and other things relating to the finances transacted. There are nine in France: that of Paris is the chief; it registers proclamations, treaties of peace, naturalizations, titles of nobility, &c. All the members wear long black gowns of velvet, of satin, or damask, according to their places. 4. Ecclesiastical chambers in France, which judge by appeal of differences about collecting the tythes. 5. Chamber of audience, or grand chamber, a jurisdiction in each parliament of France, the counsellors of which are called *jugeurs*, or judges, as those of the chamber of inquests are called *raporteurs*, reporters of processes by writing. 6. Chamber of the edict, or miparty, a court established by virtue of the edict of pacification in favour of those of the reformed religion. This chamber is now suppressed. 7. Apostolical chamber of Rome, that wherein affairs relating to the revenues of the church and the pope are transacted. This council consists of the cardinal camerlingo, the governor of the rota, a treasurer, an auditor, a president, one advocate-general, a solicitor-general, a commissary, and twelve clerks. 8. Chamber of London, an apartment in Guildhall, where the city-money is deposited.

Of the last sort are, the chambers of commerce; the chambers of assurance; and the royal or syndical chamber of booksellers in France.

1. The chamber of commerce is an assembly of merchants and traders, where the affairs relating to trade are treated of. There are several established in most of the chief cities of France; and in our own country we have lately seen chambers of this kind erected, particularly in London, Edinburgh, and Glasgow. 2. Chamber of assurance, in France, denotes a society of merchants and others for carrying on the business of insuring: but in Holland it signifies a court of justice, where causes relating to insurances are tried. 3. Chamber of booksellers in Paris, an assembly consisting of a syndic and assistants, elected by four delegates from the printers, and twelve from the booksellers, to visit the books imported from abroad, and to search the houses of sellers of marble paper, printsellers, and dealers in printed paper for hangings, who are prohibited from keeping any letters proper for printing books. In the visitation of books, which ought to be performed by three persons at least from among the syndic and assistants, all libels against the honour of God, and the welfare of the state, and all books printed either within or without the kingdom in breach of their regulations and privileges, are stopt, even with the merchandises that may happen to be in the bales with such libels or other prohibited books.

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The days appointed for this chamber to meet are Tuesdays and Fridays, at two o'clock in the afternoon.

CHAMBER, in military affairs. 1. Powder chamber, or bomb chamber; a place sunk under ground for holding the powder, or bombs, where they may be out of danger, and secured from the rain. 2. Chamber of a mine; the place, most commonly of a cubical form, where the powder is confined. 3. Chamber of a mortar; that part of the chase, much narrower than the rest of the cylinder, where the powder lies. It is of different forms; sometimes like a reversed cone; sometimes globular, with a neck for its communication with the cylinder, whence it is called a bottled chamber; but most commonly cylindrical, that being the form which is found by experience to carry the ball to the greatest distance.

CHAMBERLAIN, an officer charged with the management and direction of a chamber. See CHAMBER in *Policy*.

There are almost as many kinds of chamberlains as chambers; the principal whereof are as follows:

Lord CHAMBERLAIN *of Great Britain*, the sixth great officer of the crown; to whom belong livery and lodging in the king's court; and there are certain fees due to him from each archbishop or bishop when they perform their homage to the king, and from all peers at their creation or doing their homage. At the coronation of every king, he is to have forty ells of crimson velvet for his own robes. This officer, on the coronation day, is to bring the king his shirt, coif, and wearing clothes; and after the king is dressed, he claims his bed, and all the furniture of his chamber, for his fees: he also carries, at the coronation, the coif, gloves, and linen, to be used by the king on that occasion; also the sword and scabbard; the gold to be offered by the king, and the robes royal and crown: he dresses and undresses the king on that day, waits on him before and after dinner, &c. To this officer belongs the care of providing all things in the house of lords, in the time of parliament; to him also belongs the government of the palace of Westminster; he disposes likewise of the sword of state, to be carried before the king, to what lord he pleases.

The great chamberlain of Scotland was ranked by King Malcolm, as the third great officer of the crown, and was called *Camerarius Domini Regis*. Before a treasurer was appointed, it was his duty to collect the revenue of the crown; and he disbursed the money necessary for the king's expences, and the maintenance of the king's household. From the time that a treasurer was appointed, his province was limited to the boroughs throughout the kingdom, where he was a sort of justice general, as he had a power for judging of all crimes committed within the borough, and of the crime of forestalling. He was to hold chamberlain ayres every year. He was supreme judge: nor could any of his decrees be questioned by any inferior judicatory. His sentences were put in execution by the magistrates of the boroughs. He also regulated the price of provisions within the borough, and the fees of the workmen in the mint house. His salary, was only 200l. a-year. The smallness of his salary, and his great powers, had no doubt been the causes much oppression in this officer, and the chamberlain ayre was called rather a legal robbery than a court of justice; and when the combined lords seized King James VI. August 24. 1582, and carried him to Ruthven Castle, they issued a proclamation in the king's name, discharging the chamberlain ayres to be kept. The chamberlain had great fees arising from the profits of escheats, fines, tolls, and customs. This office was granted heritably to the family of Stuart duke of Lenox: and when their male line failed, King Charles II. conferred it in like manner upon his natural son, whom he created duke of Monmouth, and on his forfeiture it went to the duke of Lenox; but that family surrendered the office to the crown in 1703.

Lord CHAMBERLAIN *of the Household*, an officer who has the oversight and direction of all officers belonging to the king's chambers, except the precinct of the king's bedchamber.

He has the oversight of the officers of the wardrobe at all his majesty's houses, and of the removing wardrobes, or of beds, tents, revels, music, comedians, hunting, messengers, &c. retained in the king's service. He moreover has the oversight and direction of the serjeants at arms, of all physicians, apothecaries, surgeons, barbers, the king's chaplains, &c. and administers the oath to all officers above stairs.

Other chamberlains are those of the king's court of exchequer, of North Wales, of Chester, of the city of London, &c. in which case this officer is generally the receiver of all rents and revenues belonging to the place whereof he is chamberlain.

In the exchequer there are two chamberlains, who keep a controlment of the pells of receipts and exitus, and have certain keys of the treasury, records, &c.

CHAMBERLAIN *of London* keeps the city money, which is laid up in the chamber of London: he also presides over the affairs of masters and apprentices, and makes free of the city, &c.

His office lasts only a year; but the custom usually obtains to re-choose the same person, unless charged with any misdemeanour in his office.

CHAMBERLAYNE, EDWARD, descended from an ancient family, was born in Gloucestershire, 1616, and made the tour of Europe during the distractions of the civil war. After the Restoration, he went as secretary with the earl of Carlisle, who carried the order of the Garter to the king of Sweden; was appointed tutor to the duke of Grafton, natural son of Charles II. and was afterwards pitched on to instruct Prince George of Denmark in the English tongue. He died in 1703, and was buried in a vault in Chelsea churchyard: his monumental inscription mentions six books of his writing; and that he was so desirous of doing service to posterity, that he ordered some copies of his books to be covered with wax, and buried with him. That work by which he is best known, is his *Angliæ Notitiæ*, or *the Present State of England*, which has been often since printed.

CHAMBERLAYNE, *John*, son to the author of "The Present State of England," and continuator of that useful work, was admitted into Trinity College, Oxford, 1685; but it doth not appear that he took any degree. Beside the *Continuation* just mentioned, he was author of "Dissertations, historical, critical, theological, and moral, on the most memorable events of the Old and New Testaments, with Chronological Tables;" one vol.

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Chamberlayne | Chambers. vol. folio; and translated a variety of works from the French, Dutch, and other languages. He likewise was F. R. S. and communicated some pieces, inserted in the Philosophical Transactions. It was said of him that he understood sixteen languages; but it is certain that he was master of the Greek, Latin, French, High and Low Dutch, Portuguese, and Italian. Though he was qualified for employment, he had none but that of gentleman-usher to George prince of Denmark. After a useful and well-spent life, he died in the year 1724. He was a very pious and good man, and earnest in promoting the advancement of religion, and the interest of true Christianity; for which purpose he kept a large correspondence abroad.

CHAMBERRY, a considerable and populous town of Italy, in Savoy, with a castle. It is capital of the duchy, and well built, but has no fortifications. It is watered by several streams, which have their sources in St Martin's hill, and run through several of the streets. There are piazzas under most part of the houses, where people may walk dry in the worst weather. It hath large and handsome suburbs; and in the centre of the town is the royal palace. The parliament meets here, which is composed of four presidents, and a pretty large number of senators, being the supreme tribunal of the whole duchy. The population in 1815 was 11,763. The Jesuits college is the most magnificent of all the monasteries. E. Long. 5. 50. N. Lat. 45. 25.

CHAMBERS, David, a Scots historian, priest, and lawyer, was born in the shire of Ross, about the year 1530, and educated in the university of Aberdeen. From thence he went to France and Italy, where he continued some time, particularly at Boulogne, where, in 1556, he was a pupil of Marianus Sozenus.

After his return to Scotland, he was appointed, by Queen Mary, parson of Suddy and chancellor of Ross. He was soon after employed in digesting the laws of Scotland, and was principally concerned in publishing the acts of parliament of that kingdom by authority in 1566. He was also appointed one of the lords of session, and continued her majesty's faithful servant till her declining fortune obliged her adherents to seek for refuge in other kingdoms. Chambers went first to Spain, where he was graciously received by King Philip; and thence he travelled to Paris, where he was no less kindly received by Charles IX. of that kingdom, to whom, in 1572, he presented his history of Scotland, &c. He died at Paris in the year 1592, much regretted (says Mackenzie) by all who knew him. His writings were chiefly calculated to assist his royal mistress, and to extol the wisdom of the Scots nation.

Chambers, *Ephraim*, author of the Scientific Dictionary which goes under his name, was born at Milton, in the county of Westmoreland. His parents were dissenters of the Presbyterian persuasion, and his education no other than that common one which is intended to qualify a youth for trade and commerce. When he became of a proper age, he was put apprentice to Mr Senex the globe-maker, a business which is connected with literature, and especially with astronomy and geography. It was during Mr Chambers's residence with this skilful mechanic, that he contracted that taste for science and learning which accompanied him through life, and directed all his pursuits. It was even at this time that he formed the design of his grand work, the "Cyclopædia;" and some of the first articles of it were written behind the counter. Having conceived the idea of so great an undertaking, he justly concluded that the execution of it would not consist with the avocations of trade; and therefore he quitted Mr Senex, and took chambers at Gray's Inn, where he chiefly resided during the rest of his days. The first edition of the *Cyclopædia*, which was the result of many years intense application, appeared in 1728, in two vols. folio. It was published by subscription, the price being 4l. 4s.; and the list of subscribers was very respectable. The dedication, which was to the king, is dated October 15. 1727. The reputation that Mr Chambers acquired by his execution of this undertaking, procured him the honour of being elected F. R. S. November 6. 1729. In less than 10 years time a second edition became necessary; which accordingly was printed, with corrections and additions, in 1738; and was followed by a third the very next year.

Although the Cyclopædia was the grand business of Mr Chambers's life, and may be regarded as almost the sole foundation of his fame, his attention was not wholly confined to this undertaking. He was concerned in a periodical publication, entitled, "The Literary Magazine," which was begun in 1735. In this work he wrote a variety of articles, and particularly a review of Morgan's "Moral Philosophy." He was engaged likewise, in conjunction with Mr John Martyn, F. R. S. and professor of botany at Cambridge, in preparing for the press a translation and abridgment of the "Philosophical History and Memoirs of the Royal Academy of Sciences at Paris, or an Abridgment of all the Papers relating to Natural Philosophy, which have been published by the Members of that illustrious Society." This undertaking, when completed, was comprised in five volumes, 8vo, which did not appear till 1742, some time after our author's decease, when they were published under the joint names of Mr Martyn and Mr Chambers. Mr Martyn, in a subsequent publication, had passed a severe censure upon the share which his fellow-labourer had in the abridgment of the Parisian papers. The only work besides, that we find ascribed to Mr Chambers, is a translation of the *Jesuit's Perspective*, from the French; which was printed in 4to, and hath gone through several editions. Mr Chambers's close and unremitting attention to his studies at length impaired his health, and obliged him occasionally to take a lodging at Canonbury-house, Islington. This not having greatly contributed to his recovery, he made an excursion to the south of France, but did not reap that benefit from it which he had himself hoped and his friends wished. Returning to England, he died at Canonbury house, and was buried at Westminster; where the following inscription, written by himself, is placed on the north side of the cloisters of the Abbey:

Multis pervulgatis,
Paucis notus;
Qui vitam, inter lucem et umbram,
Nec eruditus, nec idiota,

Literis deditus, transegit; sed ut homo
Qui humani nihil a se alienum putat.
Vita simul, et laboribus functus,
Hic requiescere voluit,
EPHRAIM CHAMBERS, R. S. S.
Obiit xv Maii. MDCCXL.

After the author's death two more editions of his Cyclopædia were published. A supplement, which extended to two volumes more, was afterwards compiled; and in the year 1778 was published an edition of both, incorporated into one alphabet, by Dr Rees, which was completed in four volumes folio. Another edition which is now (1803) going on, and is to extend to 20 vols. 4to, has been undertaken by the same gentleman.

CHAMBRE, MARTIN CUREAU DE LA, physician in ordinary to the French king, was distinguished by his knowledge in medicine, philosophy, and polite learning. He was born at Mons, and was received into the French academy in 1635, and afterwards into the academy of sciences. He wrote a great number of works; the principal of which are, 1. The characters of the passions. 2. The art of knowing men. 3. On the knowledge of beasts, &c. He died at Paris in 1669.

CHAMELEON. See LACERTA, ERPETOLOGY *Index*.

CHAMFERING, in *Architecture*, a phrase used for cutting any thing aslope on the under side.

CHAMIER, DANIEL, an eminent Protestant divine, born in Dauphiny. He was many years preacher at Montellimart; from whence he went in 1612 to Montaubon, to be professor of divinity in that city, and was killed by a cannon-ball during the siege in 1621. The most considerable of his works is his *Panstratia Catholica*, or "Wars of the Lord," in four volumes folio; in which he treats very learnedly of the controversies between the Protestants and Roman Catholics.

CHAMOIS, or CHAMOIS GOAT, in *Zoology*. See CAPRA, MAMMALIA *Index*.

CHAMOMILE. See ANTHEMIS, BOTANY *Index*.

CHAMOS, or Chemosh, the idol or god of the Moabites.

The name of *chamos* comes from a root which, in Arabic, signifies to *make haste;* for which reason many believe Chamos to be the sun, whose precipitate course might well procure it the name of swift or speedy. Others have confounded Chamos with the god *Hammon*, adored not only in Libya and Egypt, but also in Arabia, Ethiopia, and the Indies. Macrobius shows that Hammon was the sun; and the horns, with which he was represented, denoted his rays. Calmet is of opinion that the god Hamonus, and Apollo Chomeus, mentioned by Strabo and Ammianus Marcellinus, was the very same as Chamos or the sun. These deities were worshipped in many of the eastern provinces. Some who go upon the resemblance of the Hebrew term *chamos* to that of the Greek *comos*, have believed Chamos to signify the god Bacchus, the god of drunkenness, according to the signification of the Greek *comos*. St Jerome, and with him most other interpreters, take Chamos and Peor for the same deity. But it seems that Baal Peor was the same as Tammuz or Adonis; so that Chamos must be the god whom the heathens call the sun.

CHAMOUNI, one of the elevated valleys of the Alps, situated at the foot of Mont Blanc. See ALPS and BLANC.

The first strangers whom a curiosity to visit the glaciers drew to Chamouni (M. Saussure observes), certainly considered this valley as a den of robbers; for they came armed cap-a-pee, attended with a troop of domestics armed in the same manner; they would not venture into any house; they lived in tents which they had brought along with them; fires were kept burning, and centinels on guard, the whole night over. It was in the year 1741 that the celebrated traveller Pocock, and another English gentleman called Wyndham, undertook this interesting journey. It is remembered by the old men of Chamouni, and they still laugh at the fears of the travellers, and at their unnecessary precautions. For 20 or 25 years after this period, the journey was made but seldom, and then chiefly by Englishmen, who lodged with the curate; for, when I was there in 1760, and even for four or five years afterwards, there was no habitable house except one or two miserable inns, like those in villages that are little frequented. But now that this expedition has gradually become so fashionable, three large and good inns, which have been successively built, are hardly sufficient to contain the travellers that come during the summer from all quarters.

This concourse of strangers, and the money they leave behind them at Chamouni, have somewhat affected the ancient simplicity of the inhabitants, and even the purity of their manners. Nobody, however, has any thing to fear from them; the most inviolable fidelity is observed with respect to travellers; they are only exposed to a few importunate solicitations, and some small artifices dictated by the extreme eagerness with which the inhabitants offer their services as guides.

The hope of obtaining this employment brings together, round a traveller, almost all the men in every village through which he passes, and makes him believe that there are a great many in the valley; but there are very few at Chamouni in summer. Curiosity, or the hope of making money, draws many to Paris and into Germany; besides, as the shepherds of Chamouni have the reputation of excelling in the making of cheese, they are in great request in the Tarentaise, in the valley of Aoste, and even at greater distances; and they receive there, for four or five months in summer, very considerable wages. Thus the labours of the field devolve almost entirely on the women, even such as in other countries fall solely on the men; as mowing, cutting of wood, and thrashing; even the animals of the same sex are not spared, for the cows there are yoked in the plough.

The only labours that belong exclusively to the men are the seeking for rock crystal and the chase. Happily they are now less employed than formerly in the first of these occupations; I say happily, for many of them perished in this pursuit. The hope of enriching themselves quickly by the discovery of a cavern filled with fine crystals, was so powerful a motive, that they exposed themselves in the search to the most alarming dangers; and hardly a year passed without some of them perishing in the snows, or among the precipices.

The principal indication of the grottoes or crystal ovens as they are here called, are veins of quartz, which appear

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Chamouni. appear on the outside of the rocks of granite, or of the laminated rock. These white veins are seen at a distance, and often at great heights, on vertical and inaccessible places. The adventurers endeavour to arrive at these, either by fabricating a road across the rocks, or by letting themselves down from above suspended by ropes. When they reach the place, they gently strike the rock; and if the stone returns a hollow sound, they endeavour to open it with a hammer, or to blow it up with powder. This is the principal method of searching: but young people, and even children, often go in quest of these crystals over the glaciers, where the rocks have lately fallen down. But whether they consider these mountains as nearly exhausted, or that the quantity of crystal found at Madagascar has too much lowered the price of this fossil, there are now but few people that go in search of it, and perhaps there is not a single person at Chamouni that makes it his only occupation. They go however occasionally, as to a party of pleasure.

But the chase of the chamois goat, as dangerous, and perhaps more so than the seeking for crystal, still occupies many inhabitants of the mountains, and carries off, in the flower of their age, many men whose lives are most valuable to their families. And when we are informed how this chase is carried on, we will be astonished that a course of life, at once so laborious and perilous, should have irresistible attractions for those who have been accustomed to it.

The chamois hunter generally sets out in the night, that he may reach by break of day the most elevated pastures where the goats come to feed, before they arrive. As soon as he discovers the place where he hopes to find them, he surveys it with his glass. If he finds none of them there, he proceeds, always ascending; whenever he descries any, he endeavours to get above them, either by stealing along some gully, or getting behind some rock or eminence. When he is near enough to distinguish their horns, which is the mark by which he judges of the distance, he rests his piece on a rock, takes his aim with great composure, and rarely misses. This piece is a rifle-barrelled carabine, into which the ball is thrust, and these carabines often contain two charges, though they have but one barrel; the charges are put one above another, and are fired in succession. If he has wounded the chamois, he runs to his prey, and for security he hamstrings it; then he considers his way home; if the road is difficult, he skins the chamois, and leaves the carcase; but, if it is practicable, he throws the animal on his shoulders, and bears him to his village, though at a great distance, and often over frightful precipices; he feeds his family with the flesh, which is excellent, especially when the creature is young; and he dries the skins for sale.

But if, as is the most common case, the vigilant chamois perceives the approach of the hunter, he immediately takes flight among the glaciers, through the snows, and over the most precipitous rocks. It is particularly difficult to get near these animals when there are several together; for then one of them, while the rest are feeding, stands as a centinel on the point of some rock that commands a view of the avenues leading to the pasture; and as soon as he perceives any object of alarm, he utters a sort of hiss; at which the others instantly gather round him to judge for themselves of the nature of the danger: if it is a wild beast, or a hunter, the most experienced puts himself at the head of the flock, and away they fly, ranged in a line, to the most inaccessible retreats. Chamouni.

It is here that the fatigues of the hunter begin; instigated by his passion for the chase, he is insensible to danger: he passes over snows, without thinking of the horrid precipices they conceal; he entangles himself among the most dangerous paths, and bounds from rock to rock, without knowing how he is to return. Night often surprises him in the midst of his pursuit; but he does not for that reason abandon it; he hopes that the same cause will arrest the flight of the chamois, and that he will next morning overtake them. Thus he passes the night, not at the foot of a tree, like the hunter of the plain; nor in a grotto, softly reclined on a bed of moss; but at the foot of a rock, and often on the bare points of shattered fragments, without the smallest shelter. There, all alone, without fire, without light, he draws from his bag a bit of cheese, with a morsel of oaten bread, which make his common food; bread so dry, that he is sometimes obliged to break it between two stones, or with the hatchet he carries with him to cut out steps in the ice. Having thus made his solitary and frugal repast, he puts a stone below his head for a pillow, and goes to sleep, dreaming on the route which the chamois may have taken. But soon he is awakened by the freshness of the morning; he gets up, benumbed with cold; surveys the precipices which he must traverse, in order to overtake his game; drinks a little brandy, of which he is always provided with a small portion, and sets out to encounter new dangers. Hunters sometimes remain in these solitudes for several days together, during which time their families, their unhappy wives in particular, experience a state of the most dreadful anxiety; they dare not go to rest for fear of seeing their husbands appear to them in a dream; for it is a received opinion in the country, that when a man has perished, either in the snow, or on some unknown rock, he appears by night to the person he held most dear, describes the place that proved fatal to him, and requests the performance of the last duties to his corpse.

"After this picture of the life which the chamois hunters lead, could one imagine that this chase would be the object of a passion absolutely unsurmountable! I knew a well-made handsome man, who had just married a beautiful woman:—'My grandfather,' said he to me, 'lost his life in the chase; so did my father; and I am persuaded that I too shall die in the same manner; this bag which I carry with me when I hunt I call my grave clothes, for I am sure I will have no other; yet, if you should offer to make my fortune on condition of abandoning the chase of the chamois, I could not consent.' I made some excursions on the Alps with this man: His strength and address were astonishing: but his temerity was greater than his strength; and I have heard, that two years afterwards, he missed a step on the brink of a precipice, and met with the fate he had expected. *Voyages dans les Alpes, par M. Saussure,* tom. iii.

"The few who have grown old in this employment bear upon their faces the marks of the lives they have led. A savage look, something in it haggard and wild, makes them be known in the midst of a crowd, even when

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Chamouni. when they are not in their hunting dress. And undoubtedly it is this ill look which makes some superstitious peasants believe that they are sorcerers, that they have dealings with the devil in their solitudes, and that it is he who throws them down the rocks. What then can be the passionate inducement to this course of life? It is not avarice, at least it is not an avarice consistent with reason: the most beautiful chamois is never worth more to the person that kills it than a dozen of francs, even including the value of its flesh: and now that the number is so much diminished, the time lost before one can be taken is much more than its value. But it is the very dangers that attend the pursuit, those alternations of hope and fear, the continual agitation and exercise which these emotions produce in the mind, that instigate the hunter: they animate him as they do the gamester, the warrior, the sailor, and even to a certain degree, the naturalist of the Alps; whose life, in some measure, pretty much resembles that of the hunter, whose manners we have described."

But there is another kind of hunting, which is neither dangerous nor laborious, nor fatal to any one but to the poor animals that are the objects of it.—These are the marmots, animals that inhabit the high mountains; where in summer they scoop out holes, which they line with hay, and retire to at the beginning of autumn. Here they grow torpid with the cold, and remain in a sort of lethargy, till the warmth of the spring returns to quicken their languid blood, and to recal them to life. When it is supposed that they have retired to their winter abodes, and before the snow has covered the high pastures where their holes are made, people go to unharbour them. They are found from 10 to 13 in the same hole, heaped upon one another, and buried in the hay. Their sleep is so profound, that the hunter often puts them into his bag, and carries them home without their awaking. The flesh of the young is good, though it tastes of oil, and smells somewhat of musk; the fat is used in the cure of rheumatisms and pains, being rubbed on the parts affected; but the skin is of little value, and is sold for no more than five or six sols. Notwithstanding the little benefit they reap from it, the people of Chamouni go in quest of this animal with great eagerness, and its numbers accordingly diminish very sensibly.

It has been said, that marmots, in order to transport the hay into their holes, use one of their number laid on his back as a cart; but this is fabulous, for they are seen carrying the hay in their mouths. Nor is it for food that they gather it, but for a bed, and in order to shut out the cold, and to guard the avenues of their retreat from enemies. When they are taken in autumn, their bowels are quite empty, and even as clean as if they had been washed with water; which proves that their torpidity is preceded by a fast, and even by an evacuation; a wise contrivance of nature for preventing their accumulated fæces from growing putrid or too dry, in the long lethargy they are exposed to. They also continue a few days after their revival without eating, probably to allow the circulation and digestive power to recover their activity. At first leaving their holes, they appear stupid and dazzled with the light; they are at this time killed with sticks, as they do not endeavour to fly, and their bowels are then also quite empty. They are not very lean when they awake, but grow more so for a few days after they first come abroad. Their blood is never congealed, however profound their sleep may be; for at the time that it is deepest, if they are bled, the blood flows as if they were awake.

Chamouni, Champagne.

In these countries the period is so short between the dissolution of the snow and its return, that grain has hardly time to come to maturity. M. Saussure mentions a very useful and ingenious practice, invented by the mountaineers of Argentiere, for enlarging this period, "I observed (says he) in the middle of the valley, several large spaces where the surface of the snow exhibited a singular appearance, somewhat resembling a piece of white cloth spotted with black. While I was endeavouring to divine the cause of this phenomenon, I discovered several women walking with measured pace, and sowing something in handfuls that was black; and which being scattered, regularly diverging on the surface of the snow, formed that spotted appearance that I had been admiring. I could not conceive what seed should be sown on snow six feet deep; but my guide, astonished at my ignorance, informed me that it was black earth spread upon the snow to accelerate its melting; and thus to anticipate, by a fortnight or three weeks, the time of labouring the fields, and sowing. I was struck with the elegant simplicity of a practice so useful, the effects of which I already saw very evidently in places which had not been thus treated above three days.

"As to the inhabitants of Chamouni, the men, like those of most high valleys, are neither well made nor tall; but they are nervous and strong, as are also the women. They do not attain to a great age: men of 80 are very rare. Inflammatory diseases are the most fatal to them; proceeding, no doubt, from obstructed perspiration, to which the inconstant temperature of the climate exposes them.

"They are in general honest, faithful, and diligent, in the practice of religious duties. It would, for instance, be in vain to persuade them to go anywhere on a holiday before hearing mass. They are economical, but charitable. There are amongst them neither hospitals nor foundations for the poor; but orphans and old people, who have no means of subsistence, are entertained by every inhabitant of a parish in his turn. If a man is prevented by age or infirmities from taking charge of his affairs, his neighbours join among themselves and do it for him.

"Their mind is active and lively, their temper gay, with an inclination to raillery: they observe, with singular acuteness, the ridiculous in strangers, and turn it into a fund of very facetious merriment among themselves; yet they are capable of serious thinking: many of them have attacked me on religious and metaphysical subjects; not as professing a different faith from theirs, but on general questions, which showed they had ideas independent of those they were taught."

CHAMPAGNE, a considerable province of France, about 162 miles in length, and 112 in breadth, bounded on the north by Hainault and Luxembourg, on the east by Lorrain and the Franche Compté, on the south by Burgundy, and on the west by the Isle of France

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France and Soissonnois. It has a great number of rivers, the principal of which are the Meuse, the Seine, the Marne, the Aube, and the Aine. Its principal trade consists in excellent wine, all sorts of corn, linen cloth, woollen stuffs, cattle, and sheep. It is also divided into the higher and lower; and Troyes is the capital town. Its subdivisions are Champagne Proper, and Rhemois, the Retolois, the Pertois, the Village, Basigni, the Senonois and the Brie Champenois. It now forms the departments of Ardennes, Aube, Marne, and Upper Marne.

Champagne Proper, is one of the eight parts of Champagne, which comprehends the towns of Troyes, Chalons, St Menehould, Eperney, and Vertus.

CHAMPAIN, or *Point Champain*, in *Heraldry*, a mark of dishonour in the coat of arms of him who kills a prisoner of war after he has cried quarter.

CHAMPERTRY, in *Law*, a species of MAINTENANCE, and punished in the same manner; being a bargain with the plaintiff or defendant *campum partire*, "to divide the land," or other matter sued for, between them, if they prevail at law; whereupon the champertror is to carry on the party's suit at his own expence. This *champart*, in the French law, signifies a similar division of profits, being a part of the crop annually due to the landlord by bargain or custom. In our sense of the word, it signifies the purchasing of a suit or right of suing; a practice so much abhorred by our law, that it is one main reason why a *chose* in action, or thing of which one hath the right but not the possession, is not assignable in common law; because no man should purchase any pretence to sue in another's right. These pests of civil society, that are perpetually endeavouring to disturb the repose of their neighbours, and officiously interfering in other men's quarrels even at the hazard of their own fortunes, were severely animadverted on by the Roman law, and were punished by the forfeiture of a third part of their goods, and perpetual infamy. Hitherto also must be referred the provisions of the statute 32 Henry VIII. c. 9. that no one shall sell or purchase any pretended right or title to land, unless the vender hath received the profits thereof for one whole year before such grant, or hath been in actual possession of the land, or of the reversion or remainder; on pain that both purchaser and vender shall each forfeit the value of such land to the king and the prosecutor.

CHAMPION, a person who undertakes a combat in the place or quarrel of another; and sometimes the word is used for him who fights in his own cause.

It appears that champions, in the just sense of the word, were persons who fought instead of those that, by custom, were obliged to accept the duel, but had a just excuse for dispensing with it, as being too old, infirm, or being ecclesiastics. and the like. Such causes as could not be decided by the course of common law were often tried by single combat; and he who had the good fortune to conquer, was always reputed to have justice on his side. See the article BATTLE.

Champion of the King (*campio regis*), is an ancient officer, whose office is, at the coronation of our kings, when the king is at dinner, to ride armed *cop-a-pee* into Westminster-hall, and by the proclamation of a herald make a challenge, "That if any man shall deny the king's title to the crown, he is there ready to defend it in single combat, &c." which being done, the king drinks to him, and sends him a gilt cup with a cover full of wine, which the champion drinks, and hath the cup for his fee. This office at the coronation of King Richard II. when Baldwin Ferville exhibited his petition for it, was adjudged from him to his competitor Sir John Dymocke, (both claiming from Marmion), and hath continued ever since in the family of the Dymockes; who hold the manor of Sinvelsby in Lincolnshire, hereditary from the Marmions, by grand serjeantry, viz. that the lord thereof shall be the king's champion as aforesaid. Accordingly Sir Edward Dymocke performed this office at the coronation of King Charles II.; a person of the name of Dymocke performed at the coronation of his present majesty George III.

CHAMPLAIN, Samuel de, a celebrated French navigator, the founder of the colony of New France, or Canada. He built Quebec; and was the first governor of the colony in 1603. Died after 1649. See Quebec.

CHANANÆI, in *Ancient Geography*, the name of the ancient inhabitants of Canaan in general, descendants of Canaan; but peculiarly appropriated to some one branch; though uncertain which branch or son of Canaan it was, or how it happened that they preferred the common gentilitious name to one more appropriated as descendants of one of the sons of Canaan; unless from their course of life, as being in the mercantile way, the import of the name of *Canaan*; and for which their situation was greatly adapted, they living on the sea and about Jordan, and thus occupying the greater part of the Land of Promise.

CHANCE, a term we apply to events, to denote that they happen without any necessary or foreknown cause. See Cause.

Our aim is, to ascribe those things to *chance* which are not necessarily produced as the natural effects of any proper cause: but our ignorance and precipitancy lead us to attribute effects to *chance* which have a necessary and determinate cause.

When we say a thing happens *by chance*, we really mean no more than that its cause is unknown to us: not, as some vainly imagine, that *chance* itself can be the cause of any thing.

The case of the painter, who unable to express the foam at the mouth of a horse he had painted, threw his sponge in despair at the piece, and *by chance*, did that which he could not before do by design, is an eminent instance of the force of *chance*: yet, it is obvious, all we mean here by *chance* is, that the painter was not aware of the effect; or that he did not throw the sponge with such a view: not but that he actually did every thing necessary to produce the effect; insomuch, that considering the direction wherein he threw his sponge, together with its form, specific gravity, the colours wherewith it was smeared, and the distance of the hand from the piece, it was impossible, on the present system of things, the effect should not follow.

Chance is frequently personified, and erected into a chimerical being, whom we conceive as acting arbitrarily,

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Chance, Chance-Medley.

rily, and producing all the effects whose real causes do not appear to us; in which sense the word coincides with the τυχη, *fortuna*, of the ancients.

Chance is also used for the manner of deciding things, the conduct or direction whereof is left at large, and not reducible to any determinate rules or measures, or where there is no ground for preference: as at cards, dice, lotteries, &c.

For the laws of Chance, *or the Proportion of Hazard in Gaming*, see Game.

The ancient *sortilege*, or *chance*, M. Placette observes, was instituted by God himself: and in the Old Testament we find several standing laws and express commands which prescribed its use on certain occasions. Hence the Scripture says, "The *lot*, or *chance*, fell on Matthias," when it was in question who should fill Judas's place in the apostolate.

Hence also arose the *sortes sanctorum*, or method of determining things, among the ancient Christians, by opening some of the sacred books, and pitching on the first verse they cast their eye on, as a sure prognostic of what was to befal them. The *sortes Homericæ*, *Virgilianæ*, *Prænestinæ*, &c. used by the heathens, were with the same view, and in the same manner. See Sortes.

St Augustine seems to approve of this method of determining things future, and owns that he had practised it himself; grounded on this supposition, that God presides over *chance*; and on Prov. xvi. 33.

Many among the modern divines hold *chance* to be conducted in a particular manner by Providence; and esteem it an extraordinary way which God uses to declare his will, and a kind of immediate revelation.

Chance-Medley, in *Law*, is where one is doing a lawful act, and a person is killed by chance thereby; for if the act be unlawful, it is felony. If a person cast, not intending harm, a stone, which happens to hit one, whereof he dies; or shoots an arrow in a highway, and another that passeth by is killed therewith; or if a workman, in throwing down rubbish from a house, after warning to take care, kills a person; or a schoolmaster in correcting his scholar, a master his servant, or an officer in whipping a criminal in a reasonable manner, happens to occasion his death; it is chance-medley and misadventure. But if a man throw stones in a highway where persons usually pass; or shoot an arrow, &c. in a market-place among a great many people; or if a workman cast down rubbish from a house in cities and towns where people are continually passing; or a schoolmaster, &c. correct his servant or scholar, &c. exceeding the bounds of moderation; it is manslaughter: and if with an improper instrument of correction, as with a sword or iron bar, or by kicking, stamping, &c. in a cruel manner, it is murder. If a man whips his horse in a street to make him gallop, and the horse runs over a child and kills it, it is manslaughter: but if another whips the horse, it is manslaughter in him, and chance-medley in the rider. And if two are fighting, and a third person coming to part them is killed by one of them without any evil intent, yet this is murder in him, and not manslaughter by chance-medley or misadventure. In chance-medley, the offender forfeits his goods; but hath a pardon of course.

Chancel, Chancellor.

CHANCEL, is properly that part of the choir of a church, between the altar or communion-table and the balustrade or rail that encloses it, where the minister is placed at the celebration of the communion. The word comes from the Latin *cancellus*, which in the lower Latin is used in the same sense, from *cancelli*, "lattices or cross bars," wherewith the chancels were anciently encompassed, as they now are with rails. The right of a seat and a sepulchre in the chancels is one of the privileges of founders.

CHANCELLOR, was at first only a chief notary or scribe under the emperors; and was called *cancellarius*, because he sat behind a lattice (in Latin *cancellus*), to avoid being crowded by the people: though some derive the word from *cancellare*, "to cancel." (See Chancery.) This officer was afterwards invested with several judicial powers, and a general superintendency over the rest of the officers of the prince. From the Roman empire it passed to the Roman church, ever emulous of imperial state: and hence every bishop has to this day his chancellor, the principal judge of his consistory. And when the modern kingdoms of Europe were established upon the ruins of the empire, almost every state preserved its chancellor with different jurisdictions and dignities, according to their different constitutions. But in all of them he seems to have had the supervision of all charters, letters, and such other public instruments of the crown as were authenticated in the most solemn manner: and therefore, when seals came in use, he had always the custody of the king's great seal.

Lord High Chancellor *of Great Britain*, or *Lord Keeper of the Great Seal*, is the highest honour of the long robe, being created by the mere delivery of the king's great seal into his custody: whereby he becomes, without writ or patent, an officer of the greatest weight and power of any now subsisting in the kingdom. He is a privy counsellor by his office; and, according to Lord Chancellor Ellesmere, prolocutor of the house of lords by prescription. To him belongs the appointment of all the justices of the peace throughout the kingdom. Being in former times commonly an ecclesiastic (for none else were then capable of an office so conversant in writing), and presiding over the royal chapel, he became keeper of the king's conscience; visitor, in right of the king, of all hospitals and colleges of the king's foundation; and patron of all the king's livings under the value of 20l. per annum in the king's books. He is the general guardian of all infants, idiots and lunatics; and has the general superintendence of all charitable uses in the kingdom; and all this over and above the vast extensive jurisdiction which he exercises in his judicial capacity in the court of chancery. He takes a precedence of every temporal lord except the royal family, and of all others except the archbishop of Canterbury. See Chancery.

Chancellor, in Scotland, was the chief in matters of justice. In the laws of King Malcolm II. he is placed before all other officers; and from these it appears that he had the principal direction of the chancery, or chancellary as it is called, which is his proper office. He had the custody of the king's seal; and he was the king's most intimate counsellor, as appears by an old law cited by Sir James Balfour: "The chancellar

Chancellor. chancellar sal at al tymes assist the king, in giving him counsall mhir secretly nor the rest of the nobility, to quais ordinances all officiaris, als well of the realme as of the kingis hous, sould answer and obey. The chancellar sal be ludgit neir unto the kingis grace, for keiping of his bodie, and the seill; and that he may be readie baith day and nicht at the king's command." By having the custody of the great seal, he had an opportunity of examining the king's grants, and other deeds which were to pass under it, and to cancel them if they appeared against law, and were obtained surreptitiously or by false suggestions.

King James VI. ordained the chancellor to have the first place and rank in the nation, *ratione officii;* by virtue whereof he presided in the parliament, and in all courts of judicature. After the restoration of King Charles II. by a particular declaratory law, parliament first, the lord chancellor was declared, by virtue and right of his office, president in all the meetings of parliament, or other public judicatures of the kingdom. Although this act was made to declare the chancellor president of the exchequer as well as other courts, yet in 1663 the king declared the treasurer to be president of that court.

The office of Lord Chancellor was abolished by the Union, there being no farther use for the judicial part of this office; and to answer all the other parts of the chancellor's office, a lord keeper of the great seal was erected, with a salary of 3000l. a-year.

Chancellor of a Cathedral, an officer that hears lessons and lectures read in the church, either by himself or his vicar; to correct and set right the reader when he reads amiss; to inspect schools; to hear causes; apply the seal; write and dispatch the letters of the chapter; keep the books; take care that there be frequent preachings, both in the church and out of it; and assign the office of preaching to whom he pleases.

Chancellor of the Duchy of Lancaster, an officer appointed chiefly to determine controversies between the king and his tenants of the duchy land, and otherwise to direct all the king's affairs belonging to that court. See *Duchy Court.*

Chancellor of the Exchequer, an officer who presides in that court, and takes care of the interest of the crown. He is always in commission with the lord-treasurer, for the letting of crown lands, &c. and has power with others, to compound for forfeitures of lands upon penal statutes. He has also great authority in managing the royal revenues, and in matters relating to the first fruits.

Chancellor of the order of the Garter and other Military orders, is an officer who seals the commissions and mandates of the chapter and assembly of the knights, keeps the register of their proceedings, and delivers acts thereof under the seal of their order.

Chancellor of an University, is he who seals the diplomas, or letters of degrees, provision, &c. given in the university.

The chancellor of Oxford is usually one of the prime nobility, chosen by the students themselves in convocation. He is their chief magistrate; his office is, *durante vita*, to govern the university, preserve and defend its rights and privileges, convoke assemblies, and do justice among the members under his jurisdiction.

Chancellor ‖ Chancery.

Under the chancellor is the vice-chancellor, who is chosen annually, being nominated by the chancellor, and elected by the university in convocation. He is always the head of some college, and in holy orders. His proper office is to execute the chancellor's power, to govern the university according to her statutes, to see that officers and students do their duty, that courts be duly called, &c. When he enters upon his office, he chooses four pro-vice chancellors out of the heads of the colleges, to execute his power in his absence.

The chancellor of Cambridge is also usually one of the prime nobility, and in most respects the same as that in Oxford; only he does not hold his office *durante vita*, but may be elected every three years. Under the chancellor there is a commissary, who holds a court of record for all privileged persons and scholars under the degree of master of arts, where all causes are tried and determined by the civil and statute law, and by the custom of the university.

The vice-chancellor of Cambridge is chosen annually by the senate, out of two persons nominated by the heads of the several colleges and halls.

Chancellor's Court. See *University Courts.*

CHANCERON, in *Natural History*, a name given by the French writers to the small caterpillar, that eats the corn, and does vast mischief in their granaries. See the the article *Corn-Butterfly.*

CHANCERY, the highest court of justice in Britain next to the parliament, and of very ancient institution. It has its name chancery (*cancellaria*) from the judge who presides here, the lord chancellor, or *cancellarius;* who, according to Sir Edward Coke, is so termed, *à cancellando*, from cancelling the king's letters patent when granted contrary to law, which is the highest point of his jurisdiction. In chancery there are two distinct tribunals; the one ordinary, being a court of common law; the other extraordinary, being a court of equity.

1. The *ordinary* legal court holds pleas of recognizances acknowledged in the chancery, writs of *scire facias*, for repeal of letters patent, writs of partition, &c. and also of all personal actions by or against any officer of the court. Sometimes a *supersedeas*, or writ of privilege, hath been here granted to discharge a person out of prison: one from hence may have a *habeas corpus* prohibition, &c. in the vacation; and here a *subpœna* may be had to force witnesses to appear in other courts, when they have no power to call them. But, in prosecuting causes, if the parties descend to issue, this court cannot try it by jury; but the lord chancellor delivers the record into the king's bench to be tried there; and after trial had, it is to be remanded into the chancery, and there judgment given; though if there be a demurrer in law, it shall be argued in this court. Blackst. Comment.

In this court is also kept the *officina justitiæ;* out of which all original writs that pass under the great seal, all commissions of charitable uses, sewers, bankruptcy, idiocy, lunacy, and the like, do issue; and for which it is always open to the subject, who may there at any time demand and have, *ex debito justitiæ*, any writ that his occasions may call for. These writs, relating to the business

business of the subject, and the returns of them, were, according to the simplicity of ancient times, originally kept in a hamper, *in hanaperio;* and the other (relating to such matters wherein the crown is mediately or immediately concerned) were preserved in a little sack or bag, *in parva baga;* and hence hath arisen the distinction of the *hanaper* office, and the *petty-bag* office, which both belong to the common law court in chancery.

2. The *extraordinary* court, or court of equity, proceeds by the rules of equity and conscience, and moderates the rigour of the common law, considering the *intention* rather than the *words* of the law. It gives relief for and against infants notwithstanding their minority, and for or against married women notwithstanding their coverture. All frauds and deceits for which there is no redress at common law; all breaches of trust and confidence; and accidents, as to relieve obligors, mortgagers, &c. against penalties and forfeitures, where the intent was to pay the debt, are here remedied: for in chancery, a forfeiture, &c. shall not bind, where a thing may be done after, or compensation made for it. Also this court will give relief against the extremity of unreasonable engagements entered into without consideration; oblige creditors that are unreasonable to compound with an unfortunate debtor; and make executors, &c. give security and pay interest for money that is to lie long in their hands. This court may confirm title to lands, though one hath lost his writings: and render conveyances defective through mistake, &c. good and perfect. In chancery, copy-holders may be relieved against the ill usage of their lords; enclosures of land that are common be decreed; and this court may decree money or lands given to charitable uses, oblige men to account with each other, &c. But in all cases where the plaintiff can have his remedy at law, he ought not to be relieved in chancery; and a thing which may be tried by a jury is not triable in this court.

The proceedings in chancery are, first to file the bill of complaint, signed by some counsel, setting forth the fraud or injury done, or wrong sustained, and praying relief: after the bill is filed, process of *subpœna* issues to compel the defendant to appear; and when the defendant appears, he puts in his answer to the bill of complaint, if there be no cause for the plea to the jurisdiction of the court, in disability of the person, or in bar, &c. Then the plaintiff brings his replication, unless he files exceptions against the answer as insufficient, referring it to a master to report whether it be sufficient or not; to which report exceptions may also be made. The answer, replication, rejoinder, &c. being settled, and the parties come to issue, witnesses are to be examined upon interrogatories, either in court or by commission in the country, wherein the parties usually join; and when the plaintiff and defendant have examined their witnesses, publication is to be made of the depositions, and the cause is to be set down for hearing; after which follows the decree. But it is now usual to appeal to the house of lords; which appeals are to be signed by two noted counsel, and exhibited by way of petition; the petition or appeal is lodged with the clerk of the house of lords, and read in the house, whereon the appellee is ordered to put in his answer, and a day fixed for hearing the cause; and after counsel heard, and evidence given on both sides, the lords will affirm or reverse the decree of the chancery, and finally determine the cause by a majority of votes, &c.

CHANDELIER, in fortification, a kind of moveable parapet, consisting of a wooden frame, made of two upright stakes, about six feet high, with cross planks between them; serving to support fascines to cover the pioneers.

CHANDERNAGORE, a French settlement in the kingdom of Bengal in the East Indies. It lies on the river Ganges, two leagues and a half above Calcutta. The district is hardly a league in circumference, and has the disadvantage of being somewhat exposed on the western side; but its harbour is excellent, and the air is as pure as it can be on the banks of the Ganges. Whenever any building is undertaken that requires strength, it must here, as well as in all other parts of Bengal, be built upon piles, it being impossible to dig three or four feet without coming at water.

CHANDLER, Mary, distinguished by her talent for poetry, was the daughter of a dissenting minister at Bath, and was born at Malmsbury in Wiltshire in 1687. She was bred a milliner; but from her childhood had a turn for poetry, and in her riper years applied herself to the study of the poets. Her poems, for which she was complimented by Mr Pope, breathe the spirit of piety and philosophy. She had the misfortune to be deformed, which determined her to live single; though she had great sweetness of countenance, and was solicited to marry. She died in 1745, aged 58.

CHANDLER, *Dr Samuel*, a learned and respectable dissenting minister, descended from ancestors who had heartily engaged in the cause of religious liberty, and suffered for the sake of conscience and nonconformity; was born at Hungerford in Berks, where his father was a minister of considerable worth and abilities. Being by his literary turn destined to the ministry, he was first placed at an academy at Bridgewater, and from thence removed to Gloucester under Mr Samuel Jones. Among the pupils of Mr Jones were Mr Joseph Butler, afterwards bishop of Durham, and Mr Thomas Secker, afterwards archbishop of Canterbury. With these eminent persons he contracted a friendship that continued to the end of their lives, notwithstanding the different views by which their conduct was afterwards directed, and the different situations in which they were placed.

Mr Chandler having finished his academical studies, began to preach about July 1714; and being soon distinguished by his talents in the pulpit, he was chosen in 1716 minister of the Presbyterian congregation at Peckham near London, in which station he continued some years. Here he entered into the matrimonial state, and began to have an increasing family, when, by the fatal South Sea scheme of 1720, he unfortunately lost the whole fortune which he had received with his wife. His circumstances being thereby embarrassed, and his income as a minister being inadequate to his expences, he engaged in the trade of a bookseller, and kept a shop in the Poultry, London, for about two or three years, still continuing to discharge the duties of the pastoral office. He also officiated as joint preacher with the learned Dr Lardner of a winter weekly evening lecture at the meeting house in the Old Jewry, London: in which meeting he was established assistant preacher about

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Chandler. about the year 1725, and then as the pastor. Here he administered to the religious improvement of a very respectable congregation for 40 years with the greatest applause; and with what diligence and application he improved the vacancies of time from his pastoral duties, for improving himself and benefiting the world, will appear from his many writings on a variety of important subjects. While he was thus laudably employed, not only the universities of Edinburgh and Aberdeen gave him, without any application, testimonies of their esteem in diplomas, conferring on him the degree of D. D. but he also received offers of preferment from some of the governors of the established church, which he nobly declined. He had likewise the honour of being afterwards elected F. R. and A. SS.

On the death of George II. in 1760, Dr Chandler published a sermon on that event, in which he compared that prince to King David. This gave rise to a pamphlet, which was printed in the year 1761, entitled "The History of the Man after God's own Heart;" wherein the author ventured to exhibit King David as an example of perfidy, lust, and cruelty, fit only to be ranked with a Nero or a Caligula; and complained of the insult that had been offered to the memory of the late British monarch by Dr Chandler's parallel between him and the king of Israel. This attack occasioned Dr Chandler to publish in the following year "A Review of the History of the Man after God's own Heart; in which the Falsehoods and Misrepresentations of the Historian are exposed and corrected." He also prepared for the press a more elaborate work, which was afterwards published in two volumes 8vo, under the following title: "A Critical History of the Life of David; in which the principal Events are ranged in Order of time; the chief Objections of Mr Bayle and others against the Character of this Prince, the Scripture Account of him, and the Occurrences of his Reign, are examined and refuted; and the Psalms which refer to him explained." As this was the last, it was likewise one of the best, of Dr Chandler's productions. The greatest part of this work was printed off at the time of our author's death, which happened May 8. 1766, aged 73. During the last year of his life, he was visited with frequent returns of a very painful disorder, which he endured with great resignation and Christian fortitude. He was interred in the burying-ground at Bunhill-fields on the 16th of the month; and his funeral was very honourably attended by ministers and other gentlemen. He expressly desired, by his last will, that no delineation of his character might be given in his funeral sermon, which was preached by Dr Amory. He had several children; two sons and a daughter who died before him, and three daughters who survived him; two of whom are yet living, and both married, one of them to the Rev. Dr Harwood.

Dr Chandler was a man of very extensive learning and eminent abilities; his apprehension was quick and his judgment penetrating; he had a warm and vigorous imagination; he was a very instructive and animated preacher; and his talents in the pulpit and as a writer procured him very great and general esteem, not only among the dissenters, but among large numbers of the established church. He was principally instrumental in the establishment of the fund for relieving the widows and orphans of poor Protestant dissenting ministers: the plan of it was first formed by him; and it was by his interest and application to his friends that many of the subscriptions for its support were procured.

Chandler, Chang-tong.

In 1768, four volumes of our author's sermons were published by Dr Amory, according to his own directions in his last will; to which were prefixed a neat engraving of him, from an excellent portrait by Mr. Chamberlin. He also expressed a desire to have some of his principal pieces reprinted in four volumes 8vo: proposals were accordingly published for that purpose, but did not meet with sufficient encouragement. But in 1777, another work of our author was published in one volume 4to, under the following title: "A Paraphrase and Notes on the Epistles of St Paul to the Galatians and Ephesians, with doctrinal and practical Observations: together with a critical and practical Commentary on the two Epistles of St Paul to the Thessalonians." Dr Chandler also left, in his interleaved Bible, a large number of critical notes, chiefly in Latin, which are now the property of Dr Kippis, Mr Farmer, Dr Price, and Dr Savage, and which have been intended to be published; but the design has not yet been executed. A complete list of Dr Chandler's works is given in the Biographia Britannica, vol. iii. p. 435.

CHANG-TONG, a province of China, bounded on the east by Petcheli and part of Honan, on the south by Kiang-nan, on the east by the sea, and on the north by the sea and part of Petcheli. The country is well watered by lakes, streams, and rivers; but is nevertheless liable to suffer from drought, as rain falls here but seldom. The locusts also sometimes make great devastation. However, it abounds greatly in game; and there is perhaps no country where quails, partridges, and pheasants, are sold cheaper, the inhabitants of this province being reckoned the keenest sportsmen in the empire. This province is greatly enriched by the river Yun, called the *Grand Imperial Canal*, through which all the barks bound to Pekin must pass in their way thither. The duties on this canal alone amount to more than 450,000l. annually. The canal itself is greatly admired by European travellers on account of its strong and long dikes, the banks decorated with cut stone, the ingenious mechanism of its locks, and the great number of natural obstacles which have been overcome in the execution of the work. The province produces silk of the ordinary kind: and besides this, another from a sort of insect resembling our caterpillar. It is coarser than the ordinary silk, but much stronger and more durable; so that the stuffs made from it have a very extensive sale throughout the empire.

Chang-tong is remarkable for being the birth-place of the celebrated philosopher and lawgiver Confucius. His native city is called *Kio-feou*, where there are several monuments erected in honour of this great man. This province is divided into six districts, which contain six cities of the first class, and 114 of the second and third. Along the coast, also, are 15 or 16 villages of considerable importance on account of their commerce; there is likewise a number of small islands, most of which have harbours very convenient for the Chinese junks which pass from thence to Corea or Leatong. The most remarkable cities are, 1. Tsi-nan-fou, the

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the capital, which stands south of the river Tsing-ho or Tsi. It is large and populous; but chiefly celebrated for having been the residence of a long series of kings, whose tombs rising on the neighbouring mountains, afford a beautiful prospect. 2. Yn-tcheu-fou, the second city of the province, situated between two rivers; and in a mild and temperate climate. Great quantities of gold are said to have been formerly collected in its neighbourhood. 3. Lin-tcin-tcheu, situated on the great canal, is much frequented by ships, and may be called a general magazine for every kind of merchandise. Here is an octagonal tower, divided into eight stories, the walls of which are covered on the outside with porcelain loaded with various figures neatly executed, and incrusted on the inside with variously coloured marble. A staircase, constructed in the wall, conducts to all the stories, from which there are passages that lead into magnificent galleries ornamented with gilt ballustrades. All the cornices and projections of the tower are furnished with little bells; which, says M. Grosier, when agitated by the wind, form a very agreeable harmony. In the highest story is an idol of gilt copper, to which the tower is dedicated. In the neighbourhood are some other temples, the architecture of which is exceedingly beautiful.

CHANGER, an officer belonging to the king's mint, who changes money for gold or silver bullion. See MINT.

Money-CHANGER, is a banker, who deals in the exchange, receipt, and payment of moneys. See BANKER.

CHANGES, in *Arithmetic*, &c. the permutations or variations of any number of quantities; with regard to their position, order, &c. See COMBINATION.

[*To find all the possible CHANGES of any number of Quantities, or how oft their Order may be varied.*] Suppose two quantities a and b. Since they may be either wrote ab or ba, it is evident their *changes* are $2=2.1$. Suppose three quantities abc: their *changes* will be as in the margin; as is evident by combining c first with ab, then with ba; and hence the number of *changes* arises $3.2.1=6$. If the quantities be 4, each may be combined four ways with each order of the other three; whence the number of changes arises $6.4=4.3.2.1=24$. Wherefore, if the number of quantities be supposed n, the number of *changes* will be $n.n-1.n-2.n-3.n-4.$ &c. If the same quantity occur twice, the *changes* of two will be found bb; of three, bab, abb, bbc; of four, $cbab$, $bcab$, $babc$. And thus the number of *changes* in the first case will be $1=(2.1):2.1$; in the second, $3=(3.2.1):2.1$; in the third, $12=(4.3.2.1):2.1$.

c a b
a c b
a b c
——
c b a
b c a
b a c

If a fifth letter be added, in each series of four quantities, it will beget five *changes*, whence the number of all the *changes* will be $60=(5.4.3.2.)\,1,:2.1$. Hence if the number of quantities be n, the number of *changes* will be $(n.n-1.n-2.n-3.n-4.$ &c.$):2.2$. From these special formulæ may be collected a general one, viz. if n be the number of quantities, and m the number which shows how oft the same quantity occurs; we shall have $(n.n-1.n-2.n-3.n-4.n-5.n-6.n-7.n-8.n-9.$ &c.$):(m-1.m-2.m-3.m-4.$ &c.$)$ the series being to be continued, till the continual subtraction of unity from n and m leave 0. After the same manner we may proceed further, till putting n for the number of quantities, and l, m, r, &c. for the number that shows how oft any of them is repeated, we arrive at an universal form. $(n.n-1.n-2.n-3.n-4.n-5.n-6.n-7.n-8.$ &c.$):(l.l-1.l-2.l-3.l-4.l-5.$ &c. $m.m-1.m-2.m-3.$ &c.$)\ r.r-1.r-2.r-3.r-4.r-5.$ &c.

Suppose, for instance, $n=6$, $l=3$, $r=0$. The number of *changes* will be $(6.5.4.3.2.1.):(3.2.1.3.2.1.)=(6.5.4.):(3.2=2.5.2=20)$.

Hence, suppose thirteen persons at a table, if it be required how oft they may *change* places; we shall find the number $13.12.11.10.9.8.7.6.5.4.3.2.1.=6227020800$.

In this manner may all the possible anagrams of any word be found in all languages, and that without any study: suppose, v. g. it were required to find the anagrams of the word *amor*, the number of *changes* will be

a	*oam*	*rmoa*	*maro*	*arom*
——	*aom*	*mroa*	*maor*	*aorm*
ma	*amo*	*mora*	——	*aomr*
am	——	*moar*	*raom*	——
——	*roma*	——	*oram*	*ramo*
oma	*orma*	*rmao*	*oarm*	*armo*
moa	*omra*	*mrao*	*oamr*	*amro*
mao	*omar*		——	*amor*
			roam	

The anagrams therefore of the word *amor*, in the Latin tongue, are *roma*, *mora*, *maro*, *ramo*, *armo*. See ANAGRAM.

Whether this new method of anagramatizing be like to prove of much service to that art, is left to the poets.

CHANNA, in *Zoology*, the name of a fish caught in great plenty in the Mediterranean, and brought to market in Italy and elsewhere, among the sea perch, which it so nearly resembles, that it would not be distinguishable from it, but that the sea perch is bigger, and has only broad transverse lines on its back, whereas the channa has them both transverse and longitudinal. It has a very wide mouth, and its lower jaw is longer than its upper; so that its mouth naturally falls open. Its eyes are small, and its teeth very sharp; its back is of a blackish red; it has several longitudinal lines of a reddish hue; and its tail is marked with reddish spots. There is an observation, that in all the fish of this kind which have been examined by naturalists, there have been found none but females. This is as old as the days of Aristotle. Whether this be true in fact, would require many observations. If it should prove so, the whole seems to end in this, that the channa is no distinct species, but only the female of some other fish. There is another fish not unlike this, called *cannadella*, or rather *channadella*, which at Marseilles is known by the name of *charina*.

CHANNEL, in *Geography*, an arm of the sea, or a narrow sea between two continents; or between a continent and an island. Such are the British channel, St George's channel, the channel of Constantinople, &c.

CHANNEL *of a Ship*. See CHAIN-*Wales*.

CHAN-SI, a province of China, and one of the smallest in the empire, is bounded on the east by Petcheli, on the south by Honan, on the west by Chen-si, and on the north by the great wall. The climate is healthful

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healthful and agreeable, and the soil generally fertile, though the country is full of mountains. Some of these last are rough, wild, and uninhabited; but others are cultivated with the greatest care from top to bottom, and cut into terraces, forming a very agreeable prospect; while some have on their tops vast plains no less fertile than the richest low lands. These mountains abound with coal, which the inhabitants pound and make into cakes with water; a kind of fuel which, though not very inflammable, affords a strong and lasting fire when once kindled. It is principally used for heating their stoves, which are constructed with brick as in Germany; but the inhabitants of this province give them the form of small beds, and sleep upon them. The best grapes to be met with in this part of Asia grow in the province of Chan-si; so that good wine might be made; but the people choose rather to dry and sell them to the neighbouring provinces. The country abounds with musk, porphyry, marble, lapis lazuli, and jasper of various colours; and iron mines, as well as salt pits and crystal, are very common. Here are five cities of the first class, and eighty-five of the second and third: the most remarkable are, 1. Tai-youen-fou the capital, an ancient city about three leagues in circumference, but much decayed in consequence of being no longer the residence of the princes of the blood as it was formerly. Nothing now remains of the palaces of those princes but a few ruins; but their tombs are still to be seen on a neighbouring mountain. The burying-place is magnificently ornamented; and all the tombs are of marble or cut stone, having near them triumphal arches, statues of heroes, figures of lions and different animals, especially horses, and which are disposed in very elegant order. An awful and melancholy gloom is preserved around these tombs by groves of aged cypresses, which have never felt the stroke of the axe, placed chequer-wise. The principal articles of trade here are, hardware, stuffs of different kinds, particularly carpets in imitation of those of Turkey. 2. Ngan-y is situated near a lake as salt as the ocean, from which a great quantity of salt is extracted. 3. Fuen-tcheou-fou, an ancient and commercial city, built on the banks of the river Fuen-ho: it has baths and springs almost boiling hot, which, by drawing hither a great number of strangers, add greatly to its opulence. 4. Tai-tong-fou, situated near the wall, is a place of great strength, and important by reason of its situation, as being the only one exposed to the incursions of the Tartars. Its territories abound with lapis lazuli, medicinal herbs, and a particular kind of jasper called *yieche*, which is as white and beautiful as agate; marble and porphyry are also common; and a great revenue is produced from the skins which are dressed here.

CHANT, (*cantus*), is used for the vocal music of churches.

In church history we meet with divers kinds of *chant* or *song*. The first is the *Ambrosian*, established by St Ambrose. The second, the *Gregorian chant*, introduced by Pope Gregory the Great, who established schools of chantors, and corrected the church-song. This is still retained in the church under the name of *plain song*: at first it was called the *Roman song*. The *plain* or *Gregorian chant*, is where the choir and people sing in unison, or all together in the same manner.

CHANTILLY, a village in France, about seven leagues from Paris, where there is a magnificent palace and fine forest formerly belonging to the duke of Bourbon.

CHANTOR, a singer of a choir in a cathedral. The word is almost grown obsolete, *chorister* or *singing-man* being commonly used instead of it. All great chapters have chantors and chaplains to assist the canons, and officiate in their absence.

CHANTOR is used by way of excellence for the precentor or master of the choir, which is one of the first dignities of the chapter. At St David's in Wales, where there is no dean, he is next in dignity to the bishop. The ancients called the chantor *primicerius cantorum*. To him belonged the direction of the deacons and other inferior officers.

Chantors, in the temple of Jerusalem, were a number of Levites, employed in singing the praises of God, and playing upon instruments before his altar. They had no habits distinct from the rest of the people; yet in the ceremony of removing the ark to Solomon's temple, the chantors appeared dressed in tunics of byssus or fine linen. 2 Chron. v. 12.

CHANTRY, or CHAUNTRY, was anciently a church or chapel endowed with lands, or other yearly revenue, for the maintenance of one or more priests, daily saying or singing mass for the souls of the donors, and such others as they appointed. Hence *chauntry-rents*, are rents paid to the crown by the tenants or purchasers of *chauntry-lands*.

CHAOLOGY, the history or description of the chaos. See CHAOS.

Orpheus, in his chaology, sets forth the different alterations, secretions, and diverse forms, which matter went through till it became inhabitable; which amounts to the same with what we otherwise call *cosmogony*. Dr Burnet, in his Theory of the Earth, represents the the chaos as it was at first, entire, undivided, and universally rude and deformed; or the *tohu bohu*: then shows how it came to be divided into its respective regions; how the homogeneous matter gathered itself apart from all of a contrary principle; and, lastly, how it hardened and became a solid habitable globe. See EARTH.

CHAOS, that confusion in which matter lay when newly produced out of nothing at the beginning of the world, before God, by his almighty word, had put it into the order and condition wherein it was after the six days creation. See EARTH.

Chaos is represented by the ancients as the first principle, ovum, or seed of nature and the world. All the sophists, sages, naturalists, philosophers, theologues, and poets, held that chaos was the eldest and first principle, *το αρχαιον χαος*. The Barbarians, Phœnicians, Egyptians, Persians, &c. all refer the origin of the world to a rude, mixed, confused mass of matter. The Greeks, Orpheus, Hesiod, Menander, Aristophanes, Euripides, and the writers of the Cyclic Poems, all speak of the first chaos; the Ionic and Platonic philosophers build the world out of it. The Stoics hold, that as the world was first made of a chaos, it shall at last be reduced to a chaos; and that its periods and revolutions in the mean time are only transitions from one chaos to another. Lastly, the Latins, as Ennius, Varro, Ovid, Lucretius, Statius, &c. are all of the same

same opinion. Nor is there any sect or nation whatever that does not derive their διακόσμησις, *the structure of the world*, from a chaos.

The opinion first arose among the Barbarians, whence it spread to the Greeks and from the Greeks to the Romans and other nations. Dr Burnet observes, that besides Aristotle and a few other Pseudo-Pythagoreans, nobody ever asserted that our world was always from eternity of the same nature, form, and structure, as at present; but that it had been the standing opinion of the wise men of all ages, that what we now call the *terrestrial earth*, was originally an unformed, indigested mass of heterogeneous matter, called *chaos;* and no more than the rudiments and materials of the present world.

It does not appear who first broached the notion of a chaos. Moses, the eldest of all writers, derives the origin of this world from a confusion of matter, dark, void, deep, without form, which he calls *tohu bohu;* which is precisely the chaos of the Greek and Barbarian philosophers. Moses goes no further than the chaos, nor tells us whence it took its origin, or whence its confused state; and where Moses stops, there precisely do all the rest. Dr Burnet endeavours to show that as the ancient philosophers, &c. who wrote of the cosmogony, acknowledged a chaos for the principle of their world; so the divines, or writers of the theogony, derive the origin or generation of their fabled gods from the same principle.

Mr Whiston supposed the ancient chaos, the origin of our earth, to have been the atmosphere of a comet: which though new, yet all things considered, is not the most improbable assertion. He endeavours to make it out by many arguments, drawn from the agreement which appears to be between them. So that, according to him, every planet is a comet, formed into a regular and lasting constitution, and placed at a proper distance from the sun, revolving in a nearly circular orbit: and a comet is a planet either beginning to be destroyed or re-made; that is, a chaos or planet unformed or in its primeval state, and placed as yet in an orbit very eccentrical.

Chaos, in the phrase of Paracelsus, imports the air. It has also some other significations amongst the alchemists.

Chaos, in *Zoology*, a genus of insects belonging to the order of vermes zoophyta. The body has no shell or covering, and is capable of reviving after being dead to appearance for a long time; it has no joints or external organs of sensation. There are five species, mostly obtained by infusions of different vegetables in water, and only discoverable by the microscope. See Animalculæ.

CHAPEAU, in *Heraldry*, an ancient cap of dignity worn by dukes, being scarlet-coloured velvet on the outside, and lined with a fur. It is frequently borne above a helmet instead of a wreath, under gentlemen's crests.

CHAPEL, a place of divine worship so called. The word is derived from the Latin *capella*. In former times, when the kings of France were engaged in war, they always carried St Martin's hat into the field, which was kept in a tent as a precious relick: from whence the place was called *capella;* and the priests, who had the custody of the tent, *capellani*. Afterwards the word *capella* became applied to private oratories.

In Britain there are several sorts of chapels. 1. Parochial chapels: these differ from parish churches only in name; they are generally small, and the inhabitants within the district few. If there be a presentation *ad ecclesiam* instead of *capellam*, and an admission and institution upon it, it is no longer a chapel, but a church. 2. Chapels, which adjoin to, and are part of the church: such were formerly built by honourable persons, as burying-places for themselves and their families. 3. Chapels of ease; these are usually built in very large parishes, where all the people cannot conveniently repair to the mother church. 4. Free chapels; such as were founded by kings of England. They are free from all episcopal jurisdiction, and only to be visited by the founder and his successors; which is done by the lord chancellor: yet the king may license any subject to build and endow a chapel, and by letters patent exempt it from the visitation of the ordinary. 5. Chapels in the universities, belonging to particular colleges. 6. Domestic chapels, built by noblemen or gentlemen for the private service of God in their families. See Chaplain.

Chapel is also a name given to a printer's workhouse; because, according to some authors, printing was first actually performed in chapels or churches; or, according to others, because Caxton, an early printer, exercised the art in one of the chapels in Westminster Abbey. In this sense they say, *the orders or laws of the chapel, the secrets of the chapel*, &c.

Knights of the Chapel, called also *Poor Knights of Windsor*, were instituted by Henry VIII. in his testament. Their number was at first thirteen, but has been since augmented to 26. They assist in the funeral services of the kings of England: they are subject to the office of the canons of Windsor, and live on pensions assigned them by the order of the Garter. They bear a blue or red cloak, with the arms of St George on the left shoulder.

CHAPELAIN, James, an eminent French poet, born at Paris in 1595, and often mentioned in the works of Balzac, Menage, and other learned men. He wrote several works, and at length distinguished himself by a heroic poem called *La Pucelle, ou France Delivrée*, which employed him several years; and which, raising the expectation of the public, was as much decried by some as extolled by others. He was one of the king's counsellors; and died in 1647, very rich, but was very covetous and sordid.

CHAPELET, in the manege, a couple of stirrup-leathers, mounted each of them with a stirrup, and joined atop in a sort of leather buckle, called the *head of the chapelet*, by which they were made fast to the pummel of the saddle, after being adjusted to the rider's length and bore. They are used both to avoid the trouble of taking up or letting down the stirrups every time that a gentleman mounts on a different horse and saddle, and to supply the place of the academy saddles, which have no stirrups to them.

CHAPELLE, Claudius Emanuel Luillier, the natural son of Francis Luillier, took the name of *Chapelle* from a village between Paris and St Denys, where he was born. He distinguished himself by writing small pieces of poetry, in which he discovered great delicacy,

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delicacy, an easy turn, and an admirable felicity of expression. He was the friend of Gassendi and Moliere: and died in 1686.

CHAPERON, Chaperonne, or Chaperoon, properly signifies a sort of hood or covering for the head, anciently worn both by men and women, the nobles and the populace, and afterwards appropriated to the doctors and licentiates in colleges, &c. Hence the name passed to certain little shields, and other funeral devices, placed on the foreheads of the horses that drew the hearses in pompous funerals, and which are still called *chaperoons* or *shafferoons;* because such devices were originally fastened on the *chaperonnes*, or hoods, worn by those horses with their other coverings of state.

Chaperon of a bit-mouth, in the manege, is only used for scatch-mouths, and all others that are not cannon-mouths, signifying the end of the bit that joins to the branch just by the banquet. In scatch-mouths the chaperon is round, but in others it is oval: and the same part that in scatch and other mouths is called *chaperon*, is in cannon-mouths called *fronçeau*.

CHAPITERS, in *Architecture*, the same with Capitals.

Chapiters, in *Law*, formerly signified a summary of such matters as were inquired of, or presented before justices in eyre, justices of assize, or of the peace, in their sessions.

Chapiters, at this time, denotes such articles as are delivered by the mouth of the justice in his charge to the inquest.

CHAPLAIN properly signifies a person provided with a chapel, or who discharges the duty thereof.

Chaplain is also used for an ecclesiastical person, in the house of a prince, or a person of quality, who officiates in their chapels, &c.

In England there are 48 chaplains to the king, who wait four each month, preach in the chapel, read the service to the family, and to the king in his private oratory, and say grace in the absence of the clerk of the closet. While in waiting they have a table and attendance, but no salary. In Scotland the king has six chaplains, with a salary of 50l. each, three of them having in addition the deanery of the chapel-royal divided between them, making up above 100l. to each. The only duty at present is to say prayers at the election of peers for Scotland to sit in parliament.—According to a statute of Henry VIII. the persons vested with a power of retaining chaplains, together with the number each is allowed to qualify, is as follows: An archbishop, eight; a duke or bishop, six; marquis or earl, five; viscount, four; baron, knight of the Garter, or lord chancellor, three; a duchess, marchioness, countess, baroness, the treasurer and comptroller of the king's house, clerk of the closet, the king's secretary, dean of the chapel, almoner, and master of the rolls, each of them two; chief justice of the king's bench, and warden of the cinque-ports, each one. All these chaplains may purchase a license or dispensation, and take two benefices with cure of souls. A chaplain must be retained by letters testimonial under hand and seal; for it is not sufficient that he serve as chaplain in the family.

The first chaplains are said to have been those instituted by the ancient kings of France, for preserving the chape, or cape, with the other relicks of St Martin, which the kings kept in their palace, and carried out with them to the war. The first chaplain is said to have been Gul. de Mesmes, chaplain to St Louis.

Chaplain in the order of Malta, is used for the second rank or class in that order; otherwise called *diaco*.

The knights make the first class, and the chaplains the second.

Chaplains of the Pope, are the auditors, or judges of cause in the sacred palace; so called, because the pope anciently gave audience in his chapel, for the decision of cases sent from the several parts of Christendom. He hither summoned as assessors the most learned lawyers of his time; and they hence acquired the appellation of *capellani*, chaplains. It is from the decrees formerly given by these that the body of decretals is composed: their number Pope Sixtus IV. reduced to twelve.

Some say, the shrines of relicks were covered with a kind of tent-cape, or *capella*, i. e. little cape; and that hence the priests, who had the care of them, were called chaplains. In time these relicks were reposited in a little church, either contiguous to a larger or separate from it; and the same name, *capella*, which was given to the cover, was also given to the place where it was lodged: and hence the priest who superintended it came to be called chaplain.

CHAPLET, an ancient ornament for the head, like a garland or wreath: but this word is frequently used to signify the circle of a crown. There are instances of its being borne in a coat of arms, as well as for crests; the paternal arms for Lascelles are argent, three chaplets, gules.

Chaplet also denotes a string of beads used by the Roman Catholics, to count the number of their prayers. The invention of it is ascribed to Peter the hermit, who probably learned it of the Turks, as they owe it to the East Indians.

Chaplets are sometimes called *paternosters;* and are made of coral, of diamonds, of wood, &c. The common chaplet contains 50 ave-marias, and five paternosters. There is also a chaplet of our Saviour, consisting of 33 beads, in honour of his 33 years living on the earth, instituted by Father Michael the Camaldulian.

The Orientals have a kind of chaplets which they call *chains*, and which they use in their prayers, rehearsing one of the perfections of God on each link or head. The Great Mogul is said to have 18 of these chains, all precious stones; some diamonds, others rubies, pearls, &c. The Turks have likewise chaplets, which they bear in the hand, or hang at the girdle: but Father Dandini observes, they differ from those used by the Romanists, in that they are all of the same bigness, and have not that distinction into decades, though they consist of six decades, or 60 heads. He adds, that the Mussulmans run over the chaplet almost in an instant, the prayers being extremely short, as containing only these words, "praise to God," or "glory to God," for each bead. Besides the common chaplet they have likewise a larger one consisting of 100 beads, where there is some distinction, as being

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being divided by little threads into three parts; on one of which they repeat 30 times *soubhan Allah*, i. e. "God is worthy to be praised:" on another, *ellamh Allah*, "Glory be to God:" and on the third, *Allah echer*, "God is great." These thrice thirty times making only 90; to complete the number 100, they add other prayers for the beginning of the chaplet.—He adds, that the Mahometan chaplet appears to have had its rise from the *mea beracoth*, or "hundred benedictions," which the Jews are obliged to repeat daily, and which we find in their prayer books; the Jews and Mahometans having this in common, that they scarce do any thing without pronouncing some laud or benediction.

Menage derives the word *chaplet* from *chapeau*, "hat." The modern Latins call it *chapellina*, the Italians more frequently *corona*.

CHAPLET, or *Chapelet*, in *Architecture*, a little moulding, cut or carved into round beads, pearls, olives, or the like.

CHAPMAN, GEORGE, born in 1557, a man highly esteemed in his time for his dramatic and poetic works. He wrote 17 plays; translated Homer and some other ancient poets; and was thought no mean genius. He died in 1634; and was buried in St Giles's in the Fields, where his friend Inigo Jones erected a monument to him.

CHAPPE, in *Heraldry*, the dividing an escutcheon by lines drawn from the centre of the upper edge to the angles below, into three parts, the sections on the sides being of different metal or colour from the rest.

CHAPPEL *in* FRITH, a market town of Derbyshire, about 26 miles north-west of Derby. W. Long. 1. 50. N. Lat. 53. 22.

CHAPPEL, *William*, a learned and pious bishop of Cork, Cloyne, and Ross in Ireland, born in Nottinghamshire in 1582. When the troubles began under Charles I. he was prosecuted by the puritan party in parliament, and retired to Derby, where he devoted himself to study till his death in 1649. He wrote *Methodus Concionandi*, i. e. "the Method of Preaching:" and he is one of those to whom the *Whole Duty of Man* has been attributed. He left behind him also his own life written by himself in Latin, which has been twice printed.

CHAPTER, in ecclesiastical polity, a society or community of clergymen belonging to the cathedrals and collegiate churches.

It was in the eighth century that the body of canons began to be called a chapter. The chapter of the canons of a cathedral were a standing council to the bishops, and, during the vacancy of the see, had the jurisdiction of the diocese. In the earlier ages, the bishop was head of the chapter; afterwards abbots and other dignitaries, as deans, provosts, treasurers, &c. were preferred to this distinction. The deans and chapters had the privilege of choosing the bishops in England; but Henry VIII. got this power vested in the crown: and as the same prince expelled the monks from the cathedrals, and placed secular canons in their room, those he thus regulated were called deans and chapters of the new foundation; such are Canterbury, Winchester, Ely, Carlisle, &c. See DEAN.

CHAPTER, in matters of literature, a division in a book for keeping the subject treated of more clear and distinct.

CHAR, in *Ichthyology*, a species of SALMO.

CHARA. See BOTANY *Index*.

CHARABON, a sea-port town on the northern coast of the island of Java in the East Indies. E. Long. 10. 8. S. Lat. 6.

CHARACENE, the most southern part of Susiana, a province of Persia, lying on the Persian gulf, between the Tigris and the Eulæus. It was so named from the city of Chorax, called first Alexandria, from its founder Alexander the Great; afterwards Antiochia, from Antiochus V. king of Syria, who repaired and beautified it; and lastly, Chorax Spasinæ, or Pasinæ, that is, the Mole of the Spasines, an Arabian king of that name having secured it against the overflowing of the Tigris, by a high bank or mole, extending three miles, which served as a fence to all that country. Dionysius Periegetes, and Isidorus, author of the Parthicæ Mansiones, were both natives of this city. The small district of Characene was seized by Pasines, the son of Sogdonacus, king of the neighbouring Arabs, during the troubles of Syria, and erected into a kingdom. Lucian calls him Hyspasines, and adds, that he ruled over the Characeni and the neighbouring people: he died in the 85th year of his age. The other kings of this country we find mentioned by the ancients are, Tercus, who died in the 92d year of his age, and after him Artabazus the seventh, as Lucian informs us, who was driven from the throne by his own subjects, but restored by the Parthians. And this is all we find in the ancients relating to the kings of Characene.

CHARACTER, in a general sense, signifies a mark or figure, drawn on paper, metal, stone, or other matter, with a pen, graver, chissel, or other instrument, to signify or denote any thing. The word is Greek, χαρακτηρ, formed from the verb, χαρασσειν, *insculpere*, "to engrave, impress," &c.

The various kinds of characters may be reduced to three heads, viz. *Literal Characters*, *Numeral Characters*, and *Abbreviations*.

I. *Literal* CHARACTER, is a letter of the alphabet, serving to indicate some articulate sound, expressive of some idea or conception of the mind. See ALPHABET.

1. These may be divided, with regard to their nature and use, into *Nominal Characters*, or those we properly call *letters*; which serve to express the names of things: See LETTER. *Real Characters*; those that instead of names express things and ideas: See IDEA, &c. *Emblematical* or *Symbolical Characters*; which have this in common with real ones, that they express the things themselves; but have thus further, that they in some measure personate them, and exhibit their form; such are the hieroglyphics of the ancient Egyptians. See HIEROGLYPHIC, SYMBOL, &c.

2. *Literal* CHARACTERS may be again divided, with regard to their invention and use, into *particular* and *general* or *universal*.

Particular CHARACTERS, are those peculiar to this or that nation. Such are the Roman, Italic, Greek, Hebrew, Arabic, Gothic, Chinese, &c. *characters*.—See HEBREW, GOTHIC, CHINESE, &c.

Universe

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Universal Characters, are also *real characters*, and make what some authors call a *Philosophical Language*.

That diversity of *characters* used by the several nations to express the same idea, is found the chief obstacle to the advancement of learning; to remove this, several authors have taken occasion to propose plans of *characters* that should be universal, and which each people should read in their own language. The *character* here is to be real, not nominal: to express things and notions; not, as the common ones, letters or sounds: yet to be mute, like letters, and arbitrary; not emblematical, like hieroglyphics.

Thus, every nation should retain its own language, yet every one understand that of each other, without learning it; only by seeing a real or universal *character* which should signify the same things to all people, by what sounds soever each express it in their particular idiom. For instance, by seeing the *character* destined to signify *to drink*, an Englishman should read *to drink;* a Frenchman, *boire;* a Latin, *bibere;* a Greek *πινειν;* a Jew, שתה; a German, *trincken:* and so of the rest; in the same manner as seeing a horse, each people expresses it after their own manner; but all mean the same animal.

This real *character* is no chimera; the Chinese and Japanese have already something like it. They have a common *character*, which each of those nations understand alike in their several languages; though they pronounce them with such different sounds, that they do not understand one another in speaking.

The first and most considerable attempts for a *real character*, or philosophical language, in Europe, are those of Bishop Wilkins and Dalgarno: but these, with how much art soever they were contrived, have yet proved ineffectual.

M. Leibnitz had some thoughts the same way; he thinks those great men did not hit the right method. It was probable, indeed, that by their means, people who do not understand one another might easily have a commerce together: but they have not hit on true *real characters*.

According to him, the *characters* should resemble those used in algebra; which, in effect, are very simple, yet very expressive; without any thing superfluous or equivocal; and contain all the varieties required.

The *real character* of Bishop Wilkins has its just applause: Dr Hook recommends it, on his own knowledge and experience, as a most excellent scheme; and to engage the world to the study thereof, publishes some fine inventions of his own therein.

M. Leibnitz tells us, he had under consideration an *alphabet of human thoughts;* in order to a new philosophical language on his own scheme: but his death prevented its being brought to maturity.

M. Lodwic, in the Philosophical Transactions, gives us a plan of *an universal alphabet* or *character of* another kind: this was to contain an enumeration of all such single sounds, or letters, as are used in any language; by means whereof, people should be enabled to pronounce truly and readily any language; to describe the pronunciation of any language that shall be pronounced in their hearing, so as others accustomed to this language, though they had never heard the language pronounced, shall at first be able truly to pronounce it: and, lastly, this *character* to serve as a standard to perpetuate the sounds of any language. In the Journal Litteraire, an. 1720, we have a very ingenious project for an universal *character*. The author, after obviating the objections that might be made against the feasibleness of such schemes in the general, proposes his own: his *characters* are to be the common Arabic, or numeral figures. The combinations of these nine are sufficient to express distinctly an incredible quantity of numbers, much more than we shall need terms to signify our actions, goods, evils, duties, passions, &c. Thus is all the trouble of framing and learning any new *character* at once saved; the Arabic figures having already all the universality required.

The advantages are immense. For, 1*mo*, We have here a stable, faithful interpreter; never to be corrupted or changed, as the popular languages continually are. 2*do*, Whereas the difficulty of pronouncing a foreign language is such as usually gives the learner the greatest trouble, and there are even some sounds which foreigners never attain to, in the *character* here proposed this difficulty has no place: every nation is to pronounce them according to the particular pronunciation that already obtains among them. All the difficulty is, the accustoming the pen and the eye to affix certain notions to *characters* that do not, at first sight, exhibit them. But this trouble is no more than we find in the study of any language whatever.

The inflections of words are here to be expressed by the common letters. For instance, the same *character* shall express a *fuly* or a *colt*, a *horse* or a *mare*, an *old horse* or an *old mare*, as accompanied with this or that distinctive letter, which shall show the sex, youth, maturity, or old age; a letter also to express the bigness or size of things; thus *v. g.* a man with this or that letter, to signify a *great man*, or a *little man*, &c.

The use of those letters belongs to the grammar; which, once well understood, would abridge the vocabulary exceedingly. An advantage of this grammar is, that it would only have one declension and one conjugation; those numerous anomalies of grammarians are exceeding troublesome; and arise hence, that the common languages are governed by the populace, who never reason on what is best; but in the *character* here proposed, men of sense having the introduction of it, would have a new ground, whereon to build regularly.

A new universal character has been proposed by Mr Northmore of London, by which different nations may communicate their sentiments to each other. His original plan was, to make the same numerical figure represent the same word in all languages. But he found afterwards that it might be improved, by using a figure not for every word, but every *useful* word. And even these he thinks might be abbreviated by adopting certain uniform fixed signs, the number of which would not exceed 20, for the various parts of speech. Words of negation, he proposed, to be expressed by a prefixed sign. A few instances will explain the author's meaning.

Suppose the number 5 to represent the word *see*,

6	-	-	*a man*,
7	-	-	*happy*,
8	-	-	*never*,
9	-	-	*I*,

"I

Characters.

"I would then (says he) express the tenses, genders, cases, &c. *in all languages*, in some such *uniform* manner as the following:

(1)	5	=	*present tense*,	-	see,
(2)	.5	=	*perfect tense*,	-	saw,
(3)	:5	=	*perfect participle*,	-	seen,
(4)	5:	=	*present participle*,	-	seeing,
(5)	5.	=	*future*,	-	will see,
(6)	$\underline{5}$	=	*substantive*,	-	sight,
(7)	$\underline{\underline{5}}$	=	*personal substantive*,	-	spectator,
(8)	6	=	*nominative case*,	-	a man,
(9)	$\ddot{6}$	=	*genitive*,	-	of a man,
(10)	$\dddot{6}$	=	*dative*,	-	to a man,
(11)	$\overset{\frown}{6}$	=	*feminine*,	-	a woman,
(12)	+6	=	*plural*,	-	men,
(13)	7	=	*positive*,	-	happy,
(14)	$\overset{\blacktriangle}{7}$	=	*comparative*,	-	happier,
(15)	$\overset{\blacktriangle}{7}$	=	*superlative*,	-	happiest,
	$\underline{7}$	=	as above, No. 6.	-	happiness,
(16)	—7	=	*negation*,	-	unhappy.

"From the above specimen, I should find no difficulty in comprehending the following sentence, though it were written in the language of the Hottentots:

9, 8, .5,—$\overset{\blacktriangle}{7}$, $\overset{\frown}{6}$. *I never saw a more unhappy woman.*

"Those languages which do not use the pronoun prefixed to the verb, as the Greek and Roman, &c. may apply it, in a small character, simply to denominate the person; thus, instead of 9, 8, .5, *I never saw;* they may write, 8, ₉5, which will signify that the verb is in the first person, and will still have the same meaning."

Our author thinks, that according to this scheme of an universal character, about 20 signs, and less than 10,000 *chosen* words (synonyms being set aside), would answer all the ends proposed; and that foreigners, by referring to their numerical dictionary, would easily comprehend each other. He proceeds next to shew how appropriate sounds may be given to his signs, and an universal *living language* formed from the universal *characters*.

To attain this end, he proposes to distinguish the ten numerals by ten monosyllabic names of easy pronunciation, and such as may run without difficulty into one another. To illustrate his scheme, however, he calls them, for the present, by their common English names; but would pronounce each number made use of by uttering separately its component parts, after the manner of accountants. Thus, let the number 6943 represent the word *horse*, he would not, in the universal language, call a horse *six thousand nine hudred and forty-three*, but *six*, *nine*, *four*, *three*, and so on for all the words of a sentence, making the proper stop at the end of each. In the same manner, a distinct appellation must be appropriated to each of the prefixed signs, to be pronounced immediately after the numeral to which it is an appendage. Thus, if *plu* be the appellation or the sign of the plural number, *six*, *nine*, *four*, *three*, *plu* will be *horses*.

"Thus (says our author), I hope, it is evident that about 30 or 40 distinct syllables are sufficient for the above purpose; but I am much mistaken if *eleven* only will not answer the same end. This is to be done by substituting the first 20 or 30 numerals for the signs, and saying, as in algebra, that a term is in the power of such a number, which may be expressed by the simple word *under*. *Ex gr.* Let 6943 represent the word *horse;* and suppose 4 to be the sign of the plural number, I would write the word thus $\frac{4}{6943}$; and pronounce it, six, nine, four, three, in the power of or *under* four. By these means eleven distinct appellations would be sufficient, and time and use would much abbreviate the pronunciation."

But the difficulty is not in inventing the most simple, easy, and commodious *character*, but in engaging the several nations to use it; there being nothing they agree less in, than the understanding and pursuing their common interest.

3. Literal characters may again be divided, with respect to the nations among whom they have been invented, into Greek characters, Roman characters, Hebrew characters, &c. The Latin character now used through all Europe, was formed from the Greek, as the Greek was from the Phœnician; and the Phœnician, as well as the Chaldee, Syriac, and Arabic characters, were formed from the ancient Hebrew, which subsisted till the Babylonish captivity; for after that event the character of the Assyrians, which is the square Hebrew now in use, prevailed, the ancient being only found on some Hebrew medals, commonly called Samaritan medals. It was in 1091 that the Gothic characters, invented by Ulfilas, were abolished, and the Latin ones established in their room.

Medallists observe, that the Greek character, consisting only of majuscule letters, has preserved its uniformity on all medals, as low as the time of Gallienus, from which time it appears somewhat weaker and rounder: from the time of Constantine to Michael we find only Latin characters: after Michael, the Greek characters recommence; but from that time they began to alter with the language, which was a mixture of Greek and Latin. The Latin medals preserved both their characters and language, as low as the translation of the seat of the empire to Constantinople: towards the time of Decius the character began to lose its roundness and beauty; some time after, it retrieved and subsisted tolerably till the time of Justin, when it degenerated gradually into the Gothic. The rounder, then, and better formed a character is upon a medal, the fairer pretence it has to antiquity.

II. *Numerical* Characters, or characters used to express numbers, are either letters or figures.

The Arabic character, called also the common one, because it is used almost throughout Europe in all sorts of calculations, consists of these ten digits, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

The Roman numeral character consists of seven majuscule letters of the Roman alphabet, viz. I, V, X, L, C, D, M. The I denotes one, V five, X ten, L fifty, C a hundred, D five hundred, and M a thousand. The I repeated twice makes two, II; thrice, three,

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Characters.

three, III. Four is expressed thus, IV. as I before V or X takes an unit from the number expressed by these letters. To express six, an I is added to a V, VI.; for seven, two, VII.; and for eight, three, VIII. Nine is expressed by an I before X, thus, IX. The same remark may be made of the X before L or C, except that the diminution is by tens; thus, XL denotes forty, XC ninety, and LX sixty. The C before D or M diminishes each by a hundred. The number five hundred is sometimes expressed by an I before a C inverted, thus, IƆ; and instead of M, which signifies a thousand, an I is sometimes used between two C's, the one direct, and the other inverted, thus, CIƆ. The addition of C and Ɔ before or after raises CIƆ by tens; thus, CCIƆƆ expresses ten thousand, CCCIƆƆƆ a hundred thousand. The Romans also expressed any number of thousands by a line drawn over any numeral less than a thousand; thus, $\overline{\text{V}}$ denotes five thousand, $\overline{\text{LX}}$ sixty thousand; so likewise $\overline{\text{M}}$ is one milllion, $\overline{\text{MM}}$ is two millions, &c.

The Greeks had three ways of expressing numbers: 1. Every letter, according to its place in the alphabet, denoted a number, from α, one, to ω, twenty-four. 2. The alphabet was divided into eight units, α, one, β two, γ, three, &c.; into eight tens, ι ten, κ twenty, λ thirty, &c.; and eight hundreds, ρ one hundred, σ two hundred, τ three hundred, &c. 3. I stood for one, Π five, Δ ten, H a hundred, X a thousand, M ten thousand; and when the latter Π enclosed any of these, except I, it showed the enclosed letter to be five times its value; as; |Δ| fifty, |H| five hundred, |X| five thousand, |M| fifty thousand.

The French Characters used in the chamber of accounts, and by persons concerned in the management of the revenue, is, properly speaking, nothing else than the Roman numerals, in letters that are not majuscule; thus, instead of expressing fifty-six by LVI, they denote it by smaller characters, lvj.

III. Characters of Abbreviations, &c. in several of the arts, are symbols contrived for the more concise and immediate conveyance of the knowledge of things. For the

Characters used in Algebra. See Algebra, Introduction.

Of the Aspects.

☌ or S Conjunction	△ Trine
SS Semisextile	Bq Biquintile
* Sextile	Vc Quincunx
Q Quintile	☍ Opposition
□ Quartile	☊ Dragon's head
Td Tredecile	☋ Dragon's tail

Of Time.

A. M. *ante meridiem*, before the sun comes upon the meridian.

O. or N. noon.

P. M. *post meridiem*, when the sun is past the meridian.

Characters in Commerce.

D° *ditto*, the same	S or *s* shillings
N° *numero*, or number	*d* pence or deniers
F° *folio*, or page	℔ pound weight
C or ⊕ hundred weight, or 112 pounds	R° *recto* } *folio*
qts quarters	V° *vero* } *folio*
L. or *l.* pounds Sterling	Rx rixdollar
pr *per* or by, pr *ann.* by the year, pr *cent.*	Dt ducat
	P. S. postscript, &c.

Characters in Geometry and Trigonometry.

‖ the character of parallelism	⊻ equiangular or similar
△ triangle	≛ equilateral
□ square	∠ an angle
▯ ▭ rectangle	∟ right angle
⊙ circle	⊥ perpendicular

° denotes a degree; thus 45° implies 45 degrees.

′ denotes a minute; thus, 50′ is 50 minutes. ″, ‴, ⁗, denote seconds, thirds, and fourths: and the same characters are used when the progressions are by tens, as it is here by sixties.

Characters in Grammar, Rhetoric, Poetry, &c.

( ) parenthesis	D. D. doctor in divinity
[ ] crotchet	V. D. M. minister of the word of God
- hyphen	LL. D. doctor of laws
' apostrophe	J. V. D. doctor of civil and common law
` emphasis or accent	M. D. doctor in physic
˘ breve	A. M. master of arts
·· dialysis	A. B. bachelor of arts
‸ caret and circumflex	F. R. S. fellow of the royal society
† ‡ and * references	
§ section or division	
¶ paragraph	
" quotation	

For the other characters used in Grammar, see Comma, Colon, Semicolon.

Characters among the ancient Lawyers, and in ancient Inscriptions.

§ paragraph	C. Code
ff digests	C. C. consules
Scto. senatus consulto	T. titulus
E. extra	P. P. D. D. propria pecunia dedicavit
S. P. Q. R. senatus populusque Romanus	D. D. M. dono dedit monumentum.
P. P. pater patriæ	

Characters in Medicine and Pharmacy.

℞ recipe	M. manipulus, a handful
ā, āā or ana, of each alike	P. a pugil
℔ a pound, or a pint	P. Æ. equal quantities
℥ an ounce	S. A. according to art
ʒ a drachm	q. s. a sufficient quantity
℈ a scruple	q. pl. as much as you please
gr. grains	P. P. pulvis patrum, the Jesuits bark.
ß or *f. s* half of any thing	
cong. congius, a gallon	
coch. cochleare, a spoonful	

Characters upon Tomb-stones.

S. V. Siste viator, *i. e.* Stop traveller.

M. S. Memoriæ sacrum, *i. e.* Sacred to the memory.

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Characters.

D. M. Diis manibus.

J. H. S. Jesus.

X. P. a character found in the catacombs, about the meaning of which authors are not agreed.

CHARACTERS used in Music, and of Musical Notes with their proportions, are as follows.

character of a large	8	crotchet	$\frac{1}{4}$
a long	4	quaver	$\frac{1}{8}$
a breve	2	semiquaver	$\frac{1}{16}$
a semibreve	1	demisemiquaver	$\frac{1}{32}$
a minim	$\frac{1}{2}$		

※ character of a sharp note; this character, at the beginning of a line or space, denotes that all the notes in that line are to be taken a semitone higher than in the natural series; and the same affects all the octaves above and below, though not marked: but when prefixed to any particular note, it shows that note alone to be taken a semitone higher than it would be without such a character.

♭ or *b*, character of a flat note: this is the contrary to the other above; that is, a semitone lower.

♮ character of a natural note: when in a line or series of artificial notes, marked at the beginning ♭ or ※, the natural note happens to be required, it is denoted by this character.

𝄞 character of the treble cliff.

𝄡 character of the mean cliff.

𝄢 bass cliff.

$\frac{2}{4}$ or $\frac{4}{8}$, characters of common duple time, signifying the measure of two crotchets to be equal to two notes, of which four make a semibreve.

C ₵ Ↄ characters that distinguish the movements of common time, the first implying slow, the second quick, and the third very quick.

$\frac{3}{2}$, $\frac{3}{1}$, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{3}{16}$, characters of simple triple time, the measure of which is equal to three semibreves, or to three minims.

$\frac{6}{4}$, $\frac{6}{8}$, or $\frac{6}{16}$, characters of a mixed triple time where the measure is equal to six crotchets, or six quavers.

$\frac{9}{4}$, or $\frac{9}{8}$, or $\frac{9}{16}$, or $\frac{9}{1}$, or $\frac{9}{2}$, characters of compound triple time.

$\frac{12}{4}$, $\frac{12}{8}$, $\frac{12}{16}$, or $\frac{12}{1}$, or $\frac{12}{2}$, characters of that species of triple time called the measure of twelve times.

CHARACTER, in human life, that which is peculiar in the manners of any person, and distinguishes him from all others.

Good CHARACTER, is particularly applied to that conduct which is regulated by virtue and religion; in an inferior but very common sense, it is understood of mere honesty of dealing between man and man. The importance of a good character in the commerce of life seems to be universally acknowledged.—To those who are to make their own way either to wealth or honours, a good character is usually no less necessary than address and abilities. To transcribe the observation of an elegant moralist: though human nature is degenerate, and corrupts itself still more by its own inventions; yet it usually retains to the last an esteem for excellence. But even if we are arrived at such an extreme degree of depravity as to have lost our native reverence for virtue; yet a regard to our own interest and safety, which we seldom lose, will lead us to apply for aid, in all important transactions, to men whose integrity is unimpeached. When we choose an assistant, a partner, a servant, our first inquiry is concerning his character. When we have occasion for a counsellor or attorney, a physician or apothecary, whatever we may be ourselves, we always choose to trust our property and persons to men of the best character. When we fix on the tradesmen who are to supply us with necessaries, we are not determined by the sign of the lamb, or the wolf, or the fox, nor by a shop fitted up in the most elegant taste; but by the fairest reputation. Look into a daily newspaper, and you will see, from the highest to the lowest rank, how important the characters of the employed appear to the employers. After the advertisement has enumerated the qualities required in the person wanted, there constantly follows, that none need apply who cannot bring an undeniable character. Offer yourself as a candidate for a seat in parliament, be promoted to honour and emolument, or in any respect attract the attention of mankind upon yourself, and if you are vulnerable in your character, you will be deeply wounded. This is a general testimony in favour of honesty, which no writings and no practices can possibly refute.

Young men, therefore, whose characters are yet unfixed, and who consequently may render them just such as they wish, ought to pay great attention to the first steps which they take on entrance into life. They are usually careless and inattentive to this object. They pursue their own plans with ardour, and neglect the opinions which others entertain of them. By some thoughtless action or expression, they suffer a mark to be impressed upon them, which scarcely any subsequent merit can entirely erase. Every man will find some persons, who, though they are not professed enemies, yet view him with an envious or a jealous eye, and who will gladly revive any tale to which truth has given the slightest foundation.

In this turbulent and confused scene, where our words and actions are often misunderstood, and oftener misrepresented, it is indeed difficult even for innocence and integrity to avoid reproach, abuse, contempt, and hatred. These not only hurt our interest and impede our advancement in life, but sorely afflict the feelings of a delicate and tender mind. It is then the part of wisdom first to do every thing in our power to preserve an irreproachable character, and then to let our happiness depend chiefly on the approbation of our own consciences, and on the advancement of our interest in a world where liars shall not be believed, and where slanders shall receive countenance from none but him who, in Greek, is called by way of eminence, *Diabolus*, or the calumniator.

CHARACTER, in *Poetry*, particularly the epopee and drama, is the result of the manners or peculiarities by which each person is distinguished from others.

The poetical character, says M. Bossu, is not properly any particular virtue or quality, but a composition of several which are mixed together, in a different degree, according to the necessity of the fable and the unity of the action: there must be one, however, to reign over all the rest; and this must be found, in some degree, in every part. The first quality in Achilles, is wrath; in Ulysses, dissimulation; and in Æneas,

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Æneas, mildness; but as these characters cannot be alone, they must be accompanied with others to embellish them, as far as they are capable, either by hiding their defects, as in the anger of Achilles, which is palliated by extraordinary valour; or by making them centre in some solid virtue, as in Ulysses, whose dissimulation makes a part of his prudence; and in Æneas, whose mildness is employed in a submission to the will of the gods. In the making up of which union, it is to be observed, the poets have joined together such qualities as are by nature the most compatible; valour with anger, piety with mildness, and prudence with dissimulation. The fable required prudence in Ulysses, and piety in Æneas; in this, therefore, the poets were not left to their choice; but Homer might have made Achilles a coward without abating any thing from the justness of his fable; so that it was the necessity of adorning his character, that obliged him to make him valiant; the character, then, of a hero in the epic poem, is compounded of three sorts of qualities; the first essential to the fable; the second, embellishments of the first; and valour, which sustains the other two, makes the third.

Unity of character is as necessary as the unity of the fable. For this purpose a person should be the same from the beginning to the end; not that he is always to betray the same sentiments, or one passion; but that he should never speak nor act inconsistently with his fundamental character. For instance, the weak may sometimes sally into a warmth, and the breast of the passionate be calm, a change which often introduces in the drama a very affecting variety; but if the natural disposition of the former was to be represented as boisterous, and that of the latter mild and soft, they would both act out of character, and contradict their persons.

True characters are such as we truly and really see in men, or may exist without any contradiction to nature; no man questions but there have been men as generous and as good as Æneas, as passionate and as violent as Achilles, as prudent and wise as Ulysses, as impious and atheistical as Mezentius, and as amorous and passionate as Dido; all these characters, therefore, are true, and nothing but just imitations of nature. On the contrary, a character is false when an author so feigns it, that one can see nothing like it in the order of nature wherein he designs it shall stand; these characters should be wholly excluded from a poem, because, transgressing the bounds of probability and reason, they meet with no belief from the readers; they are fictions of the poet's brain, not imitations of nature; and yet all poetry consists of an imitation of nature.

Character is also used for certain visible qualities, which claim respect or reverence to those vested therewith.—The majesty of kings gives them a character which procures respect from the people. A bishop should sustain his character by learning and solid piety, rather than by worldly lustre, &c. The law of nations secures the character of an ambassador from all insults.

Character, among naturalists, is synonymous with the definition of the genera of animals, plants, &c.

CHARACTERISTIC, in general, is that which characterises a thing or person, i. e. constitutes its character, whereby it is distinguished. See Character.

Characteristic, is peculiarly used in grammar, for the principal letter of a word; which is preserved in most of its tenses and moods, its derivatives and compounds.

Characteristic of a Logarithm, is its index or exponent. See Logarithm.

Characteristic Triangle of a Curve, in the higher geometry, is a rectilinear right-angled triangle, whose hypothenuse makes a part of the curve, not sensibly different from a right line. It is so called, because curve lines are used to be distinguished hereby. See Curve.

CHARADE, the name of a new species of composition or literary amusement. It owes its name to the idler who invented it. Its subject must be a word of two syllables, each forming a distinct word; and these two syllables are to be concealed in an enigmatical description, first separately, and then together. The exercise of charades, if not greatly instructive, is at least innocent and amusing. At all events, as it has made its way into every fashionable circle, and has employed even Garrick, it will scarcely be deemed unworthy of attention. The silliness indeed of most that have appeared in the papers under this title, are not only destitute of all pleasantry in the stating, but are formed in general of words utterly unfit for the purpose. They have therefore been treated with the contempt they deserved. In trifles of this nature, inaccuracy is without excuse. The following examples therefore are at least free from this blemish.

I.

My *first*, however here abused,
Designs the sex alone;
In Cambria, such is custom's pow'r,
'Tis Jenkin, John, or Joan.
My *second* oft is loudly call'd,
When men prepare to fist it:
Its name delights the female ear;
Its force, may none resist it:
It binds the weak, it binds the strong,
The wealthy and the poor;
Still 'tis to joy a passport deem'd,
For sullied fame a cure.
It may ensure an age of bliss,
Yet mis'ries oft attend it;
To fingers, ears, and noses too,
Its various lords commend it.
My *whole* may chance to make one drink,
Though vended in a fish shop;
'Tis now the monarch of the seas,
And has been an archbishop. *Her-ring.*

II.

My *first*, when a Frenchman is learning English, serves him to swear by. My *second*, is either hay or corn. My *whole*, is the delight of the present age; and will be the admiration of posterity. *Gar-rick.*

III.

My *first*, is plowed for various reasons, and grain is frequently buried in it to little purpose. My *second*, is neither riches nor honours; yet the former would generally be given for it, and the latter is often tasteless without it. My *whole* applies equally to spring, summer, autumn, and winter: and both fish and flesh,

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praise and censure, mirth and melancholy, are the better for being in it. *Sea-son.*

IV.

My *first*, with the most rooted antipathy to a Frenchman, prides himself, whenever they meet, upon sticking close to his jacket. My *second*, has many virtues, nor is it its least that it gives name to my first. My *whole*, may I never catch! *Tar-tar.*

V.

My *first*, is one of England's prime boasts; it rejoices the ear of a horse, and anguishes the toe of a man. My *second*, when brick, is good; when stone, better; when *wooden*, best of all. My *whole*, is famous alike for rottenness and tin. *Corn-wall.*

VI.

My *first* is called bad or good,
May pleasure or offend ye;
My *second*, in a thirsty mood,
May very much befriend ye.
My *whole*, though styled a "cruel word,"
May yet appear a kind one;
It often may with joy be heard,
With tears may often blind one. *Fare-well.*

VII.

My *first* is equally friendly to the thief and the lover, the toper and the student. My *second* is light's opposite; yet they are frequently seen hand in hand; and their union, if judicious, gives much pleasure. My *whole*, is tempting to the touch, grateful to the sight, fatal to the taste. *Night-shade.*

CHARADRIUS, the PLOVER and DOTTEREL. See ORNITHOLOGY *Index*.

CHARAG, the tribute which Christians and Jews pay to the Grand Signior.

It consists of ten, twelve, or fifteen francs per annum, according to the estate of the party. Men begin to pay it at nine or at sixteen years old; women are dispensed with, as also priests, rabbins, and religious.

CHARAIMS, a sect of the Jews in Egypt. They live by themselves, and have a separate synagogue; and as the other Jews are remarkable for their eyes, so are those for their large noses, which run through all the families of this sect. These are the ancient Essenes. They strictly observe the five books of Moses, according to the letter, and receive no written traditions. It is said that the other Jews would join the *Charaims*; but those not having observed the exact rules of the law with regard to divorces, these think they live in adultery.

CHARANTIA. See MOMORDICA, BOTANY *Index*.

CHARBON, in the manege, that little black spot or mark which remains after a large spot in the cavity of the corner teeth of a horse; about the seventh or eighth year, when the cavity fills up, the tooth being smooth and equal, it is said to be rased.

CHARCAS, the southern division of Peru in South America, remarkable for the silver mines of Potosi.

CHARCOAL, a sort of artificial coal, or fuel, consisting of wood half burnt; chiefly used where a clear strong fire, without smoke, is required; the humidity of the wood being here mostly dissipated, and exhaled in the fire wherein it is prepared.

The microscope discovers a surprising number of pores in charcoal; they are disposed in order, and traverse it lengthwise; so that there is no piece of charcoal, how long soever, but may be easily blown through. If a piece be broken pretty short, it may be seen through with a microscope. In a range the 18th part of an inch long, Dr Hook reckoned 150 pores; whence he concludes, that in a charcoal of an inch diameter, there are not less than 5,724,000 pores. It is to this prodigious number of pores that the blackness of charcoal is owing; for the rays of light striking on the charcoal, are received and absorbed in its pores, instead of being reflected; whence the body must of necessity appear black, blackness in a body being no more than a want of reflection. Charcoal was anciently used to distinguish the bounds of estates and inheritances; as being incorruptible, when let very deep within ground. In effect, it preserves itself so long, that there are many pieces found entire in the ancient tombs of the northern nations. M. Dodart says, there is charcoal made of corn, probably as old as the days of Cæsar; he adds, that it has kept so well, that the wheat may be still distinguished from the rye; which he looks on as proof of its incorruptibility.

The operation of charring wood is performed in the following manner: The wood intended for this purpose is cut into proper lengths, and piled up in heaps near the place where the charcoal is intended to be made; when a sufficient quantity of wood is thus prepared, they begin constructing their stacks, for which there are three methods. The first is this: They level a proper spot of ground, of about 12 or 15 feet in diameter, near the piles of wood; in the centre of this area a large billet of wood, split across at one end and pointed at the other, is fixed with its pointed extremity in the earth, and two pieces of wood inserted through the clefts of the other end, forming four right angles; against these cross pieces four other billets of wood are placed, one end on the ground, and the other leaning against the angles. This being finished, a number of large and straight billets are laid on the ground to form a floor, each being as it were the radius of the circular area; on this floor a proper quantity of brush or small wood is strewed, in order to fill up the interstices, when the floor will be complete; and in order to keep the billets in the same order and position in which they were first arranged, pegs or stumps are driven into the ground in the circumference of the circle, about a foot distant from one another; upon this floor a stage is built with billets set upon one end, but something inclining towards the central billet; and on the tops of these another floor is laid in a horizontal direction, but of shorter billets, as the whole is, when finished, to form a cone.

The second method of building the stacks for making charcoal is performed in this manner: A long pole is erected in the centre of the area above described, and several small billets ranged round the pole on their ends; the interstices between these billets and the pole are filled with dry brushwood, then a floor is laid on that stage, in a reclining position, and on that a second floor, &c. in the same manner as described above; but in the lower floor there is a billet larger and longer than the rest, extending from the central

Charcoal.

central pole to some distance beyond the circumference of the circle.

The third method is this: A chimney, or aperture of a square form, is built with billets in the centre, from the bottom to the top; and round these, floors and inclined stages are erected, in the same manner as in the stacks above described, except that the base of this, instead of being circular like the others, is square; and the whole stack, when completed, forms a pyramid.

The stack of either form being thus finished, is coated over with turf, and the surface plastered with a mixture of earth and charcoal dust well tempered together.

The next operation is the setting the stack on fire. In order to this, if it be formed according to the first construction, the central billet in the upper stage is drawn out, and some pieces of very dry and combustible wood are placed in the void space, called, by workmen, the chimney, and fire set to these pieces. If the stack be built according to the second construction, the central pole is drawn out, together with the large horizontal billet above described: and the void space occupied by the latter being filled with pieces of very dry combustible wood, the fire is applied to it at the base of the stack. With regard to the third construction, the square aperture or chimney is filled with small pieces of very dry wood, and the fire applied to it at the top or apex of the pyramidal stack. When the stack is set on fire, either at the top or bottom, the greatest attention is necessary in the workman; for in the proper management of the fire the chief difficulty attending the art of making good charcoal consists. In order to this, care is taken, as soon as the flame begins to issue some height above the chimney, that the aperture be covered with a piece of turf, but not so close as to hinder the smoke from passing out: and whenever the smoke appears to issue very thick from any part of the pile, the aperture must be covered with a mixture of earth and charcoal dust. At the same time, as it is necessary that every part of the stack should be equally burnt, it will be requisite for the workman to open vents in one part and shut them in another. In this manner the fire must be kept up till the charcoal be sufficiently burnt, which will happen in about two days and a half if the wood be dry; but if green, the operation will not be finished in less than three days. When the charcoal is thought to be sufficiently burnt, which is easily known from the appearance of the smoke, and the flames no longer issuing with impetuosity through the vents, all the apertures are to be closed up very carefully with a mixture of earth and charcoal dust, which, by excluding all access of the external air, prevents the coals from being any further consumed, and the fire goes out of itself. In this condition it is suffered to remain, till the whole is sufficiently cooled; when the cover is removed, and the charcoal is taken away. If the whole process is skilfully managed, the coals will exactly retain the figure of the pieces of wood: some are said to have been so dexterous as to char an arrow without altering even the figure of the feather.

There are considerable differences in the coals of different vegetables, in regard to their habitude, to fire; the very light coals of linen, cotton, some fungi, &c. readily catch fire from a spark, and soon burn out; the more dense ones of woods and roots are set on fire more difficultly, and burn more slowly: the coals of the black berry-bearing alder, of the hazel, the willow, and the lime tree, are said to answer best for the making of gunpowder and other pyrotechnical compositions, perhaps from their being easily inflammable: for the reduction of metallic calces those of the heavier woods, as the oak and the beech, are preferable, these seeming to contain a larger proportion of the phlogistic principle, and that, perhaps, in a more fixed state; considered as common fuel, those of the heavy woods give the greatest heat, and require the most plentiful supply of air to keep them burning; those of the light woods preserve a glowing heat, without much draught of air, till the coals themselves are consumed; the bark commonly crackles and flies about in burning, which the coal of the wood itself very seldom does.

Mathematical instrument makers, engravers, &c. find charcoal of great use to polish their brass and copper plates after they have been rubbed clean with powdered pumice stone. Plates of horn are polishable in the same way, and a gloss may be afterwards given with tripoli.

The coals of different substances are also used as pigments; hence the bone-black, ivory-black, &c. of the shops. Most of the paints of this kind, besides their incorruptibility, have the advantage of a full colour, and work freely in all the forms in which powdery pigments are applied; provided they have been carefully prepared, by thoroughly burning the subject in a close vessel, and afterwards grinding the coal into a powder of due fineness. Pieces of charcoal are used also in their entire state for tracing the outlines of drawings, &c.; in which intention they have an excellence, that their mark is easily wiped out. For these purposes, either the finer pieces of common charcoal are picked out and cut to a proper shape; or the pencils are formed of wood, and afterwards burnt into charcoal in a proper vessel well covered. The artists commonly make choice of the smaller branches of the tree freed from the bark and pith; and the willow and vine are preferred to all others. This choice is confirmed by the experiments of Dr Lewis, who has found *Philosoph. Commerce of Arts.* that the wood of the trunks of trees produces charcoal of a harder nature than their small twigs or branches; and the hard woods, such as box and guaiacum, produced coals very sensibly harder than the softer woods. Willow he prefers to all others. The shells and stones of fruits yielded coals so hard that they would scarce mark on paper at all; while the coals of the kernels of fruits were quite soft and mellow. The several coals produced by the doctor's experiments were levigated into fine powder, mixed both with gum water and oil, and applied as paints both thin and thick, and diluted with different degrees of white. All of them, when laid on thick, appeared of a strong full black, nor could it be judged that one was of a finer colour than another; diluted with white, or when spread thin, they had all somewhat of a bluish cast.

Horns, and the bones both of fishes and land animals, gave coals rather glossier and deeper coloured than vegetables: and which, in general, were very hard, so as difficultly, or not at all, to stain paper. Here also the

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the hardness of the coal seemed to depend on that of the subject from whence it was prepared; for silk, woollen, leather, blood, and the fleshy parts of animals, yielded soft coals. Some of these differed from others very sensibly in colour; that of ivory is superior to all the rest, and indisputably the finest of all the charcoal blacks. The animal coals had much less of the bluish cast in them than the vegetable, many of them inclining rather to a brown. Charred pit coal, on the other hand, seemed to have this blueness in a greater degree. For the chemical properties of charcoal, see CHEMISTRY *Index*.

CHARDIN, SIR JOHN, a celebrated traveller, was born at Paris in 1643. His father, who was a jeweller, had him educated in the Protestant religion; after which he travelled into Persia and India. He traded in jewels, and died at London in 1713. The account he wrote of his travels is much esteemed.

CHARENTE, a department in the south-west of France. It is about 56 miles in length, and on an average 30 in breadth; and contained 327,000 inhabitants in 1815. It covers an extent of 2240 square miles. Angouleme is the chief town.

CHARENTE Inferior, a department in the south-west of France, lying between the department of Charente above described, and the bay of Biscay. It is 80 miles long, and from 20 to 40 in breadth; and contains 2800 square miles. The population in 1815 was 393,000. The coast of this department is marshy, and the climate rather unhealthy; but the soil is fruitful in corn and flax, and produces excellent wine. There are manufactures of woollens, cottons, pottery, paper, glass, and salt. Saintes is the chief town.

CHARES the Lydian, a celebrated statuary, was the disciple of Lysippus; and made the famous Colossus of the sun in the city of Rhodes. Flourished 288 years before Christ.

CHARGE, in *Gunnery*, the quantity of powder and ball wherewith a gun is loaded for execution.

The rules for charging large pieces in war are, That the piece be first cleaned or scoured within-side: that the proper quantity of powder be next driven in and rammed down; care, however, being taken, that the powder, in ramming, be not bruised, because that weakens its effect: that a little quantity of paper, hay, lint, or the like, be rammed over it: and that the ball or shot be intruded. If the ball be red hot, a tompion, or trencher of green wood, is to be driven in before it. The common allowance for a charge of powder of a piece of ordnance, is half the weight of the ball. In the British navy, the allowance for 32 pounders is but seven sixteenths of the weight of the bullet. But a late author is of opinion, that if the powder in all ship-cannon whatever was reduced to one-third weight of the ball, or even less, it would be of considerable advantage, not only by saving ammunition, but by keeping the guns cooler and quieter, and at the same time more effectually injuring the vessels of the enemy. With the present allowance of powder the guns are heated, and their tackle and furniture strained; and this only to render the bullets less efficacious: for a bullet which can but just pass through a piece of timber, and loses almost all its motion thereby, has a much better chance of rending and fracturing it, than if it passes through with a much greater velocity.

Robins's Proposal for increasing the strength of the Navy.

CHARGE, in *Heraldry*, is applied to the figures represented on the escutcheon, by which the bearers are distinguished from one another; and it is to be observed, that too many charges are not so honourable as fewer.

CHARGE of Lead, denotes a quantity of 36 pigs. See PIG.

To CHARGE, in the military language, is to attack the enemy either with horse or foot.

CHARGE, in *Law*, denotes the instructions given to the grand jury, with respect to the articles of their inquiry, by the judge who presides on the bench.

CHARGE, in *Law*, also signifies a thing done that bindeth him who doth it; and *Discharge* is the removal of that charge. Lands may be charged in various ways; as, by grant of rent out of it, by statutes, judgments, conditions, warranties, &c.

CHARGE of Horning, in *Scots Law*. See HORNING.

CHARGE to enter Heir, in *Scots Law*, a writing passing under the signet, obtained at the instance of a creditor, either against the heir of his debtor, for fixing upon him the debt as representing the debtor, which is called a general charge; or, against the debtor himself, or his heir, for the purpose of vesting him in the right of an heritable subject to which he has made up no title, in order the creditor may attach that subject for payment of his debt, in the same manner as if his debtor or his heir were legally vested in it by service or otherwise. This last kind is called a *special charge*.

CHARGE, or rather *Overcharge*, in *Painting*, is an exaggerated representation of any person; wherein the likeness is preserved, but at the same time ridiculed.

CHARGED, in *Heraldry*, a shield carrying some impress or figure, is said to be charged therewith; so also when one bearing, or charge, has another figure added upon it, it is properly said to be charged.

CHARGED, in electrical experiments, is when a phial, pane of glass, or other electric substance, properly coated on both sides, has a quantity of electricity communicated to it; in which case the one side is always electrified positively, and the other negatively.

CHARIOT, a half coach, having only a seat behind, with a stool before. See COACH.

The chariots of the ancients, chiefly used in war, were called by the several names of *bigæ*, *trigæ*, &c. according to the number of horses applied to draw them. Every chariot carried two men, who were probably the warrior and the charioteer; and we read of several men of note and valour employed in driving the chariot. When the warriors came to encounter in close fight, they alighted out of the chariot, and fought on foot; but when they were weary, which often happened by reason of their armour, they retired into their chariot, and thence annoyed their enemies with darts and missile weapons. These chariots were made so strong, that they lasted for several generations.

Besides this sort, we find frequent mention of the *currus falcati*, or those chariots armed with hooks or scythes, with which whole ranks of soldiers were cut off together, if they had not the art of avoiding the danger; these were not only used by the Persians, Syrians, Egyptians, &c. but we find them among the ancient

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cient Britons; and notwithstanding the imperfect state of some of the most necessary arts among that nation before the invasion of the Romans, it is certain that they had war chariots in great abundance. By the Greek and Roman historians, these chariots are described by the six following names: viz. Benna, Petoritum, Currus, or Carrus, Covinus, Essedum, and Rheda. The benna seems to have been a chariot designed rather for travelling than war. It contained two persons, who were called *combennones*, from their sitting together in the same machine. The petoritum seems to have been a larger kind of chariot than the benna; and is thought to have derived its name from the British word *pedwar*, signifying *four;* this kind of carriage having four wheels. The carrus or currus was the common cart or waggon. This kind of chariot was used by the ancient Britons, in time of peace, for the purposes of agriculture and merchandise, and, in time of war, for carrying their baggage, and wives and children, who commonly followed the armies of all the Celtic nations. The covinus was a war chariot, and a very terrible instrument of destruction; being armed with sharp scythes and hooks for cutting and tearing all who were so unhappy as to come within its reach. This kind of chariot was made very slight, and had few or no men in it besides the charioteer; being designed to drive with great force and rapidity, and to do execution chiefly with its hooks and scythes. The essedum and rheda were also war chariots, probably of a larger size, and stronger made than the covinus, designed for containing a charioteer for driving it, and one or two warriors for fighting. The far greatest number of the British war chariots seem to have been of this kind. These chariots, as already observed, were to be found in great numbers among the Britons; insomuch, that Cæsar relates, that Cassibelanus, after dismissing all his other forces, retained no fewer than 4000 of these war chariots about his person. The same author relates, that, by continual experience, they had at last arrived at such perfection in the management of their chariots, that "in the most steep and difficult places they could stop their horses upon full stretch, turn them which way they pleased, run along the pole, rest on their harness, and throw themselves back into their chariots, with incredible dexterity."

CHARIOTS, in the heathen mythology, were sometimes consecrated to the sun; and the Scripture observes, that Josiah burnt those which had been offered to the sun by the kings his predecessors. This superstitious custom was an imitation of the heathens, and principally of the Persians, who had horses and chariots consecrated in honour of the sun. Herodotus, Xenophon, and Quintus Curtius, speak of white chariots crowned, which were consecrated to the sun, among the Persians, which in their ceremonies were drawn by white horses consecrated to the same luminary.

Triumphal CHARIOT, was one of the principal ornaments of the Roman celebration of a victory.

The Roman triumphal chariot was generally made of ivory, round like a tower, or rather of a cylindrical figure; it was sometimes gilt at the top, and ornamented with crowns; and to represent a victory more naturally, they used to stain it with blood. It was usually drawn by four white horses; but oftentimes by lions, elephants, tygers, bears, leopards, dogs, &c.

CHARISIA, in the heathen theology, a wake, or night festival, instituted in honour of the Graces. It continued the whole night, most of which time was spent in dancing; after which, cakes made of yellow flour mixed with honey, and other sweetmeats, were distributed among the assistants.—Charisia is also sometimes used to signify the sweetmeats used on such occasions.

CHARISIUS, in the heathen theology, a surname given to Jupiter. The word is derived from χαρις, *gratia*, "grace" or "favour;" he being the god by whose influence men obtain the favour and affection of one another. On which account the Greeks used at their meals to make a libation of a cup to Jupiter Charisius.

CHARISTIA, a festival of the ancient Romans, celebrated in the month of February, wherein the relations by blood and marriage met, in order to preserve a good correspondence; and that if there happened to be any difference among them, it might be the more easily accommodated by the good humour and mirth of the entertainment. *Ovid. Fast.* i. 617.

CHARISTICARY, commendatory, or donatory, a person to whom is given the enjoyment of the revenues of a monastery, hospital, or benefice.

The Charisticaries among the Greeks, were a kind of donatories, or commendatories, who enjoyed all the revenues of hospitals and monasteries, without giving an account thereof to any person.—The original of this abuse is referred to the Iconoclastæ, particularly Constantine Copronymus, the avowed enemy of the monks, whose monasteries he gave away to strangers. In after times, the emperors and patriarchs gave many to people of quality, not by way of gift to reap any temporal advantage from them, but to repair, beautify, and patronise them. At length avarice crept in, and those in good condition were given away, especially such as were rich; and at last they were all given away, rich and poor, those of men and of women, and that to laymen and to married men.

CHARITY, among divines, one of the three grand theological virtues, consisting in the love of God and of our neighbour, or the habit and disposition of loving God with all our heart, and our neighbour as ourselves.

CHARITY is also used for the effect of moral virtue, which consists in supplying the necessities of others, whether with money, counsel, assistance, or the like.

As pecuniary relief is generally the most efficacious, and at the same time that from which we are most apt to excuse ourselves, this branch of the duty merits particular illustration; and a better cannot be offered than what is contained in the following extracts (if we may be permitted to make them) from the elegant *Moral System* of Archdeacon *Paley*.

Whether pity be an instinct or a habit, it is in fact a property of our nature, which God appointed; and the final cause for which it was appointed, is to afford to the miserable, in the compassion of their fellow-creatures, a remedy for those inequalities and distresses which God foresaw that many must be exposed to, under

Charity.

under every general rule for the distribution of property.

The Christian Scriptures are more copious and explicit upon this duty than almost any other. The description which Christ hath left us of the proceedings of the last day, establishes the obligation of bounty beyond controversy. "When the Son of Man shall come in his glory, and all the holy angels with him, then shall he sit upon the throne of his glory, and before him shall be gathered all nations; and he shall separate them one from another. Then shall the King say unto them on his right hand, Come ye blessed of my Father, inherit the kingdom prepared for you from the foundation of the world: For I was hungered, and ye gave me meat; I was thirsty, and ye gave me drink; I was a stranger, and ye took me in; naked, and ye clothed me; I was sick, and ye visited me; I was in prison, and ye came unto me. And inasmuch as ye have done it to one of the least of these my brethren, ye have done it unto me." It is not necessary to understand this passage as a literal account of what will actually pass on that day. Supposing it only a scenical description of the rules and principles by which the Supreme Arbiter of our destiny will regulate his decisions, it conveys the same lesson to us: it equally demonstrates of how great value and importance these duties in the sight of God are, and what stress will be laid upon them. The apostles also describe this virtue as propitiating the divine favour in an eminent degree. And these recommendations have produced their effect. It does not appear that, before the times of Christianity, an infirmary, hospital, or public charity of any kind, existed in the world; whereas most countries in Christendom have long abounded with these institutions. To which may be added, that a spirit of private liberality seems to flourish amidst the decay of many other virtues: not to mention the legal provision for the poor, which obtains in this country, and which was unknown and unthought of by the most polished nations of antiquity.

St Paul adds upon the subject an excellent direction; and which is practicable by all who have any thing to give. "Upon the first day of the week (or any other stated time) let every one of you lay by in store, as God hath prospered him." By which the apostle may be understood to recommend, what is the very thing wanting with most men, *the being charitable upon a plan;* that is, from a deliberate comparison of our fortunes with the reasonable expences and expectations of our families, to compute what we can spare, and to lay by so much for charitable purposes, in some mode or other. The mode will be a consideration afterwards.

The effects which Christianity produced upon some of its converts, was such as might be looked for from a divine religion coming with full force and miraculous evidence upon the consciences of mankind. It overwhelmed all worldly considerations in the expectation of a more important existence. "And the multitude of them that believed were of one heart and of one soul; neither said any of them that aught of the things which he possessed was his own; but they had all things in common.—Neither was there any among them that lacked; for as many as were possessors of lands or houses sold them, and brought the prices of the things that were sold, and laid them down at the apostles feet; and distribution was made unto every man according as he had need." Acts iv. 32.

Nevertheless, this community of goods, however it manifested the sincere zeal of the primitive Christians, is no precedent for our imitation. It was confined to the church at Jerusalem; continued not long there; was never enjoined upon any (Acts v. 4.); and, although it might suit with the particular circumstances of a small and select society, is altogether impracticable in a large and mixed community.

The conduct of the apostles upon the occasion deserves to be noticed. Their followers laid down their fortunes at their feet: but so far were they from taking advantage of this unlimited confidence to enrich themselves or establish their authority, that they soon after got rid of this business as inconsistent with the main object of their mission, and transferred the custody and management of the public fund to deacons elected to that office by the people at large (Acts vi.)

There are three kinds of charity, our author observes, which prefer a claim to attention.

1. The first, and apparently one of the best, is to give stated and considerable sums, by way of pension or annuity to individuals or families, with whose behaviour and distress we ourselves are acquainted. In speaking of considerable sums, it is meant only, that five pounds, or any other sum, given at once, or divided amongst five or fewer families, will do more good than the same sum distributed amongst a greater number in shillings or half crowns; and that, because it is more likely to be properly applied by the persons who receive it. A poor fellow who can find no better use for a shilling than to drink his benefactor's health, and purchase half an hour's recreation for himself, would hardly break into a guinea for any such purpose, or be so improvident as not to lay it by for an occasion of importance, for his rent, his clothing, fuel, or stock of winter's provision. It is a still greater recommendation of this kind of charity, that pensions and annuities, which are paid regularly, and can be expected at the time, are the only way by which we can prevent one part of a poor man's sufferings, the dread of want.

2. But as this kind of charity supposes that proper objects of such expensive benefactions fall within our private knowledge and observation, which does not happen to all, a second method of doing good, which is in every one's power who has the money to spare, is by subscription to public charities. Public charities admit of this argument in their favour, that your money goes farther towards attaining the end for which it is given, than it can do by any private and separate beneficence. A guinea, for example, contributed to an infirmary, becomes the means of providing one patient, at least, with a physician, surgeon, apothecary, with medicine, diet, lodging, and suitable attendance; which is not the tenth part of what the same assistance, if it could be procured at all, would cost to a sick person or family in any other situation.

3. The last, and, compared with the former, the lowest exertion of benevolence, is in the relief of beggars. Nevertheless, the indiscriminate rejection of all who implore our alms, in this way, is by no means approved.

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Charity. proved. Some may perish by such a conduct. Men are sometimes overtaken by distress, for which, all other relief would come too late. Besides which, resolutions of this kind compel us to offer such violence to our humanity, as may go near, in a little while, to suffocate the principle itself; which is a very serious consideration. A good man, if he do not surrender himself to his feelings without reserve, will at least lend an ear to importunities which come accompanied with outward attestations of distress; and after a patient hearing of the complaint, will direct himself by the circumstances and credibility of the account that he receives.

There are other species of charity well contrived to make the money expended *go far;* such as keeping down the price of fuel or provisions in case of a monopoly or temporary scarcity, by purchasing the articles at the best market, and retailing them at prime cost, or at a small loss; or the adding a bounty to a particular species of labour, when the price is accidentally depressed.

The proprietors of large estates have it in their power to facilitate the maintenance, and thereby encourage the establishment of families (which is one of the noblest purposes to which the rich and great can convert their endeavours), by building cottages, splitting farms, erecting manufactures, cultivating wastes, embanking the sea, draining marshes, and other expedients, which the situation of each estate points out. If the profits of these undertakings do not repay the expence, let the authors of them place the difference to the account of charity. It is true of almost all such projects, that the public is a gainer by them, whatever the owner be. And where the loss can be spared, this consideration is sufficient.

It is become a question of some importance, Under what circumstances works of charity ought to be done in private, and when they may be made public without detracting from the merit of the action? if indeed they ever may, the Author of our religion having delivered a rule upon this subject, which seems to enjoin universal secrecy. "When thou dost alms, let not thy left hand know what thy right hand doth; that thy alms may be in secret; and thy Father which seeth in secret, himself shall reward thee openly." (Matt. vi. 3, 4.). From the preamble to this prohibition it is plain, that our Saviour's sole design was to forbid *ostentation*, and all publishing of good works which proceeds from that motive. "Take heed that ye do not your alms before men, *to be seen of them;* otherwise ye have no reward of your Father which is in heaven; therefore, when thou doest thine alms, do not sound a trumpet before thee, as the hypocrites do, in the synagogues and in the streets, *that they may have glory of men.* Verily I say unto thee, they have their reward," v. 2. There are motives for the doing our alms in public besides those of ostentation; with which therefore our Saviour's rule has no concern: such as to testify our approbation of some particular species of charity, and to recommend it to others; to take off the prejudice which the want, or, which is the same thing, the suppression, of our name in the list of contributors, might excite against the charity or against ourselves. And so long as these motives are free from any mixture of vanity, they are in no danger of invading our Saviour's prohibition: they rather seem to comply with another direction which he has left us: "Let your light so shine before men, that they may see your good works, and glorify your Father which is in heaven." If it be necessary to propose a precise distinction upon the subject, there can be none better than the following: When our bounty is beyond our fortune or station, that is, when it is more than could be expected from us, our charity should be private, if privacy be practicable: when it is not more than might be expected, it may be public: for we cannot hope to influence others to the imitation of extraordinary generosity, and therefore want, in the former case, the only justifiable reason for making it public.

The pretences by which men excuse themselves from giving to the poor are various; as,

1. "That they have nothing to spare;" *i. e.* nothing, for which they have not some other use; nothing, which their plan of expence, together with the savings they have resolved to lay by, will not exhaust; never reflecting whether it be in their power, or that it is their duty, to retrench their expences, and contract their plan, "that they may have to give to them that need;" or rather that this ought to have been part of their plan originally.

2. "That they have families of their own, and that charity begins at home." A father is no doubt bound to adjust his economy with a view to the reasonable demands of his family upon his fortune; and until a sufficiency for these is acquired, or in due time probably will be acquired (for in human affairs probability is enough, he is justified in declining *expensive* liberality; for to take from those who want, in order to give to those who want, adds nothing to the stock of public happiness. Thus far, therefore, and no farther, the plea in question is an excuse for parsimony, and an answer to those who solicit our bounty.

3. "That charity does not consist in giving money, but in benevolence, philanthropy, love to all mankind, goodness of heart," &c. Hear St James. "If a brother or sister be naked, and destitute of daily food, and one of you say unto them, Depart in peace, be ye warmed and filled, notwithstanding *ye give them not those things which are needful for the body*, what doth it profit?" (James ii. 15, 16.).

4. "That giving to the poor is not mentioned in St Paul's description of charity, in the 13th chapter of the first epistle to the Corinthians." This is not a description of charity, but of good nature; and it is not necessary that every duty be mentioned in every place.

5. "That they pay the poor rates." They might as well allege that they pay their debts; for the poor have the same right to that portion of a man's property which the laws assign them, that the man himself has to the remainder.

6. "That they employ many poor persons;"—for their own sake, not the poor's—otherwise it is a good plea.

7. "That the poor do not suffer so much as we imagine; that education and habit have reconciled them to the evils of their condition, and make them easy under it." Habit can never reconcile human nature to the extremities of cold, hunger, and thirst, any more than it can reconcile the hand to the touch of

of a red-hot iron: besides, the question is not, how unhappy any one is, but how much more happy we can make him.

8. "That these people, give them what you will, will never thank you, or think of you for it." In the first place, this is not true: in the second place, it was not for the sake of their thanks that you relieved them.

9. "That we are so liable to be impossed upon." If a due inquiry be made, our motive and merit is the same; besides that the distress is generally real, whatever has been the cause of it.

10. "That they should apply to their parishes." That is not always practicable: to which we may add, that there are many requisites to a comfortable subsistence, which parish-relief does not always supply; and that there are some who would suffer almost as much from receiving parish-relief as by the want of it; and lastly, that there are many modes of charity, to which this answer does not relate at all.

11. "That giving money encourages idleness and vagrancy." This is true only of injudicious and indiscriminate generosity.

12. "That we have too many objects of charity at home to bestow any thing upon strangers; or that there are other charities which are more useful, or stand in greater need." The value of this excuse depends entirely upon the *fact*, whether we actually relieve those neighbouring objects, and contribute to those other charities.

Besides all these excuses, pride, or prudery, or delicacy, or the love of ease, keep one half of the world out of the way of observing what the other half suffer.

Charity Schools, are schools erected and maintained in various parishes by the voluntary contributions of the inhabitants, for teaching poor children to read, write, and other necessary parts of educations. See School.

Brothers of Charity, a sort of religious hospitallers, founded about the year 1297, since denominated *Billetins*. They took the third order of St Francis, and the scapulary, making the three usual vows, but without begging.

Brothers of Charity, also denotes an order of hospitallers, still subsisting in Romish countries, whose business is to attend the sick poor, and minister to them both spiritual and temporal succour.

They are all laymen, except a few priests, for administering the sacraments to the sick in their hospitals. The brothers of charity usually cultivate botany, pharmacy, surgery, and chemistry, which they practise with success.

They were first founded at Granada, by St John de Dieu; and a second establishment was made at Madrid in the year 1553; the order was confirmed by Gregory XIII. in 1572: Gregory XIV. forbade them to take holy orders; but by leave of Paul V. in 1609, a few of the brothers might be admitted to orders. In 1619 they were exempted from the jurisdiction of the bishop. Those of Spain are separated from the rest; and they, as well as the brothers of France, Germany, Poland, and Italy, have their distinct generals, who reside at Rome. They were first introduced into France by Mary of Medicis in 1601, and have since built a fine hospital in the fauxbourg of St Germain.

Charity of Hippolitus, a religious congregation founded about the end of the 16th century, by one Bernardin Alvarez, a Mexican, in honour of St Hippolitus the martyr, patron of the city of Mexico; and approved by Pope Gregory XIII.

Charity of our Lady, in church history, a religious order in France, which, though charity was the principal motive of their union, grew in length of time so disorderly and irregular, that their order dwindled, and at last became extinct.

There is still at Paris a religious order of women, called *nuns hospitallers of the charity of our lady*. The religious of this hospital are by vow obliged to administer to the necessities of the poor and sick, but those only women.

CHARLATAN, or Charletan, signifies an empiric or quack, who retails his medicines on a public stage, and draws people about him with his buffooneries, feats of activity, &c. The word, according to Calepine, comes from the Italian *ceretano*; of *Cæretum*, a town near Spoletto in Italy, where these impostors are said to have first risen. Menage derives it from *ciarlatano*, and that from *circulatorius* or *circulator*, a quack.

CHARLEMAGNE, or Charles I. king of France by succession, and emperor of the West by conquest in 800 (which laid the foundation of the dynasty of the western Franks, who ruled the empire 472 years till the time of Rodolphus Auspurgensis, the founder of the house of Austria). Charlemagne was as illustrious in the cabinet as in the field; and, though he could not write his name, was the patron of men of letters, the restorer of learning, and a wise legislator; he wanted only the virtue of humanity to render him the most accomplished of men; but when we read of his beheading 4500 Saxons, solely for their loyalty to their prince, in opposing his conquests, we cannot think he merits the extravagant encomiums betowed on him by some historians. He died in 814, in the 74th year of his age, and 47th of his reign.

France had nine sovereigns of this name, of whom Charles V. merited the title of *the wise* (crowned in 1364, died in 1380): and Charles VIII. signalized himself in the field by rapid victories in Italy; (crowned in 1483, died in 1498). The rest do not deserve particular mention in this place. See (*History of*) France.

CHARLEMONT, a town of France, in the department of Ardennes, containing 4100 inhabitants in 1815. It is about eighteen miles south of Namur. E. Long. 4. 40. N. Lat. 50. 10.

Charlemont is also the name of a town of Ireland, situated on the river Blackwater, in the county of Armagh, and province of Ulster, about six miles south-east of Dungannon. W. Long. 6. 50. N. Lat. 50. 16.

CHARLEROY, a strong town in the province of Namur in the kingdom of the Netherlands, situated on the river Sambre, about 19 miles west of Namur. Population 4500. E. Long. 46. 20. N. Lat. 50. 30.

CHARLES Martel, a renowned conqueror in the early annals of France. He deposed and restored

Childeric

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Charles. Childeric king of France; and had the entire government of the kingdom, first with the title of *mayor of the palace*, and afterwards as *duke of France;* but he would not accept the crown. He died regretted, in 741.

Charles le Gros, emperor of the west in 881, king of Italy and Suabia, memorable for his reverse of fortune; being dethroned at a diet held near Mentz, by the French, the Italians, and the Germans, in 887: after which he was obliged to subsist on the bounty of the archbishop of Mentz. He died in 888.

Charles V. (emperor and king of Spain) was son of Philip, archduke of Austria, and of Jane queen of Castile. He was born at Ghent, February 24. 1500, and succeeded to the crown of Spain in 1517. Two years afterwards he was chosen emperor at Francfort after the death of Maximilian his grandfather. He was a great warrior and politician: and his ambition was not satisfied with the many kingdoms and provinces he possessed; for he is supposed, with reason, to have aspired at universal empire. He is said to have fought 60 battles, in most of which he was victorious. He took the king of France (Francis I.) prisoner, and sold him his liberty on very hard terms; yet afterwards, when the people of Ghent revolted, he asked leave to pass through his dominions: and though the generous king thus had him in his power, and had an opportunity of revenging his ill treatment, yet he received and attended him with all pomp and magnificence. He sacked Rome, and took the pope prisoner; and the cruelties which his army exercised there are said to have exceeded those of the northern barbarians. Yet the pious emperor went into mourning on account of this conquest: forbade the ringing of bells; commanded processions to be made, and prayers to be offered up for the deliverance of the pope his prisoner; yet did not inflict the least punishment on those who treated the holy father and the holy see with such inhumanity. He is accused by some Romish writers of favouring the Lutheran principles, which he might easily have extirpated. But the truth is, he found his account in the divisions which that sect occasioned; and he for ever made his advantage of them, sometimes against the pope, sometimes against France, and at other times against the empire itself. He was a great traveller, and made 50 different journeys into Germany, Spain, Italy, Flanders, France, England, and Africa. Though he had been successful in many unjust enterprises, yet his last attempt on Metz, which he besieged with an army of 100,000 men, was very just, and very unsuccessful.

Vexed at the reverse of fortune which seemed to attend his latter days, and oppressed by sickness, which unfitted him any longer for holding the reins of government with steadiness, or to guide them with address, he resigned his dominions to his brother Ferdinand and his son Philip; and retreated to the monastery of St Justus near Placentia in Estremadura.

When Charles entered this retreat, he formed such a plan of life for himself as would have suited a private gentleman of moderate fortune. His table was neat, but plain; his domestics few; his intercourse with them familiar; all the cumbersome and ceremonious forms of attendance on his person were entirely abolished, as destructive of that social ease and tranquillity which he courted in order to soothe the remainder of his days. As the mildness of the climate, together with his deliverance from the burdens and cares of government, procured him at first a considerable remission from the acute pains of the gout, with which he had been long tormented, he enjoyed perhaps more complete satisfaction in this humble solitude than all his grandeur had ever yielded him. The ambitious thoughts and projects which had so long engrossed and disquieted him, were quite effaced from his mind. Far from taking any part in the political transactions of the princes of Europe, he restrained his curiosity even from an inquiry concerning them; and he seemed to view the busy scene which he had abandoned, with all the contempt and indifference arising from his thorough experience of its vanity, as well as from the pleasing reflection of having disentangled himself from its cares.

Other amusements, and other subjects, now occupied him. Sometimes he cultivated the plants in his garden with his own hand; sometimes he rode out to the neighbouring wood on a little horse, the only one that he kept, attended by a single servant on foot. When his infirmities confined him to his apartment, which often happened, and deprived him of these more active recreations, he either admitted a few gentlemen who resided near the monastery to visit him, and entertained them familiarly at his table; or he employed himself in studying mechanical principles, and in forming curious works of mechanism, of which he had always been remarkably fond, and to which his genius was peculiarly turned. With this view he had engaged Turriano, one of the most ingenious artists of that age, to accompany him in his retreat. He laboured together with him in framing models of the most useful machines, as well as in making experiments with regard to their respective powers; and it was not seldom that the ideas of the monarch assisted or perfected the inventions of the artist. He relieved his mind at intervals with slighter and more fantastic works of mechanism, in fashioning puppets, which, by the structure of internal springs, mimicked the gestures and actions of men, to the no small astonishment of the ignorant monks, who, beholding movements which they could not comprehend, sometimes distrusted their own senses, and sometimes suspected Charles and Turriano of being in compact with invisible powers. He was particularly curious with regard to the construction of clocks and watches; and having found, after repeated trials, that he could not bring any two of them to go exactly alike, he reflected, it is said, with a mixture of surprise as well as regret, on his own folly, in having bestowed so much time and labour in the more vain attempt of bringing mankind to a precise uniformity of sentiment concerning the intricate and mysterious doctrines of religion.

But in what manner soever Charles disposed of the rest of his time, he constantly reserved a considerable portion of it for religious exercises. He regularly attended divine service in the chapel of the monastery, every morning and evening; he took great pleasure in reading books of devotion, particularly the works of St Augustine and St Bernard; and conversed much with his confessor, and the prior of the monastery, on

Charles. on pious subjects. Thus did Charles pass the first year of his retreat in a manner not unbecoming a man perfectly disengaged from the affairs of this present life, and standing on the confines of a future world, either in innocent amusements which soothed his pains, and relieved a mind worn out with excessive application to business; or in devout occupations, which he deemed necessary in preparing for another state.

But, about six months before his death, the gout, after a longer intermission than usual, returned with a proportional increase of violence. His shattered constitution had not strength enough remaining to withstand such a shock. It enfeebled his mind as much as his body; and from this period we hardly discern any traces of that sound and masculine understanding which distinguished Charles among his cotemporaries. An illiberal and timid superstition depressed his spirit. He had no relish for amusements of any kind. He endeavoured to conform, in his manner of living, to all the rigour of monastic austerity. He desired no other society than that of monks, and was almost continually employed in chaunting with them the hymns of the missal. As an expiation for his sins, he gave himself the discipline in secret, with such severity that the whip of cords which he employed as the instrument of his punishment, was found, after his decease, tinged with his blood. Nor was he satisfied with these acts of mortification, which, however severe, were not unexampled. The timorous and distrustful solicitude which always accompanies superstition, still continued to disquiet him, and depreciating all that he had done, prompted him to aim at something extraordinary, at some new and singular act of piety that would display his zeal, and merit the favour of heaven. The act on which he fixed was as wild and uncommon as any that superstition ever suggested to a disordered fancy. He resolved to celebrate his own obsequies before his death. He ordered his tomb to be erected in the chapel of the monastery. His domestics marched thither in funeral procession, with black tapers in their hands. He himself followed in his shroud. He was laid in his coffin with much solemnity. The service for the dead was chaunted; and Charles joined in the prayers which were offered up for the rest of his soul, mingling his tears with those which his attendants shed, as if they had been celebrating a real funeral. The ceremony closed with sprinkling holy water on the coffin in the usual form; and, all the assistants retiring, the doors of the chapel were shut. Then Charles rose out of the coffin, and withdrew to his apartment, full of those awful sentiments which such a singular solemnity was calculated to inspire. But either the fatiguing length of the ceremony, or the impression which this image of death left on his mind, affected him so much, that next day he was seized with a fever. His feeble frame could not long resist its violence; and he expired on the 21st of September, after a life of 58 years 6 months and 21 days.

CHARLES I. } Kings of Britain. See BRITAIN,
CHARLES II. } No. 49.——254.

CHARLES XII. King of Sweden, was born in 1682. By his father's will, the administration was lodged in the hands of the queen dowager Eleonora, with five senators, till the young prince was 18; but he was declared major at 15, by the states convened at Stockholm. The beginning of his administration raised no favourable ideas of him, as he was thought both by Swedes and foreigners to be a person of mean capacity. But the difficulties that gathered round him, soon afforded him an opportunity to display his real character. Three powerful princes, Frederick king of Denmark, Augustus king of Poland and elector of Saxony, and Peter the Great, czar of Muscovy, presuming on his youth, conspired his ruin almost at the same instant. Their measures alarming the council, they were for diverting the storm by negotiations; but Charles, with a grave resolution that astonished them, said, "I am resolved never to enter upon an unjust war, nor to put an end to a just one but by the destruction of my enemies. My resolution is fixed: I will attack the first who shall declare against me; and when I have conquered him, I may hope to strike a terror into the rest." The old counsellors received his orders with admiration; and were still more surprised when they saw him on a sudden renounce all the enjoyments of a court, reduce his table to the utmost frugality, dress like a common soldier, and, full of the ideas of Alexander and Cæsar, propose these two conquerors for his models in every thing but their vices. The king of Denmark began by ravaging the territories of the duke of Holstein. Upon this Charles carried the war into the heart of Denmark, and made such a progress that the king of Denmark thought it best to accept of peace, which was concluded in 1700. He next resolved to advance against the king of Poland, who had blocked up Riga. He had no sooner given orders for his troops to go into winter quarters, than he received advice that Narva, where Count Horne was governor, was besieged by an army of 100,000 Muscovites. This made him alter his measures, and move towards the czar; and at Narva he gained a surprising victory, which cost him not above 2000 men killed and wounded. The Muscovites were forced to retire from the provinces they had invaded. He pursued his conquests, till he penetrated as far as where the diet of Poland was sitting; when he made them declare the throne of Poland vacant, and elect Stanislaus their king: then making himself master of Saxony, he obliged Augustus himself to renounce the crown of Poland, and acknowledge Stanislaus by a letter of congratulation on his accession. All Europe was surprised with the expeditious finishing of this great negotiation, but more at the disinterestedness of the king of Sweden, who satisfied himself with the bare reputation of this victory, without demanding an inch of ground for enlarging his dominions. After thus reducing the king of Denmark to peace, placing a new king on the throne of Poland, having humbled the emperor of Germany, and protected the Lutheran religion, Charles prepared to penetrate into Muscovy, in order to dethrone the czar. He quickly obliged the Muscovites to abandon Poland, pursued them into their own country, and won several battles over them. The czar, disposed to peace, ventured to make some proposals; Charles only answered, "I will treat with the czar at Moscow." When this haughty answer was brought to Peter, he said, "My brother Charles still affects to act the Alexander, but I flatter myself

Charles.

self he will not in me find a Darius." The event justified him: for the Muscovites, already beaten into discipline, and under a prince of such talents as Peter, entirely destroyed the Swedish army at the memorable battle of Pultowa, July 8. 1709; on which decisive day, Charles lost the fruits of nine years labour, and of almost 100 battles! The king, with a small troop, pursued by the Muscovites, passed the Boristhenes to Oczakow in the Turkish territories: and from thence, through desert countries, arrived at Bender; where the sultan, when informed of his arrival, sent orders for accommodating him in the best manner, and appointed him a guard. Near Bender Charles built a house, and intrenched himself; and had with him 1800 men, who were all clothed and fed, with their horses, at the expence of the grand signior. Here he formed a design of turning the Ottoman arms upon his enemies; and is said to have had a promise from the vizier of being sent into Muscovy with 200,000 men. While he remained here, he insensibly acquired a taste for books; he read the tragedies of Corneille and Racine, with the works of Despreaux, whose satires he relished, but did not much admire his other works. When he read that passage in which the author represents Alexander as a fool and a madman, he tore out the leaf. He would sometimes play at chess: but when he recovered of his wounds, he renewed his fatigues in exercising his men: he tired three horses a-day; and those who courted his favour were all day in their boots. To dispose the Ottoman Porte to this war, he detached about 800 Poles and Cossacks of his retinue, with orders to pass the Niester, that runs by Bender, and to observe what passed on the frontiers of Poland. The Muscovite troops, dispersed in those quarters, fell immediately upon this little company, and pursued them even to the territories of the grand signior. This was what the king expected. His ministers at the Porte excited the Turks to vengeance; but the czar's money removed all difficulties, and Charles found himself in a manner prisoner among the Tartars. He imagined the sultan was ignorant of the intrigues of his grand vizier. Poniatowsky undertook to make his complaints to the grand signior. The sultan, in answer, some days after, sent Charles five Arabian horses, one of which was covered with a saddle and housing of great richness; with an obliging letter, but conceived in such general terms, as gave reason to suspect that the minister had done nothing without the sultan's consent: Charles therefore refused them. Poniatowsky had the courage to form a design of deposing the grand vizier, who accordingly was deprived of his dignity and wealth, and banished. The seal of the empire was given to Numan Cuproughly; who persuaded his master, that the law forbade him to invade the czar, who had done him no injury; but to succour the king of Sweden as an unfortunate prince in his dominions. He sent his majesty 800 purses, every one of which amounted to 500 crowns, and advised him to return peaceably to his own dominions. Charles rejected this advice, threatening to hang up the bashaws, and shave the beards of any janizaries who brought him such messages, and sent word that he should depend upon the grand signior's promise, and hoped to re-enter Poland as a conqueror with an army of Turks. After various intrigues at the Porte, an order was sent to attack this *head of iron*, as he was called, and to take him either alive or dead. He stood a siege in his house, with 40 domestics, against the Turkish army; killed no less than 20 janizaries with his own hand; and performed prodigies of valour on a very unnecessary and unwarrantable occasion. But the house being set on fire, and himself wounded, he was at last taken prisoner, and sent to Adrianople, where the grand signior gave him audience, and promised to make good all the damages he had sustained. At last, after a stay of above five years, he left Turkey; and, having disguised himself, traversed Wallachia, Transylvania, Hungary, and Germany, attended only by one person; and in sixteen days riding, during which time he never went to bed, came to Stralsund at midnight, November 21. 1714. His boots were cut from his swollen legs, and he was put to bed; where, when he had slept some hours, the first thing he did was to review his troops, and examine the state of the fortifications. He sent out orders that very day to renew the war with more vigour than ever. But affairs were now much changed: Augustus had recovered the throne of Poland; Sweden had lost many of its provinces, and was without money, trade, credit, or troops. The kings of Denmark and Prussia seized the island of Rugen; and besieged him in Stralsund, which surrendered; but Charles escaped to Carlscroon. When his country was threatened with invasion by so many princes, he, to the surprise of all Europe, marched into Norway with 20,000 men. A very few Danes might have stopped the Swedish army; but such a quick invasion they could not foresee. Europe was yet more at a loss to find the czar so quiet, and not making a descent upon Sweden, as he had before agreed with his allies. This inaction was the consequence of one of the greatest designs, and at the same time the most difficult of any, that were ever formed by the imagination of man. In short, a scheme was set on foot for a reconciliation with the czar; for replacing Stanislaus on the throne of Poland; and setting James II.'s son upon that of England, besides restoring the duke of Holstein to his dominions. Charles was pleased with these grand ideas, though without building much upon them, and gave his minister leave to act at large. In the mean time, Charles was going to make a second attempt upon Norway in 1718; and he flattered himself with being master of that kingdom in six months; but while he was examining the works at Frederickshall, a place of great strength and importance, which is reckoned to be the key of that kingdom, he was killed by a shot from the enemy, as has been generally believed, though it has been also reported, that he fell by the treachery of one of his own officers, who had been bribed for that purpose.

This prince experienced the extremes of prosperity and of adversity, without being softened by the one or disturbed for a moment at the other; but was a man rather extraordinary than great, and fitter to be admired than imitated. He was honoured by the Turks for his rigid abstinence from wine, and his regularity in attending public devotion.

As to his person, he was tall and of a noble mien, had a fine open forehead, large blue eyes, flaxen hair, fair

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Charles ‖ Charles's Fort.

fair complexion, a handsome nose, but little beard, and a laugh not agreeable. His manners were harsh and austere, not to say savage: and as to religion, he was indifferent towards all, though exteriorly a Lutheran, and a strong believer in predestination. A few anecdotes will illustrate his character. No dangers, however great, made the least impression upon him. When a horse or two were killed under him at the battle of Narva, in 1700, he leaped nimbly upon fresh ones, saying, "These people find me exercise." One day, when he was dictating letters to a secretary, a bomb fell through the roof into the next room of the house where they were sitting. The secretary, terrified lest the house should come down upon them, let his pen drop out of his hand: "What is the matter?" says the king calmly. The secretary could only reply, "Ah, Sir, the bomb." "The bomb! (says the king) what has the bomb to do with what I am dictating to you! Go on."

He preserved more humanity than is usually found among conquerors. Once, in the middle of an action, finding a young Swedish officer wounded and unable to march, he obliged the officer to take his horse, and continued to command his infantry on foot. The Princess Lubomirski, who was very much in the interest and good graces of Augustus, falling by accident into the hands of one of his officers, he ordered her to be set at liberty: saying, "That he did not make war with women." One day, near Leipsic, a peasant threw himself at his feet, with a complaint against a grenadier, that he had robbed him of certain eatables, provided for himself and his family. "Is it true (said Charles sternly), that you have robbed this man?" The soldier replied, "Sir, I have not done near so much harm to this man as your majesty has done to his master; for you have taken from Augustus a kingdom, whereas I have only taken from this poor scoundrel a dinner." Charles made the peasant amends, and pardoned the soldier for his firmness: "However, my friend (says he to him), you will do well to recollect, that if I took a kingdom from Augustus, I did not take it for myself."

Though Charles lived hardly himself, a soldier did not fear to remonstrate to him against some bread, which was very black and mouldy, and which yet was the only provision the troops had. Charles called for a piece of it, and calmly ate it up; saying, "that it was indeed not good, but that it might be eaten."—From the danger he was in in Poland, when he beat the Saxon troops in 1702, a comedy was exhibited at Marienburg, where the combat was represented to the disadvantage of the Swedes. "Oh, (says Charles, hearing of it) I am far from envying them this pleasure. Let them beat me in the theatres as long as they will, provided I do but beat them in the field." He wrote some observations on war, and on his own campaigns from 1700 to 1709: but the MS. was lost at the unfortunate battle of Pultowa.

CHARLES'S CAPE, a promontory of Virginia, in North America, forming the northern headland of the strait that enters the bay of Chesapeak.

CHARLES's Fort, a fortress in the county of Cork, and province of Munster in Ireland, situated at the mouth of Kinsale harbour. W. Long. 8. 20. N. Lat. 51. 21.

Charleston.

CHARLESTON, the metropolis of South Carolina, is the most considerable town in the state; situated in the district of the same name, and on the tongue of land formed by the confluent streams of Ashley and Cooper, which are short rivers, but large and navigable. These waters unite immediately below the city, and form a spacious and convenient harbour; which communicates with the ocean just below Sullivan's island, which it leaves on the north, seven miles south-east of Charleston. In these rivers the tide rises, in common, about 6½ feet; but uniformly rises 10 or 12 inches more during a night tide. The fact is certain; the cause unknown. The continual agitation which the tides occasion in the waters which almost surround Charleston, the refreshing sea-breezes which are regularly felt, and the smoke arising from so many chimneys, render this city more healthy than any part of the low country in the southern states. On this account it is the resort of great numbers of gentlemen, invalids from the West India islands, and of the rich planters from the country, who come here to spend the sickly months, as they are called, in quest of health and of the social enjoyments which the city affords. And in no part of America are the social blessings enjoyed more rationally and liberally than here. Unaffected hospitality, affability, ease of manners and address, and a disposition to make their guests welcome, easy, and pleased with themselves, are characteristics of the respectable people of Charleston. In speaking of the capital, it ought to be observed, for the honour of the people of Carolina in general, that when in common with the other colonies, in the contest with Britain, they resolved against the use of certain luxuries, and even necessaries of life; those articles, which improve the mind, enlarge the understanding, and correct the taste, were excepted; the importation of books was permitted as formerly.

The land on which the town is built is flat and low, and the water brackish and unwholesome. The streets are pretty regularly cut, and open beautiful prospects, and have subterranean drains to carry off filth and keep the city clean and healthy; but are too narrow for so large a place and so warm a climate. Their general breadth is from 35 to 66 feet. The houses which have been lately built, are brick, with tiled roofs. The buildings in general are elegant, and most of them are neat, airy, and well furnished. The public buildings are, an exchange, a state-house, an armoury, a poor-house, and an orphan's house. Here are several respectable academies. Part of the old barracks has been handsomely fitted up, and converted into a college, and there are a number of students; but it can only be called as yet a respectable academy. Here are two banks, a branch of the national bank, and the South Carolina bank, established in 1792. The houses for public worship are two Episcopal churches, two for Independents, three for Scotch Presbyterians, one for Baptists, one for German Lutherans, three for Methodists, one for French Protestants, a meeting-house for Quakers, a Roman Catholic chapel, and a Jewish synagogue.

Little attention is paid to the public markets; a great proportion of the more wealthy inhabitants having plantations from which they receive supplies of almost every article of living. The country abounds with

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with poultry and wild ducks. Their beef, mutton, and veal, are not generally of the best kind; and few fish are found in the market.

In 1787, it was computed that there were 1600 houses in this city, and 15,000 inhabitants, including 5400 slaves; and what evinces the healthiness of the place, upwards of 200 of the white inhabitants were above 60 years of age. In 1817, the population was 22,944, of which 11,229 were white inhabitants, and 11,715 slaves. The city has often suffered from fires. It has also often been visited by the yellow fever. This disease carried off 150 persons in each of the years 1792 and 1794, and in 1817 1249 persons fell victims to it.

Charleston was incorporated in 1783, and divided into three wards, which choose as many wardens, from among whom the citizens elect an intendant of the city. The intendant and wardens form the city-council, who have power to make and enforce by-laws for the regulation of the city. There are a considerable number of charitable institutions in the town. There is besides a literary and philosophical society, and an agricultural society. Three daily and two weekly newspapers are published in the town. Nearly the whole trade of the state centres in this town, which had 35,857 tons of shipping belonging to it in 1815.

Charles's Wain, in *Astronomy*, seven stars in the constellation called *Ursa Major*, or the Great Bear.

CHARLETON, an island at the bottom of Hudson's bay, in North America, subject to Great Britain. W. Long. 80. 0. N. Lat. 53. 30.

Charleton, *Walter*, a learned English physician, born in 1619, was physician in ordinary to Charles I. and Charles II. one of the first members of the royal society, and president of the college of physicians. He wrote on various subjects; but at last his narrow circumstances obliged him to retire to the island of Jersey, where he died in 1707.

CHARLOCK, the English name of the Raphanus. It is a very troublesome weed among corn, being more frequent than almost any other. There are two principal kinds of it: the one with a yellow flower, the other with a white. Some fields are particularly subject to be overrun with it. especially those which have been manured with cow-dung alone, that being a manure very favourable to the growth of it. The farmers in some places are so sensible of this, that they always mix horse-dung with their cow-dung, when they use it for arable land. When barley, as is often the case, is infested with this weed to such a degree as to endanger the crop, it is a very good method to mow down the charlock in May, when it is in flower, cutting it so low as just to take off the tops of the leaves of barley with it: by this means the barley will get up above the weed; and people have got four quarters of grain from an acre of such land as would have scarce yielded any thing without this expedient. Where any land is particularly subject to this weed, the best method is to sow it with grass seed, and make a pasture of it; for then the plant will not be troublesome, it never growing where there is a coat of grass upon the ground.

Queen CHARLOTTE's *Island*, an island in the South sea, first discovered by Captain Wallis in the Dolphin, in 1767, who took possession of it in the name of King George III. Here is good water, and

plenty of cocoa nuts, palm nuts, and scurvy grass. The inhabitants are of a middle stature and dark complexion, with long hair hanging over their shoulders; the men are well made, and the women handsome; their clothing is a kind of coarse cloth, or matting, which they fasten about their middle.

Queen Charlotte's Islands, a cluster of South sea islands, discovered in 1767 by Captain Carteret. He counted seven, and there were supposed to be many more. The inhabitants of these islands are described as extremely nimble and vigorous, and almost as well qualified to live in the water as upon land: they are very warlike; and, on a quarrel with some of Captain Carteret's people, they attacked them with great resolution; mortally wounded the master and three of the sailors; were not at all intimidated by the fire arms; and at last, notwithstanding the aversion of Captain Carteret to shed blood, he was obliged to secure the watering places by firing grape shot into the woods, which destroyed many of the inhabitants. These islands lie in S. Lat. 11. E. Long. 164. They are supposed to be the Santa Cruz of Mandana, who died there in 1595.

CHARM, a term derived from the Latin *carmen*, "a verse;" and used to denote a magic power, or spell, by which, with the assistance of the devil, sorcerers and witches were supposed to do wonderful things, far surpassing the power of nature.

CHARNEL, or Charnel-house, a kind of portico, or gallery, usually in or near a churchyard, over which were anciently laid the bones of the dead, after the flesh was wholly consumed. Charnel-houses are now usually adjoining to the church.

CHARON, in fabulous history, the son of Erebus and Nox, whose office was to ferry the souls of the deceased over the waters of Acheron, for which each soul was to pay a piece of money. For this reason the Pagans had a custom of putting a piece of money into the mouth of the dead, in order that they might have something to pay Charon for their passage.

CHARONDAS, a celebrated legislator of the Thurians, and a native of Catanea, in Sicily, flourished 446 before Christ. He forbade any person's appearing armed in the public assemblies of the nation; but one day going thither in haste, without thinking of his sword, he was no sooner made to observe his mistake than he ran it through his body.

CHAROST, a town of France, in Berry, with the title of a duchy. It is seated on the river Arnon. E. Long. 2. 15. N. Lat. 46. 56.

CHAROUX, a town of France, in the Bourbonnois, seated on an eminence, near the river Sioulle. It has two parishes, which are in different dioceses. E. Long. 3. 15. N. Lat. 46. 10.

CHARPENTIER, Francis, dean of the French academy, was born in 1620. His early capacity inclined his friends to educate him at the bar: but he was much more delighted with the study of languages and antiquity than of the law; and preferred repose to tumult. M. Colbert made use of him in establishing his new academy of medals and inscriptions; and no person of that learned society contributed more than himself toward that noble series of medals which were struck on the considerable events that distinguished the reign of Louis XIV. He published several

works,

works, which were all well received; and died in 1702.

CHARR. See SALMO, ICHTHYOLOGY *Index*.

CHARRON, PETER, the author of a book entitled *Of Wisdom*, which gained him great reputation, was born at Paris in the year 1541. After being advocate in the parliament of Paris for five or six years, he applied himself to divinity; and became so great a preacher, that the bishops of several dioceses offered him the highest dignities in their gift. He died at Paris, suddenly in the street, November 16. 1603.

CHART, or SEA CHART, an hydrographical map, or a projection of some part of the earth's superficies *in plano*, for the use of navigators.

Charts differ very considerably from geographical or land maps, which are of no use in navigation. Nor are sea charts all of the same kind, some being what we call plane charts, others Mercator charts, and others globular charts.

Plane CHART, is a representation of some part of the superficies of the terraqueous globe, in which the meridians are supposed parallel to each other, the parallels of latitude at equal distances, and consequently the degrees of latitude and longitude everywhere equal to each other. See *PLANE Chart*.

Mercator's CHART, is that where the meridians are straight lines, parallel to each other, and equidistant; the parallels are also straight lines, and parallel to each other; but the distance between them increases from the equinoctial towards either pole, in the ratio of the secant of the latitude to the radius. See NAVIGATION.

Globular CHART, a meridional projection, wherein the distance of the eye from the plane of the meridian, upon which the projection is made, is supposed to be equal to the sine of the angle 45°. This projection comes the nearest of all to the nature of the globe, because the meridians therein are placed at equal distances; the parallels also are nearly equidistant, and consequently the several parts of the earth have their proper proportion of magnitude, distance, and situation, nearly the same as on the globe itself. See *GLOBULAR Projection*.

Hydrographic CHARTS, sheets of large paper, whereon several parts of the land and sea are described, with their respective coasts, harbours, sounds, flats, rocks, shelves, sands, &c. together with the longitude and latitude of each place, and the points of the compass. See *MERCATOR's Chart*.

Selenographic CHARTS, particular descriptions of the spots, appearances, and maculæ of the moon. See ASTRONOMY *Index*.

Topographic CHARTS, draughts of some small parts of the earth only, or of some particular place, without regard to its relative situation, as London, York, &c.

CHARTA, or CARTA, primarily signifies a sort of paper made of the plant *papyrus* or *biblus*. See PAPER and CHARTER.

CHARTA Emporetica, in *Pharmacy*, &c. a kind of paper made very soft and porous, used to filter withal. See FILTRATION, &c.

CHARTA is also used in our ancient customs for a charter, or deed in writing. See CHARTER.

Magna CHARTA, the great charter of the liberties of Britain, and the basis of our laws and privileges.

This charter may be said to derive its origin from King Edward the Confessor, who granted several privileges to the church and state by charter; these liberties and privileges were also granted and confirmed by King Henry I. by a celebrated great charter now lost; but which was confirmed or re-enacted by King Henry II. and King John. Henry III. the successor of this last prince, after having caused 12 men make inquiry into the liberties of England in the reign of Henry I. granted a new charter; which was the same as the present magna charta. This he several times confirmed, and as often broke; till, in the 37th year of his reign, he went to Westminster Hall, and there, in presence of the nobility and bishops, who held lighted candles in their hands, magna charta was read, the king all the time holding his hand to his breast, and at last solemnly swearing faithfully and inviolably to observe all the things therein contained, &c. Then the bishops extinguishing the candles, and throwing them on the ground, they all cried out, "Thus let him be extinguished, and stink in hell, who violates this charter." It is observed that, notwithstanding the solemnity of this confirmation, King Henry, the very next year, again invaded the rights of his people, till the barons entered into a war against him; when, after various success, he confirmed this charter, and the charter of the forest, in the 52d year of his reign.

This charter confirmed many liberties of the church, and redressed many grievances incident to feodal tenures, of no small moment at the time; though now, unless considered attentively and with this retrospect, they seem but of trifling concern. But, besides these feodal provisions, care was also taken therein to protect the subject against other oppressions, then frequently arising from unreasonable amercement, from illegal distresses or other process for debts or services due to the crown, and from the tyrannical abuse of the prerogative of purveyance and pre-emption. It fixed the forfeiture of lands for felony in the same manner as it still remains: prohibited for the future the grants of exclusive fisheries; and the erection of new bridges so as to oppress the neighbourhood. With respect to private rights, it established the testamentary power of the subject over part of his personal estate, the rest being distributed among his wife and children; it laid down the law of dower, as it hath continued ever since; and prohibited the appeals of women, unless after the death of their husbands. In matters of public police and national concern, it enjoined an uniformity of weights and measures; gave new encouragements to commerce, by the protection of merchant strangers; and forbade the alienation of lands in mortmain. With regard to the administration of justice, besides prohibiting all denials or delays of it, it fixed the court of common pleas at Westminster, that the suitors might no longer be harassed with following the king's person in all his progresses; and at the same time brought the trial of issues home to the very doors of the freeholders, by directing assizes to be taken in the proper counties, and establishing annual circuits; it also corrected some abuses then incident to the trials by wager of law and of battle; directed the regular awarding

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ing of inquests for life or member; prohibited the king's inferior ministers from holding pleas of the crown, or trying any criminal charge, whereby many forfeitures might otherwise have unjustly accrued to the exchequer; and regulated the time and place of holding the inferior tribunals of justice, the county-court, sheriff's torn and court-leet. It confirmed and established the liberties of the city of London, and all other cities, boroughs, towns, and ports of the kingdom. And, lastly, (which alone could have merited the title that it bears, of the *great charter*), it protected every individual of the nation in the free enjoyment of his life, his liberty, and his property, unless declared to be forfeited by the judgment of his peers, or the law of the land.

This excellent charter, so equitable and beneficial to the subject, is the most ancient written law in the kingdom. By the 25th Edward I. it is ordained, that it shall be taken as the common law; and by the 43d Edward III. all statutes made against it are declared to be void.

CHARTER, in *Law*, a written instrument, or evidence of things acted between one person and another. The word charter comes from the Latin *charta*. anciently used for a public and authentic act, a donation contract, or the like, from the Greek χαρτης "thick paper" or "pasteboard," whereon public acts were wont to be written. Britton divides charters into those of the king, and those of private persons. 1. Charters of the king, are those whereby the king passeth any grant to any person or body politic, as a *charter of exemption*, of privilege, &c.; *charter of pardon*, whereby a man is forgiven a felony, or other offence committed against the king's crown and dignity; *charter of the forest*, wherein the laws of the forest are comprised, such as the charter of Canutus, &c. 2. Charters of private persons, are deeds and instruments for the conveyance of lands, &c. And the purchaser of lands shall have all the charters, deeds, and evidences, as incident to the same, and for the maintenance of his title.

Charter-Governments in America. See Colony.

Charter-Land, such land as a person holds by charter; that is, by evidence in writing; otherwise called *freehold*.

CHARTERPARTY, in *Commerce*, denotes the instrument of freightage, or articles of agreement for the hire of a vessel. See Freight, &c.

The charterparty is to be in writing; and to be signed both by the proprietor or master of the ship, and the merchant who freights it. It is to contain the name and burden of the vessel; the names of the master and the freighter; the price or rate of freight; and the time of loading and unloading; and the other conditions agreed on. It is properly a deed, or policy, whereby the master or proprietor of the vessel engages to furnish immediately a tight sound vessel, well equipped, caulked, and stopped, provided with anchors, sails, cordage, and all other furniture to make the voyage required, as equipage, hands, victuals, and other munitions; in consideration of a certain sum to be paid by the merchant for the freight. Lastly, The ship with all its furniture, and the cargo, are respectively subjected to the conditions of the *charterparty*. The *charterparty* differs from a *bill of lading*, in that the first is for the entire freight, or lading, and that both for going and returning; whereas the latter is only for a part of the freight, or at most only for the voyage one way.

Boyer says, the word is derived from hence, that *per medium charta incidebatur, et sic fiebat charta partita:* because, in the time when notaries were less common, there was only one instrument made for both parties; this they cut in two, and gave each his portion; joining them together at their return, to know if each had done his part. This he observes to have been practised in his time; agreeable to the method of the Romans, who, in their stipulations, used to break a staff, each party retaining a moiety thereof as a mark.

CHARTOPHYLAX, the name of an officer of the church of Constantinople, who attends at the door of the rails when the sacrament is administered, and gives notice to the priests to come to the holy table. He represents the patriarch upon the bench, tries all ecclesiastical causes, keeps all the marriage registers, assists at the consecration of bishops, and presents the bishop elect at the solemnity, and likewise all other subordinate clergy. This office resembles in some shape that of the *bibliothecarius* at Rome.

CHARTRES, a large city of France, in the department of Eure and Loire, containing 13,000 inhabitants. E. Long. 1. 20. N. Lat. 48. 26. It is a bishop's see.

CHARTREUSE, or Chartreuse-grand, a celebrated monastery, the capital of all the convents of the Carthusian monks, situated on a steep rock in the middle of a large forest of fir trees, about seven miles north-east of Grenoble, in the province of Dauphiny in France. E. Long. 5. 5. N. Lat. 45. 20. See Carthusians.

From this mother convent, all the others of the same order took their name; among which was the Chartreuse of London, corruptly called the *charterhouse*, now converted into an hospital, and endowed with a revenue of 600l. per annum.

Here were maintained 80 decayed gentlemen, not under 50 years of age; also 40 boys are educated and fitted either for the university or trades. Those sent to the university have an exhibition of 20l. a-year for eight years: and have an immediate title to nine church-livings in the gift of the governors of the hospital, who are sixteen in number, all persons of the first distinction, and take their turns in the nomination of pensioners and scholars.

CHARTULARY, Chartularius, a title given to an ancient officer in the Latin church, who had the care of charters and papers relating to public affairs. The chartulary presided in ecclesiastical judgments, in lieu of the pope. In the Greek church the chartulary was called *chartophylax;* but his office was there much more considerable; and some even distinguished the chartulary from the chartophylax in the Greek church. See Chartophylax.

CHARYBDIS, in *Ancient Geography*, a whirlpool in the straits of Messina, according to the poets; near Sicily, and opposite to Scylla, a rock on the coast of Italy. Thucydides makes it to be only a strong flux and reflux in the strait, or a violent reciprocation of the tide, especially if the wind sets south. But on diving into the Charybdis, there are found vast gulfs and

Charybdis, Chase.

and whirlpools below, which produce all the commotion on the surface of the water.

Charybdis is used by Horace to denote a rapacious prostitute.

CHASE, or CHACE, in *Law*, is used for a driving of cattle to or from any place; as to a distress, or sortlet, &c.

CHASE, or *Chace*, is also a place of retreat for deer and wild beasts; of a middle kind between a forest and a park, being usually less than a forest, and not possessed of so many privileges; but wanting *v. g.* courts of attachment, swainmote, and justice seat *. Yet it is of a large extent, and stocked both with a greater diversity of wild beasts or game, and more keepers, than a park. Crompton observes, that a forest cannot be in the hands of a subject; but it forthwith loses its name, and becomes a *chase;* in regard all those courts lose their nature when they come into the hands of a subject; and that none but a king can make a lord chief justice in eyre of the forest. See JUSTICE *in Eyre*.

* See Forest.

The following history of the English chase is given by Mr Pennant. "At first the beasts of chase had this whole island for their range; they knew no other limits than the ocean, nor confessed any particular master. When the Saxons had established themselves in the heptarchy, they were reserved by each sovereign for his own particular diversion. Hunting and war, in those uncivilized ages, were the only employ of the great; their active, but uncultivated minds, being susceptible of no pleasures but those of a violent kind, such as gave exercise to their bodies, and prevented the pain of thinking.

British Zool. i. 42.

"But as the Saxon kings only appropriated those lands to the use of forests which were unoccupied, so no individuals received any injury; but when the Conquest had settled the Norman line on the throne, this passion for the chase was carried to an excess, which involved every civil right in a general ruin: it superseded the consideration of religion even in a superstitious age: the village communities, nay even the most sacred edifices, were turned into one vast waste, to make room for animals, the objects of a lawless tyrant's pleasure. The New forest in Hampshire is too trite an instance to be dwelt on; sanguinary laws were enacted to preserve the game; and in the reigns of William Rufus, and Henry I. it was less criminal to destroy one of the human species than a beast of chase. Thus it continued while the Norman line filled the throne; but when the Saxon line was restored under Henry II. the rigour of the forest laws was immediately softened.

"When our barons began to form a power, they claimed a vast, but more limited, tract for a diversion that the English were always fond of. They were very jealous of any encroachments on their respective bounds, which were often the cause of deadly feuds; such a one gave cause to the fatal battle of *Chevy-chase;* a fact which, though recorded only in a ballad, may, from what we know of the manners of the times, be founded on truth; not that it was attended with all the circumstances which the author of that natural but heroic composition has given it: for on that day neither a *Percy* nor a *Douglas* fell: here the poet seems to have claimed his privilege, and mixed with this fray some of the events of the battle of *Otterbourne*.

"When property became happily more divided by the relaxation of the feodal tenures, those extensive hunting grounds became more limited; and as tillage and husbandry increased, the beasts of chase were obliged to give way to others more useful to the community. The vast tracts of land, before dedicated to hunting, were then contracted; and, in proportion as the useful arts gained ground, either lost their original destination, or gave rise to the invention of *parks*. Liberty and the arts seem coeval; for when once the latter got footing, the former protected the labours of the industrious from being ruined by the licentious sportsman, or being devoured by the objects of his diversion: for this reason, the subjects of a despotic government still experience the inconveniences of vast wastes and forests, the terrors of the neighbouring husbandmen; while in our well regulated monarchy very few chases remain. The English still indulge themselves in the pleasures of hunting; but confine the deer kind to parks, of which England boasts of more than any other kingdom in Europe. The laws allow every man his pleasure; but confine them in such bounds as to prevent them from being injurious to the meanest of the community. Before the Reformation, the prelates seem to have guarded sufficiently against this want of amusement; the see of Norwich, in particular, being possessed, about that time, of thirteen parks."

CHASE, in the sea language, is to pursue a ship; which is also called *giving chace*.

Stern-CHASE, is when the chaser follows the chased astern directly upon the same point of the compass.

To lie with a ship's fore-foot in a CHASE, is to sail and meet with her by the nearest distance; and so to cross her in her way, or to come across her fore-foot.

A ship is said to have a *good chase*, when she is so built forward on, or a-stern, that she can carry many guns to shoot forwards or backwards; according to which she is said to have a *good forward* or *good stern chase*.

CHASE Guns, are such whose ports are either in the head (and then they are used in chasing of others); or in the stern, which are only useful when they are pursued or chased by any other ship.

CHASE of a Gun, is the whole bore or length of a piece taken withinside.

Wild-goose CHASE, a term used to express a sort of racing on horseback used formerly, which resembled the flying of wild geese; those birds generally going in a train one after another, not in confused flocks as other birds do. In this sort of race the two horses, after running twelve score yards, had liberty, which horse soever could take the leading, to ride what ground the jockey pleased, the hindmost horse being bound to follow him within a certain distance agreed on by the articles, or else to be whipped in by the tryers and judges who rode by; and whichever horse could distance the other won the race. This sort of racing was not long in common use; for it was found inhuman, and destructive to good horses, when two such were matched together. For in this case neither was able to distance the other till they were both ready to sink under their riders; and often two very good

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Chase
‖
Chastity.

good horses were both spoiled, and the wagers forced to be drawn at last. The mischief of this sort of racing soon brought in the method now in use, of running only for a certain quantity of ground, and determining the plate or wager by the coming in first at the post.

Chasing of Gold, Silver, &c. See Enchasing.

CHASTE tree. See Vitex, Botany *Index*.

CHASTITY. Purity of the body, or freedom from obscenity.—The Roman law justifies homicide in defence of the chastity either of one's self or relations; and so also, according to Selden, stood the law in the Jewish republic. Our law likewise justifies a woman for killing a man who attempts to ravish her. So the husband or father may justify killing a man who attempts a rape upon his wife or daughter; but not if he takes them in adultery by consent; for the one is forcible and felonious, but not the other.

Chastity is a virtue universally celebrated. There is indeed no charm in the female sex that can supply its place. Without it beauty is unlovely, and rank is contemptible; good breeding degenerates into wantonness, and wit into impudence. Out of the numerous instances of eminent chastity recorded by authors, the two following are selected on account of the lesson afforded by the different modes of conduct which they exhibit.

Lucretia was a lady of great beauty and noble extraction; she married Collatinus, a relation of Tarquinius Superbus king of Rome. During the siege of Ardea, which lasted much longer than was expected, the young princes passed their time in entertainments and diversions. One day as they were at supper*, at Sextus Tarquin's, the king's eldest son, with Collatinus, Lucretia's husband, the conversation turned on the merit of their wives; every one gave his own the preference. "What signify so many words?" says Collatinus; "you may in a few hours, if you please, be convinced by your own eyes how much my Lucretia excels the rest. We are young; let us mount our horses, and go and surprise them. Nothing can better decide our dispute than the state we shall find them in at a time when most certainly they will not expect us." They were a little warmed with wine: "Come on, let us go," they all cried together. They quickly galloped to Rome, which was about twenty miles from Ardea, where they find the princesses, wives of the young Tarquins, surrounded with company, and every circumstance of the highest mirth and pleasure. From thence they rode to Collatia, where they saw Lucretia in a very different situation. With her maids about her, she was at work in the inner part of her house, talking of the dangers to which her husband was exposed. The victory was adjudged to her unanimously. She received her guests with all possible politeness and civility. Lucretia's virtue, which should have commanded respect, was the very thing which kindled in the breast of Sextus Tarquin a strong and detestable passion. Within a few days he returned to Collatia; and, upon the plausible excuse he made for his visit, he was received with all the politeness due to a near relation, and the eldest son of a king. Watching the fittest opportunity, he declared the passion she had excited at his last visit, and employed the most tender entreaties, and all the artifices possible to touch a woman's heart; but all to no purpose. He then endeavoured to extort her compliance by the most terrible threatenings. It was in vain. She still persisted in her resolution; nor could she be moved even by the fear of death. But when the monster told her that he would first dispatch her, and then having murdered a slave, would lay him by her side, after which he would spread a report, that having caught them in the act of adultery, he had punished them as they deserved; this seemed to shake her resolution. She hesitated, not knowing which of these dreadful alternatives to take, whether, by consenting to dishonour the bed of her husband, whom she tenderly loved; or, by refusing, to die under the odious character of having prostituted her person to the lust of a slave. He saw the struggle of her soul; and seizing the unlucky moment, obtained an inglorious conquest. Thus, Lucretia's virtue, which had been proof against the fear of death, could not hold out against the fear of infamy. The young prince having gratified his passion, returned home as in triumph. On the morrow, Lucretia, overwhelmed with grief and despair, sent early in the morning to desire her father and her husband to come to her, and bring with them each a trusty friend, assuring them there was no time to lose. They came with all speed, the one accompanied with Valerius (so famous after under the name of Publicola), and the other with Brutus. The moment she saw them come, she could not command her tears; and when her husband asked her if all was well? "By no means," said she, "it cannot be well with a woman after she has lost her honour. Yes, Collatinus, thy bed has been defiled by a stranger: but my body only is polluted; my mind is innocent, as my death shall witness. Promise me only not to suffer the adulterer to go unpunished: it is Sextus Tarquinius, who last night, a treacherous guest, or rather cruel foe, offered me violence, and reaped a joy fatal to me; but, if you are men, it will be still more fatal to him." All promised to revenge her; and at the same time, tried to comfort her with representing, "That the mind only sins, not the body; and where the consent is wanting, there can be no guilt." "What Sextus deserves," replies Lucretia, "I leave you to judge; but for me, though I declare myself innocent of the crime, I exempt not myself from punishment. No immodest woman shall plead Lucretia's example to outlive her dishonour." Thus saying, she plunged into her breast a dagger she had concealed under her robe, and expired at their feet. Lucretia's tragical death has been praised and extolled by Pagan writers, as the highest and most noble act of heroism. The Gospel thinks not so: it is murder, even according to Lucretia's own principles, since she punished with death an innocent person, at least acknowledged as such by herself. She was ignorant that our life is not in our own power, but in his disposal from whom we receive it. St Austin, who carefully examines, in his book *De Civitate Dei*, what we are to think of Lucretia's death, considers it not as a courageous action flowing from a true love of chastity, but as an infirmity of a woman too sensible of worldly fame and glory; and who, from a dread of appearing in the eyes of men an accomplice of the violence she abhorred, and of a crime to which she was entirely a stranger, commits a real crime upon herself voluntarily and designedly. But what cannot be

* *Liv.* l. i. c. 56—60. *Dionys.* l. iv. p. 261.—277. *Flor.* l. iii. 9.

be sufficiently admired in this Roman lady, is her aphorrence of adultery, which she seems to hold so detestable as not to bear the thoughts of it. In this sense, she is a noble example for all her sex.

Chiomara, the wife of Ortiagon, a Gaulish prince, was equally admirable for her beauty and chastity.

During the war between the Romans and the Gauls, A. R. 563, the latter were totally defeated on Mount Olympus. Chiomara, among many other ladies, was taken prisoner, and committed to the care of a centurion, no less passionate for money than women. He at first endeavoured to gain her consent to his infamous desires; but not being able to prevail upon her, and subvert her constancy, he thought he might employ force with a woman whom misfortune had reduced to slavery. Afterwards, to make her amends for that treatment, he offered to restore her liberty; but not without ransom. He agreed with her for a certain sum, and to conceal this design from the other Romans, he permitted her to send any of the prisoners she should choose to her relations, and assigned a place near the river where the lady should be exchanged for gold. By accident there was one of her own slaves among the prisoners. Upon him she fixed; and the centurion soon after carried him beyond the advanced posts, under cover of a dark night. The next evening two of the relations of the princess came to the place appointed, whither the centurion also carried his captive. When they had delivered him the Attic talent they had brought, which was the sum they had agreed on, the lady, in her own language, ordered those who came to receive her to draw their swords and kill the centurion, who was then amusing himself with weighing the gold. Then, charmed with having revenged the injury done her chastity, she took the head of the officer, which she had cut off with her own hands, and hiding it under her robe, went to her husband Ortiagon, who had returned home after the defeat of his troops. As soon as she came into his presence, she threw the centurion's head at his feet. He was strangely surprised at such a sight; and asked her whose head it was, and what had induced her to do an act so uncommon to her sex? With her face covered with a sudden blush, and at the same time expressing her fierce indignation, she declared the outrage which had been done her, and the revenge she had taken for it. During the rest of her life, she stedfastly retained the same attachment for the purity of manners which constitutes the principal glory of the sex, and nobly sustained the honour of so glorious, bold, and heroic an action.—This lady was much more prudent than Lucretia, in revenging her injured honour by the death of her ravisher rather than by her own. Plutarch relates this fact, in his treatise upon the virtue and great actions of women; and it is from him we have the name of this, which is well worthy of being transmitted to posterity.

The above virtue in men is termed *continence*. See CONTINENCE.

CHATEAU-BRIANT, a town of France in the department of Lower Loire, with an old castle. W. Long. 1. 20. N. Lat. 47. 40.

CHATEAU-Chinon, a town of France in the department of Nievre, with a considerable manufactory of cloth. E. Long. 3. 48. N. Lat. 47. 2.

CHATEAU-Dauphin, a very strong castle of Piedmont in Italy, and in the marquisate of Saluces, belonging to the king of Sardinia. It was taken by the combined army of France and Spain in 1744, and was restored by the treaty of Aix-la-Chapelle.

CHATEAU-du-Loire, a town of France in the department of Indre and Loire, famous for sustaining a siege of seven years against the count of Mans. It is seated on the river Loire, in E. Long. 0. 25. N. Lat. 47. 40.

CHATEAU-Dun, an ancient town of France, in the department of Eure and Loire, with a castle and rich monastery; seated on an eminence near the river Loire, in E. Long. 1. 26. N. Lat. 48. 4.

CHATEAU-Neuf, the name of several towns of France, viz. one in Perche; another in Angumois, on the river Charente, near Angoulesme; a third in Berry, seated on the river Cher; and several other small places.

CHATEAU-Portien, a town of France in the department of Ardennes, with a castle built on a rock, near the river Aisne. Population 1030. E. Long. 4. 23. N. Lat. 49. 35.

CHATEAU-Renaud, a town of France, in the Gatenois, where clothes are made for the army, and where there is a trade in saffron. E. Long. 4. 25. N. Lat. 48. 0. This is also the name of a town of Touraine, in France, with the title of marquisate. E. Long. 2. 41. N. Lat. 47. 22.

CHATEAU-Roux, a town of France, in the department of Indre. It has a cloth manufacture, and is seated in a very large pleasant plain on the river Indre, in E. Long. 1. 47. N. Lat. 46. 49.

CHATEAU-Thiery, a town of France, in the department of Aisne, with a handsome castle on an eminence, seated on the river Maine. It contains 4080 inhabitants. E. Long. 3. 23. N. Lat. 49. 12.

CHATEAU-Vilain, a town of France, in the department of Upper Marne, with a castle; seated on the river Anjou. E. Long. 2. 59. N. Lat. 48. 0.

CHATEL, or CHATE, a town of Loraine, in the Vosges, seated on the river Moselle, eight miles from Mirecourt.

CHATEL-Allon, a maritime town of France, in the department of Lower Charente, five miles from Rochelle; formerly very considerable, but now greatly decayed.

CHATEL-Chalon, a town of France, in the department of Jura, remarkable for its abbey of Benedictine nuns. E. Long. 5. 25. N. Lat. 46. 50.

CHATELET, a town of the Netherlands, in Namur, seated on the Sambre, in the bishopric of Liege. E. Long. 4. 28. N. Lat. 50. 25.

CHATELET, the name of certain courts of justice established in several cities in France. The grand chatelet at Paris is the place where the presidial or ordinary court of justice of the provost of Paris is kept; consisting of a presidial, a civil chamber, a criminal chamber, and chamber of policy. The little chatelet is an old fort, now serving as a prison.

CHATELLERAULT, a town of France, in the department of Vienne, with the title of a duchy; seated in a fertile and pleasant country, on the river Vienne, over which there is a handsome stone bridge. E. Long. 0. 40. N. Lat. 46. 34.

CHATHAM, a town of Kent, adjoining to Rochester, and seated on the river Medway. It is the principal

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principal station of the royal navy; and the yards and magazines are furnished with all kinds of naval stores, as well as materials for building and rigging the largest men of war. The entrance into the river Medway is defended by Sheerness and other forts; notwithstanding which, the Dutch fleet burnt several ships of war here in the reign of Charles II. after the peace of Breda had been agreed upon. In the year 1757, by direction of the duke of Cumberland, several additional fortifications were begun at Chatham; so that now the ships are in no danger of an insult either by land or water. It has a church, a chapel of ease, and a new chapel for the docks, built in 1811. The dock-yard, including the ordnance wharfs, is a mile in length. Handsome barracks, capable of accommodating 1200 men, were built in 1804. The town contained 12,652 inhabitants in 1811. The principal employment of the labouring hands is ship-building. This town gave title of earl to that great statesman William Pitt, in the reigns of George II. and III. E. Long. 0. 40. N. Lat. 51. 20.

CHATIGAN, a town of Asia, in the kingdom of Bengal, on the most easterly branch of the river Ganges. It is but a poor place, though it was the first the Portuguese settled at in these parts, and who still keep a sort of possession. It has but a few cotton manufactures; but affords the best timber for building of any place about it. The inhabitants are so suspicious of each other, that they always go armed with a sword, pistol, and blunderbuss, not excepting the priests. It is subject to the British government. E. Long. 91. 10. N. Lat. 23. 0.

CHATILLON SUR SEINE, a town of France, in the department of Cote D'or, divided into two by the river Seine. This town was the scene of the fruitless negociations between the allies and Bonaparte in 1814. E. Long. 4. 33. N. Lat. 47. 45.

CHATRE, a town of France, in the department of Indre, seated on the river Indre, 37 miles from Bourges. It carries on a considerable trade in cattle. E. Long. 1. 55. N. Lat. 46. 35.

CHATTELS, a Norman term, under which were anciently comprehended all moveable goods; those immoveable being termed *fief* or *fee*.

CHATTELS, in the modern sense of the word, are all sorts of goods, moveable or immoveable, except such as are in the nature of freehold.

CHATTERER. See AMPELIS, ORNITHOLOGY *Index*.

CHATTERTON, THOMAS, a late unfortunate poet, whose fate and performances have excited in no small degree the public attention, as well as given rise to much literary controversy. He was born at Bristol, Nov. 20. 1752; and educated at a charity school on St Augustine's Back, where nothing more was taught than reading, writing, and accounts. At 14 years of age, he was articled clerk to an attorney at Bristol, with whom he continued about three years; yet, though his education was thus confined, he discovered an early turn towards poetry and English antiquities, and particularly towards heraldry. How soon he began to be an author is not known. In the Town and Country Magazine for March 1769, are two letters, probably from him, as they are dated from Bristol, and subscribed with his usual signature, D. B. that is, *Dunhelmus Bristoliensis*. The former contains short extracts from two MSS. "written 300 years ago by one Rowley, a monk," concerning dress in the age of Henry II.; the latter, "Ethelgar, a Saxon poem," in bombast prose. In the same magazine for May 1769 are three communications from Bristol, with the same signature D. B. one of them entitled, "Observations upon Saxon Heraldry, with drawings of Saxon Achievements;" and in the subsequent months of 1769 and 1770, there are several other pieces in the same magazine, which are undoubtedly of his composition.

In April 1770, he left Bristol, disgusted with his profession, and irreconcileable to the line of life in which he was placed; and coming to London in hopes of advancing his fortune by his pen, he sunk at once from the sublimity of his views to an absolute dependence on the patronage of booksellers. Things, however, seem soon to have brightened up a little with him; for, May 14. he writes to his mother, in high spirits, upon the change of his situation, with the following sarcastic reflections upon his former patrons at Bristol. "As to Mr ——, Mr ——, Mr ——, &c. &c. they rate literary lumber so low, that I believe an author, in their estimation, must be poor indeed: but here matters are otherwise. Had Rowley been a Londoner instead of a Bristowyan, I could have lived by copying his works." In a letter to his sister, May 30. he informs her that he is to be employed in writing a voluminous History of London, to appear in numbers the beginning of next winter. Meanwhile, he had written something in praise of Beckford, then lord mayor, which had procured him the honour of being presented to his lordship; and, in the letter just mentioned, he gives the following account of his reception, with certain observations upon political writing: "The lord mayor received me as politely as a citizen could; but the devil of the matter is, there is no money to be got on this side of the question.—However, he is a poor author who cannot write on both sides.—Essays on the patriotic side will fetch no more than what the copy is sold for. As the patriots themselves are searching for places, they have no gratuity to spare.—On the other hand, unpopular essays will not even be accepted, and you must pay to have them printed; but then you seldom lose by it, as courtiers are so sensible of their deficiency in merit, that they generously reward all who know how to daub them with the appearance of it."

He continued to write incessantly in various periodical publications. July 11. he tells his sister that he had pieces last month in several magazines; in The Gospel Magazine, The Town and Country, The Court and City, The London, The Political Register, &c. But all these exertions of his genius brought in so little profit, that he was soon reduced to the extremest indigence; so that at last, oppressed with poverty and disease, in a fit of despair, he put an end to his existence, August 1770, with a dose of poison. This unfortunate person, though certainly a most extraordinary genius, seems yet to have been a most ungracious composition. He was violent and impetuous to a strange degree. From the first of the above cited letters he seems to have had a portion of ill humour and spleen more than enough for a lad of 17; and the editor of his

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Chatterton. his Miscellanies records, "that he possessed all the vices and irregularities of youth, and that his profligacy was at least as conspicuous as his abilities."

In 1777 were published in one volume 8vo, "Poems, supposed to have been written at Bristol, by Thomas Rowley and others, in the 15th century: the greatest part now first published from the most authentic copies, with an engraved specimen of one of the MSS. To which are added, a Preface, an Introductory Account of the several pieces, and a Glossary." And in 1778 were published, in one volume 8vo, "Miscellanies in Prose and Verse, by Thomas Chatterton, the supposed author of the Poems published under the names of Rowley," &c.

Of Rowley's poems we have the following account in the preface, given in the words of Mr George Catcot of Bristol, to whom, it is said, the public is indebted for them: "The first discovery of certain MSS. having been deposited in Redclift church above three centuries ago, was made in the year 1768, at the time of opening the new bridge at Bristol; and was owing to a publication in Farley's Weekly Journal, Oct. 1. containing an account of the ceremonies observed at the opening of the old bridge, taken, as it was said, from a very ancient MS. This excited the curiosity of some persons to inquire after the original. The printer, Mr Farley, could give no account of it, or of the person who brought the copy; but after much inquiry, it was discovered that this person was a youth between 15 and 16 years of age, whose name was Thomas Chatterton, and whose family had been sextons of Redclift church for near 150 years. His father, who was now dead, had also been master of the free school in Pile-street. The young man was at first very unwilling to discover from whence he had the original: but, after many promises made to him, was at last prevailed on to acknowledge that he had received this, together with many other MSS. from his father, who had found them in a large chest in an upper room over the chapel on the north side of Redclift church." It is added, that soon after this Mr Catcot commenced an acquaintance with Chatterton, and partly as presents, partly as purchases, procured from him copies of many of his MSS. in prose and verse; as other copies were disposed of in like manner to others. It is concluded, however, that whatever may have been Chatterton's part in this very extraordinary transaction, whether he was the author, or only (as he constantly asserted) the copier of all these productions, he appears to have kept the secret entirely to himself, and not to have put it in any one's power to bear certain testimony either of his fraud or of his veracity.

This affair, however, has since become the foundation of a mighty controversy among the critics, which hath yet scarcely subsided. The poems in question, published in 1777, were republished in 1778, with an "Appendix, containing some observations upon their language; tending to prove that they were written, not by an ancient author, but entirely by Chatterton." Mr Warton, in the third volume of his History of English Poetry, hath espoused the same side of the question. Mr Walpole also obliged the world with a Letter on Chatterton, from his press at Strawberry-hill. On the other hand have appeared, "Observations" upon these poems, "in which their authenticity is ascertained," by Jacob Bryant, Esq.; 1781, 2 vols. 8vo; and another edition of the "Poems, with a Comment, in which their antiquity is considered and defended, by Jeremiah Milles, D. D. Dean of Exeter, 1782," 4to. In answer to these two works, we have had three pamphlets: 1. "Cursory Observations on the Poems, and Remarks on the Commentaries of Mr Bryant and Dr Milles; with a salutary proposal addressed to the friends of these gentlemen." 2. "An Archæological Epistle to Dean Milles, editor of a superb edition of Rowley's Poems," &c. 3. "An Inquiry into the authenticity of the Poems attributed to Thomas Rowley, in which the Arguments of the Dean of Exeter and Mr Bryant are examined, by Thomas Warton;" and other pieces in the public prints and magazines: All preparatory to the complete settlement of the business in "A Vindication of the Appendix to the Poems called Rowley's, in reply to the Answers of the Dean of Exeter, Jacob Bryant, Esq. and a third Anonymous Writer; with some further Observations upon these Poems, and an Examination of the Evidence which has been produced in support of their Authenticity. By Thomas Tyrwhitt, 1782," 8vo.

Chatterton, Chaucer.

CHAUCER, Sir Geofrey, an eminent English poet in the 14th century, born at London in 1328. After he left the university, he travelled into Holland, France, and other countries. Upon his return he entered himself in the Inner Temple, where he studied the municipal laws of England. His first station at court was page to Edward III. and he had a pension granted him by that prince till he could otherwise provide for him. Soon after we find him gentleman of the king's privy chamber; next year, shield-bearer to the king. Esteemed and honoured, he spent his younger days in a constant attendance at court, or for the most part living near it, in a square stone house near the park-gate at Woodstock, still called *Chaucer's House*.

Soon after, having got the duke of Lancaster for his patron, Chaucer began every day to rise in greatness. In 1373, he was sent with other persons to the republic of Genoa to hire ships for the king's navy (our want of shipping in those times being usually supplied by such means); and the king was so well satisfied with his negotiation, that, on his return, he obtained a grant of a pitcher of wine daily in the port of London, to be delivered by the butler of England; and soon after was made comptroller of the customs for wool, wool fells, and hides; an office which he discharged with great diligence and integrity. At this period, Chaucer's income was about 1000l. a-year; a sum which in those days might well enable him to live, as he says he did, with dignity in office, and hospitality among his friends. It was in this meridian blaze of prosperity, in perfect health of body and peace of mind, that he wrote his most humorous poems. His satires against the priests were probably written to oblige his patron the duke of Lancaster, who favoured the cause of Wickliff, and endeavoured to expose the clergy to the indignation of the people. In the last year of Edward III. our poet was employed in a commission to treat with the French; and in the beginning of King Richard's reign, he was in some degree of favour at court.

The duke of Lancaster at last finding his views checked, began to abandon Wickliff's party; upon which

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which Chaucer likewise, how much soever he had espoused that divine's opinions, thought it prudent to conceal them more than he had done. With the duke's interest that of Chaucer entirely sunk; and the former passing over sea, his friends felt all the malice of the opposite party. These misfortunes occasioned his writing that excellent treatise, *The Testament of Love*, in imitation of Boethius on the Consolation of Philosophy. Being much reduced, he retired to Woodstock, to comfort himself with study, which produced his admirable treatise of the *Astrolabe*.

The duke of Lancaster at last surmounting his troubles, married Lady Catharine Swynford, sister to Chaucer's wife; so that Thomas Chaucer, our poet's son, became allied to most of the nobility, and to several of the kings of England. Now the sun began to shine upon Chaucer with an evening ray: for by the influence of the duke's marriage, he again grew to a considerable share of wealth. But being now 70, he retired to Dunnington castle near Newbury. He had not enjoyed this retirement long before Henry IV. son of the duke of Lancaster, assumed the crown, and in the first year of his reign gave our poet marks of his favour. But however pleasing the change of affairs might be to him at first, he afterwards found no small inconveniences from it. The measures and grants of the late king were annulled: and Chaucer, in order to procure fresh grants of his pensions, left his retirement, and applied to court: where, though he gained a confirmation of some grants, yet the fatigue of attendance, and his great age, prevented him from enjoying them. He fell sick at London: and ended his days in the 72d year of his age, leaving the world as though he despised it, as appears from his song of *Flie from the Prese*. The year before his death he had the happiness, if at his time of life it might so be called, to see the son of his brother-in-law (Henry IV.) seated on the throne. He was interred in Westminster Abbey; and in 1556, Mr Nicholas Bingham, a gentleman of Oxford, at his own charge, erected a handsome monument for him there. Caxton first printed the Canterbury Tales; but his works were first collected and published in one volume folio, by William Thynne, London, 1542. They were afterwards reprinted in 1561, 1598, 1602. Oxford, 1721.

Chaucer was not only the first, but one of the best poets which these kingdoms ever produced. He was equally great in every species of poetry which he attempted; and his poems in general possess every kind of excellence, even to modern readers, except melody and accuracy of measure; defects which are to be attributed to the imperfect state of our language, and the infancy of the art in this kingdom at the time when he wrote. "As he is the father of English poetry (says Mr Dryden), so I hold him in the same degree of veneration as the Grecians did Homer, or the Romans Virgil. He is a perpetual fountain of good sense, learned in all sciences, and therefore speaks properly on all subjects. As he knew what to say, so he knows also when to leave off; a continence which is practised by few writers, and scarcely by any of the ancients, except Virgil and Horace." This character Chaucer certainly deserved. He had read a great deal; and was a man of the world, and of sound judgment. He was the first English poet who wrote *poetically*, as Dr Johnson observes in the preface to his Dictionary, and (he might have added) who wrote like a gentleman. He had also the merit of improving our language considerably, by the introduction and naturalization of words from the Provençal, at that time the most polished dialect in Europe.

CHALCIS, in *Ancient Geography*, the country of the Chouci, a people of Germany: divided into the *Minores*, now *East Friesland*, and the county of *Oldenburgh;* and into the *Majores*, now the duchy of *Bremen* and a part of *Lunenburgh*.

CHAUD MEDLEY, in *Law*, is of much the same import with *CHANCE Medley*. The former in its etymology signifies an affray in the heat of blood or passion: the latter, a casual affray. The latter is in common speech too often erroneously applied to any manner of homicide by misadventure; whereas it appears by the stat. 24 Hen. VIII. c. 5. and ancient books (Standf. P. C. 16.), that it is properly applied to such killing as happens in self-defence upon sudden encounter.

CHAUL, a town of the East Indies, on the coast of Malabar, in the province of Baglana, and kingdom of Visapour. Its river affords a good harbour for small vessels. The town is fortified, and so is the island on the south side of the harbour. It had formerly a good trade, but is now miserably poor. It was taken by the Portuguese in 1507, to whom it still belongs. It is 15 miles south of Bombay, and five miles from the sea. E. Long. 72. 45. N. Lat. 18. 30.

CHAULIEU, WILLIAM AMFREYEDE, Abbé d'Amale, one of the most polite and ingenious of the French poets, was born in 1639, and died at the age of 84. The most complete edition of his poems is that printed in two vols. 8vo, in 1733.

CHAUMONT, a town of France, in the department of Upper Marne, of which it is the capital. It is seated on a mountain near the river Marne. E. Long. 5. 15. N. Lat. 48. 6.

CHAUNE, a town of France, in the department of Somme, with the title of a duchy. E. Long. 2. 55. N. Lat. 49. 45.

CHAUNTRY. See CHANTRY.

CHAUNY, a town of France, in the department of Aisne, seated on the river Oise, in Chantry. E. Long. 3. 17. N. Lat. 49. 37.

CHAUVIN, STEPHEN, a celebrated minister of the reformed religion, born at Nismes, left France at the revocation of the edict of Nantz, and retired to Rotterdam, where he began a new *Journal des Sçavans;* and afterwards removing to Berlin, continued it there three years. At this last place, he was made professor of philosophy, and discharged that office with much honour and reputation. His principal work is a philosophical dictionary, in Latin, which he published at Rotterdam in 1692; and gave a new edition of it, much augmented, at Lewarden, in 1703, in folio. He died in 1725, aged 85.

CHAVEZ, a strong town of Tra-los-Montes in Portugal, seated at the foot of a mountain on the river Tamega. It has two suburbs, and as many forts; one of which looks like a citadel. Between the town and suburb of Magdalena, is an old Roman stone bridge about 92 geometrical paces long. W. Long. 7. 1. N. Lat. 41. 45.

CHAZELLES,

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Chazelles, Chazinzarians. CHAZELLES, JEAN MATTHEW, a celebrated French mathematician and engineer, was born at Lyons in 1657. M. du Hamel, with whom he got acquainted, finding his genius incline towards astronomy, presented him to M. Cassini, who employed him in his observatory. In 1684, the duke of Mortemar made use of Chazelles to teach him mathematics; and, the year after, procured him the preferment of hydrography professor for the galleys of Marseilles, where he set up a school for young pilots designing to serve aboard the galleys. In 1686, the galleys made four little campaigns, or rather four courses, purely for exercise. Chazelles went on board every time with them, kept his school upon the sea, and showed the practice of what he taught. In the years 1687 and 1688, he made two other sea campaigns, in which he drew a great many plans of ports, roads, towns, and forts, which were lodged with the ministers of state. At the beginning of the war which ended with the peace of Ryswick, some marine officers, and Chazelles among the rest, fancied the galleys might be so contrived as to live upon the ocean; that they might serve to tow the men of war when the wind failed or proved contrary, and also help to secure the coast of France upon the ocean. Chazelles was sent to the west coasts in July 1689, to examine the practicability of this scheme; and in 1690, fifteen galleys new built set sail from Rochefort, and cruised as far as Torbay, in England, and proved serviceable at the descent upon Tinmouth. After this, he digested into order the observations he had made on the coasts of the ocean; and drew distinct maps, with a portulan to them, viz. a large description of every haven, of the depth, the tides, the dangers and advantages discovered, &c. These maps were inserted in the *Neptune Françoise*, published in 1692, in which year Chazelles was engineer at the descent at Oneille. In 1693, Monsieur de Pontchartrain, then secretary of state for the marine, and afterwards chancellor of France, resolved to get the *Neptune Françoise* carried on to a second volume, which was also to take in the Mediterranean. Chazelles desired that he might have a year's voyage on this sea, for making astronomical observations; and the request being granted, he passed through Greece, Egypt, and other parts of Turkey, with his quadrant and telescope in his hand. When he was in Egypt, he measured the pyramids: and finding the sides of the largest precisely facing the four cardinal points, naturally concluded this position to have been intended, and also that the poles of the earth and meridians had not since deviated. Chazelles likewise made a report of his voyage in the Levant, and gave the academy all the satisfaction they wanted concerning the position of Alexandria: upon which he was made a member of the academy in 1695. He died in 1710.

CHAZINZARIANS, a sect of heretics who rose in Armenia in the seventh century. The word is formed of the Armenian *chazus*, "cross." They are also called *staurolatræ*, which in Greek signifies the same as *Chazinzarians* in Armenian, viz. *adorers of the cross;* they being charged with paying adoration to the cross alone. In other respects they were Nestorians; and admitted two persons in Jesus Christ: Nicephorus ascribes other singularities to them; particularly their holding an annual feast in memory of the dog of their false prophet Sergius, which they called *artzibartzes*.

Chazinzarians ‖ Check. CHEADLE, a town of England in the county of Stafford, situated on the side of a hill. It is surrounded by coal pits; and in the neighbourhood are carried on extensive manufactories in brass, copper, and tin. A weekly market is held here, and there are four annual fairs. Population 3191 in 1811. Distant 15 miles N. E. of Stafford, and 146 N. N. W. of London. W. Long. 2. N. Lat. 53.

CHEADLE Bulkeley, a township of England in the county of Chester, situated on the river Bollin. Population 2509.

CHEADLE Moseley, a township of England in the county of Chester, situated on the river Bollin, adjoining Cheadle Bulkeley. Population 1209. Distant three miles S. W. from Stockport.

CHEATS, are deceitful practices, in defrauding, or endeavouring to defraud, another person of his right, by means of some artful device, contrary to the plain rules of common honesty: as by playing with false dice, or by causing an illiterate person to execute a deed to his prejudice, by reading it over to him in words different from those in which it was written, &c.—If any person deceitfully get into his hands or possession any money or other things of any other person's, by colour of any false token, &c. being convicted, he shall have such punishment by imprisonment, setting upon the pillory, or by any corporeal pain except pains of death, as shall be adjudged by the persons before whom he shall be convicted.—As there are frauds which may be relieved civilly, and not punished criminally; so there are other frauds which in a special case may not be helped civilly, and yet shall be punished criminally. Thus, if a minor goes about the town, and, pretending to be of age, defrauds many persons by taking credit for a considerable quantity of goods, and then insisting on his nonage, the persons injured cannot recover the value of their goods, but they may inflict and punish him for a common cheat. Persons convicted of obtaining money or goods by false pretences, or of sending threatening letters in order to extort money or goods, may be punished with fine or imprisonment, or by pillory, whipping, or transportation.

CHEBRECHIN, a town of Poland, in the province of Red Russia and palatinate of Belskow. It is seated on the declivity of a hill; and the river Wierpi waters its walls, and afterwards falls into the river Bog. The Jews there are very rich. E. Long. 23. 51. N. Lat. 50. 35.

CHECAYA, in Turkish affairs, the second officer of the janizaries, who commands them under the aga, and is otherwise called *protogero*.

There is also a checaya of the treasury, stables, kitchen, &c. the word signifying as much as lieutenant, or the second in any office.

CHECK, or *CHECK-Roll*, a roll or book, wherein are contained the names of such persons as are attendants and in the pay of the king, or other great personages, as their household servants.

Clerk of the CHECK in the king's household, has the check and controlment of the yeomen of the guard, and all the ushers belonging to the royal family, allowing their absence or defects in attendance, or diminishing

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nishing their wages for the same, &c. He also, by himself or deputy, takes the view of those who are to watch in the court, and has the setting of the watch, &c.

Clerk of the CHECK *in the royal dock yards*, an officer who keeps a muster or register of all the men employed aboard his majesty's ships and vessels, and also of all the artificers and others in the service of the navy at the port where he is settled.

CHECK, in falconry, a term used of a hawk, when she forsakes her proper game, to fly at pies, crows, rooks, or the like, that cross her in her flight.

CHECKY, in *Heraldry*, is when the shield, or a bordure, &c. is chequered, or divided into chequers or squares, in the manner of a chessboard.

This is one of the most noble and most ancient figures used in armoury; and a certain author saith, that it ought to be given to none but great warriors, in token of their bravery; for the chessboard represents a field of battle; and the pawns placed on both sides represent the soldiers of the two armies, which move, attack, advance, or retire, according to the will of the gamesters, who are the generals.

This figure is always composed of metal and colour. But some authors would have it reckoned among the several sorts of furs.

CHEEK, in *Anatomy*, that part of the face situated below the eyes on each side.

CHEEKS, a general name among mechanics, for almost all those pieces of their machines and instruments, that are double and perfectly alike. Thus, the cheeks of a printing press are its two principal pieces: they are placed perpendicular, and parallel to each other; serving to sustain the three sommers, viz. the head, shelves, and winter, which bear the spindle and other parts of the machine. See *Printing Press*.

The cheeks of a turner's lathe, are two long pieces of wood, between which are placed the puppets, which are either pointed or otherwise, serving to support the work and the mandrils of the workman. These two pieces are placed parallel to the horizon, separated from one another by the thickness of the tail of the puppets, and joined with tenons to two other pieces of wood placed perpendicularly, called the *legs of the lathe*.

Cheeks of the glazier's vice, are two pieces of iron joined parallel at top and bottom; in which are the axles, or spindles, little wheel, cushions, &c. whereof the machine is composed.

The cheeks of a mortar, or the *brackets*, in *Artillery*, are made of strong planks of wood, bound with thick plates of iron, and are fixed to the bed by four bolts; they rise on each side of the mortar, and serve to keep her at what elevation is given her, by the help of strong bolts of iron which go through both cheeks both under and behind the mortar, betwixt which are driven quoins of wood; these bolts are called the *bracket bolts*; and the bolts which are put one in each end of the bed, are the traverse bolts, because with handspikes the mortar is by these traversed to the right or left.

CHEEKS, in *Ship-building*, are two pieces of timber, fitted on each side of the mast at the top, serving to strengthen the masts there. The uppermost bail or piece of timber in the beak of a ship is called the *cheek*. The knees which fasten the beak head to the ship are called *cheeks;* and the sides of any block, or the sides of a ship's carriage of a gun, are also called *cheeks*.

CHEESE, a sort of food prepared of curdled milk purged from the serum or whey, and afterwards dried for use.

Cheese differs in quality according as it is made from new or skimmed milk, from the curd which separates spontaneously upon standing, or that which is more speedily produced by the addition of runnet. Cream also affords a kind of cheese, but quite fat and butyraceous, and which does not keep long. Analyzed chemically, cheese appears to partake much more of an animal nature than butter. It is insoluble in every liquid except spirit of nitre, and caustic alkaline ley. Shaved thin, and properly treated with hot water, it forms a very strong cement if mixed with quicklime *. When prepared with hot water, it is recommended in the Swedish Memoirs to be used by anglers as a bait; it may be made into any form, is not softened by the cold water, and the fishes are fond of it.—As a food, physicians condemn the too free use of cheese. When new, it is extremely difficult of digestion: when old, it becomes acrid and hot; and, from Dr Percival's experiments, is evidently of a septic nature. It is a common opinion that old cheese digests every thing, yet is left undigested itself; but this is without any solid foundation. Cheese made from the milk of sheep digests sooner than that from the milk of cows, but is less nourishing; that from the milk of goats digests sooner than either, but is also the least nourishing. In general, it is a kind of food fit only for the laborious, or those whose organs of digestion are strong.

* See *Cement*.

Every country has places noted for this commodity: thus Cheshire and Gloucester cheese are famous in England; and the Parmesan cheese is in no less repute abroad, especially in France. This sort of cheese is entirely made of sweet cow-milk: but at Rochefort in Languedoc, they make it of ewes milk; and in other places it is usual to add goat or ewes milk in a certain proportion to that of the cow. There is likewise a kind of medicated cheese made by intimately mixing the expressed juice of certain herbs, as sage, baum, mint, &c. with the curd, before it is fashioned into a cheese.—The Laplanders make a sort of cheese of the milk of their rein deer; which is not only of great service to them as food, but on many other occasions. It is a very common thing in these climates to have a limb numbed and frozen with the cold: their remedy for this is the heating an iron red hot, and thrusting it through the middle of one of these cheeses; they catch what drops out, and with this anoint the limb, which soon recovers. They are subject also to coughs and diseases of the lungs, and these they cure by the same sort of medicine: they boil a large quantity of the cheese in the fresh deer's milk, and drink the decoction in large draughts warm several times a-day. They make a less strong decoction of the same kind also, which they use as their common drink, for three or four days together, at several times of the year. For an account of the different processes for making cheese, see CHEESE, AGRICULTURE *Index*.

Cheese-Rennet. See GALIUM and RUNNET.

CHEGOE, or Nigua, the Indian name of an insect common in Mexico, and also found in other hot countries, where it is called *pique*, is an exceeding small animal, not very unlike a flea, and is bred in the dust. It fixes upon the feet, and breaking insensibly the cuticle, it nestles betwixt that and the true skin, which also, unless it is immediately taken out, it breaks, and pierces at last to the flesh, multiplying with a rapidity almost incredible. It is seldom discovered until it pierces the true skin, when it causes an intolerable itching. These insects, with their astonishing multiplication, would soon depopulate those countries, were it less easy to avoid them, or were the inhabitants less dexterous in getting them out before they begin to spread. On the other hand, nature, in order to lessen the evil, has not only denied them wings, but even that conformation of the legs and those strong muscles which are given to the flea for leaping. The poor, however, who are in some measure doomed to live in the dust, and to an habitual neglect of their persons, suffer these insects sometimes to multiply so far as to make large holes in their flesh, and even to ocasion dangerous wounds.

CHEIRANTHUS, Stock-gilliflower, or *Wallflower*. See Botany *Index*.

CHEKAO, in *Natural History*, the name of an earth found in many parts of the East Indies, and sometimes used by the Chinese in their porcelain manufactures. It is a hard and stony earth; and the manner of using it is this: they first calcine it in an open furnace, and then beat it to a fine powder. This powder they mix with large quantities of water: then stirring the whole together, they let the coarser part subside; and pouring off the rest, yet thick as cream, they leave it to settle, and use the matter which is found at the bottom in form of a soft paste, and will retain that humidity a long time. This supplies the place of the earth called *hoache*, in the making of that elegant sort of china-ware which is all white, and has flowers which seem formed by a mere vapour within its surface. The manner of their using it is this: they first make the vessel of the common matter of the manufacture; when this is almost dry, they paint upon it the flowers, or whatever other figures they please, with a pencil dipt in this preparation of the chekao; when this is thoroughly dry, they cover the whole vessel with the varnish in the common way, and bake it as usual. The consequence is, that the whole is white: but the body of the vessel, the figures, and the varnish, being three different substances, each has its own particular white; and the flowers being painted in the finest white of all, are distinctly seen through the varnish upon the vessel, and seem as if traced by a vapour only. The hoache does this as well as the chekao; and has besides this the quality of serving for making the porcelain ware either alone, or in the place of kaolin: the chekao has not this property, nor any other substance besides this hoache, which appears to be the same with our steatites or soap-rock.

CHEKE, Sir John, a celebrated statesman, grammarian, and divine, of an ancient family in the isle of Wight, was born at Cambridge in the year 1514, and educated at St John's college in that university; where, after taking his degrees in arts, he was first chosen Greek lecturer, and in 1540 professor of that language, with a stipend of 40l. a-year. In this station he was principally instrumental in reforming the pronunciation of the Greek language, which, having been much neglected, was imperfectly understood. About the year 1543 he was incorporated master of arts at Oxford, where, we are told, he had studied for some time. In the following year he was sent to the court of King Henry VIII. and appointed tutor for the Latin language, jointly with Sir Anthony Cooke, to Prince Edward, about which time he was made canon of the college newly founded at Oxford; wherefore he must have now been in orders. On the accession of his royal pupil to the crown, Mr Cheke was first rewarded with a pension of 100 merks, and afterwards obtained several considerable grants from the crown. In 1550 he was made chief gentleman of the privy-chamber, and was knighted the following year; in 1552, chamberlain of the exchequer for life; in 1553, clerk of the council; and soon after secretary of state and privy-counsellor. But these honours were of short duration. Having concurred in the measures of the duke of Northumberland for settling the crown on the unfortunate Jane Grey, and acted as her secretary during the nine days of her reign, on the accesion of Queen Mary, Sir John Cheke was sent to the Tower, and stript of the greatest part of his possessions. In September 1554 he obtained his liberty, and a license from her majesty to travel abroad. He went first to Basil, thence to Italy, and afterwards returned to Strasburg, where he was reduced to the necessity of reading Greek lectures for subsistence. In 1556 he set out in an evil hour to meet his wife at Brussels: but, before he reached that city, he was seized by order of King Philip II. hoodwinked, and thrown into a waggon; and thus ignominiously conducted to a ship, which brought him to the Tower of London. He soon found that religion was the cause of his imprisonment; for he was immediately visited by two Romish priests, who piously endeavoured to convert him, but without success. However, he was at last visited by Fleckenham; who told him from the queen, that he must either comply or burn. This powerful argument had the desired effect; and Sir John Cheke accordingly complied in form, and his lands, upon certain conditions, were restored; but his remorse soon put an end to his life. He died in September 1557, at the house of his friend Mr Peter Osborne in Wood-street, London, and was buried in St Alban's church. He left three sons, the eldest of whom, Henry, was knighted by Queen Elizabeth. He wrote, 1. A Latin translation of two of St Chrysostom's homilies. Lond. 1543, 4to. 2. The Hurt of Sedition. Lond. 1549, 1576, 1641. 3. Latin translation of the English Communion Service. Printed among Bucer's opuscula. 4. *De pronunciatione Græcæ*. Basil, 1555, 8vo. 5. Several letters published in his life by Strype; and a great number of other books.

CHE-KYANG, or Tche-kiang, a maritime province of China, and one of the most considerable in the empire; is bounded on the south by Fo-kien: on the north and west by Kiang-nan and Kiang-si; and on the east by the sea. The air is pure and healthful, and the soil fertile, being watered by a number of rivers and canals, as well as springs and lakes. The chief produce is silk; a vast quantity of which is cultivated

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tivated here, and for which the whole country is covered with mulberry trees. These are purposely checked in their growth by the natives, experience having taught them, that the leaves of the smallest trees produce the best silk. The stuffs made in this province, which are embroidered with gold and silver, are reckoned the best in the empire; and notwithstanding a vast exportation to the Japan and Philippine islands, as well as to every part of China, and to Europe, such an abundance is left in the province, that a complete suit of silk may be bought here as cheap as one of the coarsest woollen in France.

This province is also remarkable for a particular species of mushrooms, which are exported to every part of the empire. They are pickled, and then dried; when they will keep good for a whole year. When used they must be soaked in water, which renders them as fresh as at first. Here also the tallow tree is met with; and the province affords excellent hams, and those small gold fishes with which the ponds are usually stocked.

Che-kyang contains 11 cities of the first class, 72 of the third, and 18 fortresses, which, in Europe, would be accounted large cities. The principal of these are, 1. Hang-tcheou-fou, the metropolis, accounted by the Chinese to be the paradise of the earth. It is four leagues in circumference, exclusive of the suburbs; and the number of its inhabitants is computed at more than a million, and 10,000 workmen are supposed to be employed within its walls in manufacturing of silk. Its principal beauty is a small lake, close to the walls on the western side, the water of which is pure and limpid, and the banks almost everywhere covered with flowers. Its banks are likewise adorned with halls and open galleries supported by pillars, and paved with large flag stones for the convenience of those who are fond of walking; and the lake itself is intersected with causeways cased with cut stone, openings covered with bridges being left in them for the passage of boats. In the middle are two islands with a temple and several pleasure houses, and the emperor has a small palace in the neighbourhood. The city is garrisoned by 3000 Chinese and as many Tartars, and has under its jurisdiction seven cities of the third class. 2. Hou-tcheou-fou is also situated on a lake, and manufactures an incredible quantity of silk, insomuch, that the tribute of a city under its jurisdiction, amounts to more than 500,000 ounces of silver. 3. Ning-po-fou, by Europeans called Liampo, is an excellent port, opposite to Japan. Eighteen or twenty leagues from it is an island called Tcheou-can, where the English first landed on their arrival at China. 4. Ning-po is remarkable for the silk manufactured there, which is much esteemed in foreign countries, especially Japan, where it is exchanged for gold, silver, and copper. 5. Chao-hing-fou, situated in an extensive and fertile plain, is remarkable for a tomb about half a league distant, which is said to be that of *Yu*. The people of this province are said to be the most versed in chicanery of any in China. 6. Tchu-tcheou-fou, remarkable for having in its neighbourhood pines of an extraordinary size, capable of containing 40 men in their trunks. The inhabitants are ingenious, polite, and courteous to strangers, but very superstitious.

CHELIDONIAS, according to Pliny, an anniversary wind, blowing at the appearance of the swallows; otherwise the Favonius, or Zephyrus.

CHELIDONIUM, Celandine, and Horned or Prickly Poppy. See Botany *Index*.

CHELIDONIUS lapis, in *Natural History*, a stone said by the ancients to be found in the stomachs of young swallows, and greatly esteemed for its virtues in the falling sickness.

CHELM, a town of Poland, capital of a palatinate of the same name. It is situated in the province of Red Russia. E. Long. 23. 30. N. Lat. 51. 25.

CHELMSFORD, the county town of Essex, situated on the river Chelmer, in E. Long. 0. 30. N. Lat. 51. 40. It sends two members to parliament.

CHELONE. See Botany *Index*.

CHELSEA, a fine village situated on the northern bank of the river Thames, a mile westward of Westminster, remarkable for a magnificent hospital of invalids and old decrepid soldiers; and a pleasure house, called Ranelagh, to which a great deal of fine company resort in summer; and a noble botanic garden belonging to the company of apothecaries. The royal hospital of invalids was begun by Charles II. carried on by James II. and finished by King William. Its consists of a vast range of buildings, that form three large squares, in which there is an uncommon air of neatness and elegance observed. It is under the direction of commissioners, who consist generally of the officers of state and of war. There is a governor with 500l. salary, a lieutenant-governor with 400l. and a major with 250l. besides inferior officers, serjeants, corporals, and drums, with above 400 men, who all do garrison duty: and there are above 10,000 outpensioners, who receive an annuity of 7l. 12s. 6d. each; all which expence is defrayed by a poundage deducted from the army, deficiencies being made good by parliament. The botanic garden is very extensive, enriched with a vast variety of domestic and exotic plants, the original stock of which was given to the apothecaries of London by Sir Hans Sloane.—At Ranelagh garden and amphitheatre, the entertainment is a fine band of music, with an organ and some of the best voices; and the regale is tea and coffee.

CHELTENHAM, or Chiltenham, a market town of Gloucestershire, seven miles north-east of Gloucester. W. Long. 2. 10. N. Lat. 51. 50. It is chiefly remarkable for its mineral waters, of the same kind with those of Scarborough. See Scarborough.

CHEMISE, in *Fortification*, the wall with which a bastion, or any other bulwark of earth, is lined for its greater support and strength: or it is the solidity of wall from the talus to the stone row.

Fire Chemise, a piece of linen cloth, steeped in a composition of oil of petrol, camphor, and other combustible matters, used at sea to set fire to an enemy's vessel.

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CHEMISTRY.

INTRODUCTION.

1 Definition. CHEMISTRY is defined, by Dr Black, to be " the study of the effects produced by heat and by mixture, in all bodies, or mixtures of bodies, natural or artificial, with a view to the improvement of the arts, and the knowledge of nature;" or, according to the definition proposed by the learned editor of his lectures, " chemistry is the study of the effects of heat and mixture, with the view of discovering their general and subordinate laws, and of improving the useful arts."

Fourcroy has defined " chemistry to be that science which teaches the knowledge of the intimate and reciprocal action of all the bodies in nature on one another." To this definition it has been objected, that it requires much explanation, that the terms reciprocal and intimate action not being readily understood, would need new definitions to explain them, and that it embraces more than what strictly belongs to the science of chemistry.

Perhaps no definition of chemistry has yet been given which is of sufficient logical precision to be entirely free from objection. The object of chemistry, however, as distinguished from other departments of science, admits of no ambiguity. It is the province of natural history to arrange and distribute natural bodies into classes and orders, and to give an accurate character of each, by means of which the objects which it includes may be readily recognized and distinguished. Mechanical science is employed about those agencies of bodies which have no reference to their composition, and the force and measure of which are subject to calculation. But it is the object of chemistry to discover the component parts of bodies, to examine the properties and uses of the combinations formed, either naturally or artificially, from these simple elements, and to observe and trace the laws by which the formation of these combinations is regulated.

SECT. I. *Division of Natural Knowledge.*

2 Variety of objects immense. When we consider the boundless variety of objects which present themselves to the eye, it must appear, at first sight, impossible to acquire even a general knowledge of their qualities and properties. The longest life, with the most vigorous mind and the most indefatigable industry, would be greatly inadequate to the task of examining every individual object. It is a law of the human mind, by which it spontaneously facilitates its own intellectual acquirements, to arrange the objects of its investigation into certain classes, the individuals of which are found to possess certain general properties. These are again subdivided into other classes with additional discriminative marks; and these last are still farther subdivided, till we arrive at the individual; and, if the arrangement be correct, this must possess all the characteristic marks of reference to the general and subordinate divisions of that class of objects to which it belongs. This proves conducive to the communication as well as to the acquirement of knowledge. Thus it is the province of natural history to arrange the objects which come under our observation, and to describe them with such precision and accuracy that they may be easily distinguished from each other. It may be considered as a descriptive view of the material world. 3 Natural history.

But the operations of nature are subjected to important movements. Change succeeds change, new combinations are formed, and new productions make their appearance. The primary planets revolve round the sun as their centre; the secondary planets, or moons, attracted by the primary, perform similar revolutions; the air of the atmosphere presses on the surface of the earth with a certain force; a stone, when unsupported, falls to the earth in a course directed towards its centre; water deprived of a certain portain of heat becomes solid, and assumes the form of ice; when combined with a greater portion of heat than what is necessary to retain it in the fluid state, it assumes the form of vapour, ascends into the atmosphere, is there by certain processes robbed of its heat, and re-appears in the form of rain; or, when a large portion is abstracted, takes that of snow or hail, and falls to the earth. When a seed is put into the ground; if heat, air, and moisture be applied, it germinates and springs up; and if, with the addition of light, the operation of the same agents be continued, it becomes a new plant, puts forth leaves and flowers, and produces seeds similar to that from which it sprung. 4 Natural philosophy.

Now, to determine what are these changes, to observe the laws by which they are effected, and to ascertain the measure and quantity of the effect produced, belong to that department of knowledge which is included under the general term *natural philosophy* or *physics*. But of these changes or motions, some are obvious and palpable; others entirely elude our senses. We see a stone descend to the earth; and experience informs us, that it falls with a force in a certain proportion to its weight and the height from which it fell. The peculiar change or motion which takes place when water assumes the solid form, when a fluid undergoes the process of fermentation, or when a combustible body is burned, is altogether imperceptible. These motions are too minute to be recognized. The effect is produced before we can discover the change. 5 Physics.

Thus natural philosophy divides itself into two great branches. The objects of the *first* are the sensible changes or motions which are observed in the material world; and the consideration of these objects is, properly speaking, natural philosophy or physics. The *second* great branch, which is employed in discovering the laws, and appreciating the effects, of the insensible motions of bodies, constitutes the science of chemistry. 6 Chemistry.

SECT. II. *Of the Objects and Importance of Chemistry.*

The importance and extensive utility of this science must appear obvious to those who have at all consider-

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Introduction. ed the subject. But for the sake of others who are yet unacquainted with it, we shall take a general view of the objects which it embraces, and the advantages to

7 Useful in explaining natural phenomena; be derived from the study of chemistry, whether in explaining many of the striking operations of nature, or in improving the arts of life.

The most wonderful effects, after frequent repetition, become familiar, and cease to produce any emotion in the mind. It is on this account that many of the most striking appearances of nature pass unheeded as trifling occurrences, and are unnoticed by common observers. Had we been always accustomed to the rigour of winter, and never known the genial warmth of spring, or the ripening heat of summer, the striking changes effected by the return of these seasons could not have failed to fill us with admiration. The beneficial effects of these changes are felt in the inanimate as well as in the animated creation. The same power which gives origin to a gay profusion of numberless vegetable species, restores to a new existence myriads of animals, whose vital functions had been suspended. The air, the earth, the waters, now swarm with life.

The principal agent in the production of these changes is heat; an agent, the most powerful and irresistible in its operations, unlimited in its effects, and extensive in its importance and utility. This agent, therefore, acting so powerfully in chemical operations, becomes an essential object of chemical science. Closely connected with heat is light, which is also a powerful agent in many of the processes of nature, and becomes a subject of chemical investigation, not less curious and interesting. Such, indeed, is the universal importance of light and heat in all the processes of nature, that no change takes place, no new combination is formed, or new product makes its appearance, in which the one or the other, or both, are not either evolved or absorbed.

In acquiring a knowledge of the constitution of the atmosphere, in investigating the changes to which it is subject, the variations of temperature, the laws of winds, dew, rain, hail, and snow, chemistry is our principal, our only satisfactory guide. These remarkable changes are chemical operations on a magnificent scale, and can only be explained by chemical laws.

8 To man in the study of

In surveying the infinite variety of objects from which man must derive the means of his comfort, his happiness, and his luxuries, and even of his existence, chemistry affords him the most important aid. Whether his researches be carried into the mineral, the vegetable, or the animal kingdoms, the cultivation of chemical science becomes essentially requisite for the successful progress of his investigations.

9 Minerals.

Of the importance of chemistry to the mineralogist, the limited and unsettled state of mineralogy previous to the improvements of modern chemistry, is a convincing proof. The knowledge of chemistry is indispensable in detecting and discriminating the various substances of which the globe which we inhabit is composed, in separating and purifying these substances, and in adapting them to the numerous purposes of life.

10 Vegetables.

Of the knowledge which we possess of the vegetable kingdom, chemistry furnishes a very large share. It is from this science that we derive the means of tracing the progress of vegetation, of illustrating the peculiar functions of plants, and discovering the compounds which are formed from a few simple principles, the nature and properties of these compounds, and their relative proportions, which exhibit an immense variety of new productions, many of them of the utmost importance to man, on account of their nutritious qualities, or indirectly useful to him by affording nourishment to those animals which he employs as food. Hence the advantage of applying chemical knowledge to agriculture, in determining the nature of the soil fit for the reception of plants, their proper food, and the mode of supplying it in the preparation of manures. With these objects in view, chemistry holds out incalculable advantages in the improvement of many departments of agriculture and rural economy, many of which, from the rapid and successful progress of the science, there is room to hope, may be soon obtained.

11 Animals.

Nor is the application of chemical science to the economy of animals less limited in its importance and utility. It not only contributes to the means of decomposing animal matters, and of exhibiting and examining separately the constitutent parts of animal substances; but also serves to explain in some measure many of the essential functions of the living animal body: such are digestion, respiration, secretion, which, so far as matter is concerned, and the changes which it undergoes, are to be considered as true chemical processes, and can only be investigated by chemical principles. But it is here necessary to observe, that the functions of the living vegetable or animal cannot be wholly accounted for from the nature of chemical action, without taking into consideration the operations of the vital principle, which counteract and regulate the operation of other chemical laws, aid and promote the beneficial effects of those that are useful to its health and growth, resist those that are hurtful, and give rise to chemical as well as vital phenomena peculiar to itself.

12 Medicine.

The utility of chemistry in medicine is too obvious to require much illustration. It is now universally considered as one of the essential branches of medical education. So far as the principles of chemistry can be applied in investigating the nature of the functions of the animal body in a state of health, or can be employed in accounting for the irregular action of these powers, whether excessive or deficient, which indicates a deranged state of the functions, and constitutes disease, its relation to medicine must be allowed to be close and intimate. But the medical art comprehends more than a bare knowledge of the structure and functions of the animal body. It also includes an accurate knowledge of the substances employed as remedies, of their nature and properties as simple substances, and their new qualities and effects under new combinations. This knowledge can only be acquired by the study of chemistry, which is indebted to the excitements afforded by medicine for some part of its progress as an art, in the discoveries which were accidentally made by the rude experiments of medical practitioners in the early ages, to ascertain the sensible qualities and salutary effects of the remedies which they employed. Chemistry, by its rapid progress in modern times, has amply repaid these advantages, and in the hands of the intelligent and accurate observer, has, in some points, greatly contributed to give more rational and simple views of medical science.

13 The arts.

In considering the application of chemistry to the improvement

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improvement of the arts of civilized life, a wide field of contemplation opens to our view. So extensive indeed are its influence and importance, that in most of the arts, many of the processes, in some all that are employed, depend on chemical principles. The bare mention of some of these arts will suggest ample illustration of its extensive utility. In the art of extracting metals from their ores, in purifying and combining them with each other, and in forming instruments and utensils, whether for useful or ornamental purposes, almost all the processes are purely chemical. The essential improvements which modern chemistry has introduced in the manufacture of glass and porcelain, shew its importance and utility in these arts. Nor has it contributed less by the application of its principles to the arts of tanning, soapmaking, dyeing, and bleaching. All the processes in baking, brewing, and distilling, most of the culinary arts, and many others in domestic economy, are chemical operations. In short, wherever, in any of the processes of nature or of art, the addition or the abstraction of heat takes place; wherever substances in combination are to be decomposed or separated; wherever the union of simple substances and the formation of new compounds are wanted, the effects produced can only be explained by chemical principles.

From this general view of the extensive application of chemical science, those who have not considered the objects which it embraces will be enabled to judge of the importance of this study.

14 As a science.

But however much we may be interested in observing and admiring the effects produced by chemical action, if we extend our views to the consideration of chemistry purely as a science, and the subject of philosophical investigation, it will command a greater share of our attention and study. Perhaps there is no study better calculated to encourage that generous love of truth which confers dignity and superiority on those who successfully pursue it. In this view, indeed, no science holds out more interesting subjects of research, in the singular and surprising changes which everywhere present themselves. And it is surely no small recommendation to the study of chemistry, that its speculations are not barren, and that while we store the mind with interesting truths, we add something to the stock of human knowledge, which is perhaps immediately applicable to some of the most important purposes of life. The practical value of the facts and discoveries in any science might be fairly estimated by the proportion in which they enlarge our resources by their useful application, and interest and gratify the mind as subjects of curious speculation. From these joint considerations the whole range of chemical facts derives the highest value, and becomes entitled to a distinguished place among the sciences.

Chemistry has a still higher claim to our attention, as it affords some of the most striking proofs of the wisdom and beneficence of the Creator of the universe. A machine constructed by human art is admired in proportion to the simplicity of its contrivance, the extent of its usefulness, and the niceness of its adaptations. But the works of man sink into nothing when brought into comparison with the works of nature. In our examination of the former, every step of our progress is obscured with comparative clumsiness and defect: in contemplating the latter, we behold perfection rise on perfection, and more exquisite wonders meet our view. It is the merit of chemistry that by its aid we are enabled to take a minuter survey of the great system of the universe. And so far as our limited powers can comprehend it, the whole is nicely balanced and adjusted, and all its changes tend to the most beneficial purposes. Circumstances which, on a superficial view, were seeming imperfections and defects, a closer inspection points out to be real excellencies. In all the changes which are constantly going forward, the more closely we observe and examine them, the more we shall admire the simple means by which they are accomplished, and the intelligent design and perfect wisdom displayed in the beneficial ends to which they are directed.

15 In contemplating the works of nature.

Sect. III. *History of Chemistry.*

The word Chemistry, which is supposed to have been of Egyptian origin, seems to have been first used in a very extensive sense (A). It appears to have included all the knowledge which the ancients possessed of natural objects. It was afterwards more limited in its signification, and solely confined to the art of working metals. The great importance which the ancients attached to this art was probably the cause of this limitation. Such indeed was its importance, that those who were supposed to have discovered or improved it, were regarded by mankind as their greatest benefactors. They were deemed worthy of being enrolled among the gods, and temples and statues were consecrated to their honour.

It is not necessary to trace minutely the history of chemistry to the remote periods of antiquity, or labour to prove its origin to be coeval with the earliest ages of the world. Man indeed could not exist long without some knowledge of chemical processes; and as he improved in civilization and accurate observation, this knowledge must have been improved and extended. Tubal-Cain, who is mentioned in the sacred Scriptures as a worker in metals, and is supposed to have given rise to the fabulous story of Vulcan, in ancient mythology and poetry, is considered by some as the first chemist whose name has been transmitted to the present times. But, although the working of metals, and other chemical arts, were known in the earliest ages of the

16 Chemistry existed as an art.

(A) According to some it is derived from the word *kema*, which was supposed to be a book of secrets given to the women by the demons. Others derive it from *Cham* the son of Noah, from whom Egypt took the name of *Chemie*, or *Chamie*. Sometimes the origin of the word is ascribed to *Chemmis*, a king of the Egyptians; and sometimes to the Greek word χυμος, which signifies *liquid*, because the art was at first applied in the preparation of liquids; and sometimes to the Greek verb χυω "pour out," because chemistry is the art of fusing metals.

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the world; and among the Egyptians, Greeks, and Romans, many of the arts dependent on chemistry had reached some degree of perfection; this knowledge can only be considered as consisting of a number of scattered, unconnected facts, which have no claim to be dignified with the name of science. A carpenter may erect a piece of machinery, arranged and constructed exactly similar to a pattern which he has seen, without the knowledge of a single principle of its construction; while the man of science, who can neither handle the axe nor the chissel, observes and estimates the power and operation of all its parts, and determines the general effect of the whole.

Nor will it afford us much instruction to pursue the supposed history of chemistry, even to a comparatively later period. Moses, who is said to have been skilled in all the wisdom of the Egyptians, has been ranked among the number of the earliest chemists, and as a proof of his knowledge of chemistry, the means he employed of dissolving the golden calf made by the Israelites, to render it potable, are adduced. It is said that Democritus was, of all the Greeks who travelled into Egypt to
17 among the Egyptians, acquire knowledge, the only one admitted into their mysteries. According to Diodorus Siculus, the art of chemistry had made considerable progress among the Egyptians. The knowledge of their priests is supposed to have consisted chiefly of chemical processes. They were acquainted, it is said, with the preparation of many medicines, perfumes, plasters, and soaps: they used burnt ashes as caustic substances; they fabricated bricks, glass, porcelain; they painted on glass, and practised the art of gilding with silver and gold. They extracted natron or soda from the mud of the Nile. They prepared alum, sea salt, and sal ammoniac; worked in gold and copper, and possessed many other processes in metallurgy. The extraction of oils, and the preparation of wine and vinegar, were well known to them; and they were also acquainted with the art of dyeing silk by the intermedium of mordants.

18 Greeks, Fewer traces of chemistry are found among the Greeks, although they derived the knowledge of many of the arts from Egypt. The ancient philosophers of Greece, as Pythagoras, Thales, and Plato, were more devoted to the cultivation of mathematical and astronomical knowledge, than the physical sciences. Some chemical arts, however, were not unknown to this people. The alloy of metals formed at Corinth has been much celebrated. Cinnabar was employed in some parts of Greece. Tychius knew the art of tanning leather; Plato has described the process of filtration; Hippocrates was acquainted with that of calcination; Galen speaks of distillation *per descensum*, and the word *embic* as the name of a piece of apparatus, is mentioned by Dioscorides a long time before the Arabic article *al* was prefixed to it. According to Athenæus, there was a manufactory of glass established at Lesbos. Democritus of Abdera prepared and examined the juices of plants: Aristotle and Theophrastus treated of stones and of metals.

19 Phœnicians, The Phœnicians are said to have been acquainted with the making of glass; and among this people the celebrated Tyrian purple was found. They were also skilled in the working of metals and other mineral substances. The Persians are said to be the first who distinguished the metals by the names of the planets, a practice which they retained for many centuries.

Among the Chinese, if we may believe their historians, many chemical arts were known from the earliest ages: they were acquainted with nitre, borax, alum, 20 Chinese, gunpowder, verdigris, mercurial ointments, sulphur, and colouring matters; nor were the arts of dyeing linen and silk, paper-making, manufacturing of pottery and porcelain, unknown to them. They were skilled in the art of alloying metals, and in the working of ivory and of horn. From the early knowledge which the Chinese possessed of these arts, they have been supposed by some to have been a colony from Egypt. 21

The wars in which the Romans were almost constantly engaged, and the spirit which prompted them to military affairs, gave them neither time nor taste to cultivate and improve the arts of peace. Chemistry, therefore, appears to have been little known among that people. Petronius indeed speaks of malleable glass, which was presented to Cæsar; and a similar fact is mentioned by Pliny with regard to Tiberius. But it appears, that this art was long known before the time of the Romans. Romans.

To us it may seem singular, that chemistry, now of such universal importance to mankind, should be indebted, in some measure, for its origin as an art, and for part of its progress, to one of the least generous of the human passions. It was cultivated in its early dawn, by men who were instigated by avarice to prosecute and study it. About the 10th century, or perhaps earlier, a set of men arose, and continued to flourish till the 16th, who assumed, by way of distinction, the name of *alchemists*, that 22 The alchemists.
is *the chemists*, because they considered themselves, on account of the knowledge they possessed, as more highly favoured than the rest of mankind. It was natural enough for men who observed the remarkable changes produced by chemical action, to be powerfully struck with these effects; and overlooking the variations and differences in the result of their operations, which were the consequences of partial or inaccurate observation, to flatter themselves, that their power over the substances on which they operated was as extensive as their wishes. Hence originated all the extravagances and follies, similar indeed to those of speculators and projectors of every age, with which the history and works of the alchemistical writers are filled. Many of the alchemists were the dupes of their own ignorance and credulity; but many more, there is little doubt, took advantage of the ignorance and barbarity which prevailed in the dark ages, during which period they chiefly flourished, to impose on the credulity of mankind.

It was one of the first principles among the alchemists, that all metals consist of the same ingredients, and, that hence the substances which enter into the composition of gold, are found in all metals, but mixed with many impurities, from which they might, by certain processes, be freed. The constant object of all their researches, was the discovery of a substance possessed of the wonderful property of converting the baser metals into gold, which, on account of its scarcity and durability, is more valued than the other more common metals. This celebrated substance was denominated

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23 Philosophers stone.

minated the *philosophers stone;* and those who were supposed to be so singularly fortunate as to accomplish this great discovery, or those to whom it was imparted by others, were regarded as the peculiar favourites of heaven. They were ranked in the highest order of alchemists, and assumed the name of *adepts.*

These adepts never seemed to think of enriching themselves by their great discoveries. They were too generous to monopolize the wealth of the world. They accordingly offered their services to others, and liberally proposed to communicate the fruit of their labours for a moderate reward. The ambitious man to procure riches, that he might increase his power, and the avaricious man to add to his wealth, eagerly sought after, and encouraged them in the prosecution of their extravagant schemes. They were kept in the pay of princes and other great men, to fill and repair their exhausted treasuries. These flattering hopes, it may well be supposed, were never realized. The rich prospect fled before them, and the golden prize, which they often supposed was just within their reach, eluded their eager grasp. The magnitude of the plan, however, fired the imagination, and produced a sort of conviction in the mind, of the possibility, and even certainty, of obtaining the object of all their wishes and labours. With unabating ardour, and unexampled assiduity, they pursued their researches, persuading themselves and their employers, that they were on the point of being soon in possession of unlimited wealth.

Beholding man by anticipation possessed of immense riches, the alchemists saw that something more was requisite to secure him in the uninterrupted enjoyment of them. Experience fatally taught them, that his feeble frame was liable to the pains and languor of disease; that gold and silver could neither prevent the paroxysm of a fever, nor confer on the possessor the blessings of constant health. Another most desirable object was consequently held up to view, and deluded their distempered minds into the false hope of attaining it. This was the famous *panacea*, or universal medicine, which was to cure all diseases; and even to prevent their occurrence. Thus fortunate in the enjoyment of vast riches; thus blessed with unbroken health, the desires of man were yet unsatisfied. Another seeming evil still remained, which was naturally to be dreaded as the destroyer of this fancied scene of apparently perfect felicity. The melancholy reflection, that it was limited by the short span of human life, roused the alchemists again into exertion, and produced new efforts of ingenuity in their labours, to secure to man exemption from the common lot of mortality. In imagination they had discovered the means of prolonging life at pleasure to an indefinite length, of rescuing man from the grave, and of making him immortal upon earth.

24 Universal medicine.

Such were the extraordinary pursuits of the alchemists. The exact period of the origin of this study is unknown; nor can it now be ascertained what progress it had made, or indeed whether it was at all cultivated among those whom we strictly call the ancients. Julius Firmicus Maternus is the first historian who mentions this study as well known in his day; and the period when he flourished was about the beginning of the 4th century. A subsequent author, Æneas Blasius, who lived in the following century, also makes mention of it: and Suidas defines the term by informing us, that it is the art of making gold and silver. Dioclesian, he says, prohibited all chemical operations, during his persecution of the Christians, that his subjects might not be instigated to acts of rebellion against him by the formation of gold. In some places where gold is washed down in minute particles, by brooks and rivulets, from the mountains, it is customary to suspend the skins of animals in the water, by which means the particles containing the gold are detained; a circumstance from which the fabulous story of the golden fleece probably derived its origin. Suidas, however, who flourished in the 10th century, is not entitled to any high degree of credit, especially as the ancient authors are wholly silent on the subject of alchemy.

It is from the physicians of Arabia that we obtain the most satisfactory evidence concerning alchemy. Avicenna, who lived in the 10th century, is said, by one of his own disciples, to have written on this subject. He likewise takes notice of rose-water, and some other chemical preparations; and in the 12th century we find it recommended to physicians to cultivate an acquaintance with the chemists. Another Arabian writer says, that the method of preparing rose-water, &c. was at that time well understood. These proofs of the existence of alchemy among the Arabians, and particularly from the particle *Al* prefixed to it, have induced some to conclude, that the doctrine of the transmutation of metals first originated with the Arabians, and was introduced into Europe by the crusades, as well as by the rapid conquests of the Arabians, in Europe, Asia, and Africa. At that period Europe was in a state of the utmost barbarity, owing to the incursions of the northern nations; but some of the sciences, among which alchemy was comprehended, were happily revived by the Arabians: and about the middle of the 17th century, the extravagance of such as were the professors of alchemy arrived at its greatest height.

25 Principal alchemists.

It appears that the alchemists began to be established in the west of Europe, as early as the ninth century; and between the eleventh and fifteenth, this study was in its most flourishing state. Among the principal alchemists who flourished during this period, and who were distinguished for their discoveries and writings, were Albertus Magnus, Roger Bacon, Arnoldus de Villanova, and Raymond Lully. They all lived in the 13th century. Albertus Magnus was a Dominican monk of Cologne, and was regarded by his cotemporaries, as a magician. He was born in the year 1205, and died in 1280. He left numerous works, one of the most curious of which is a treatise entitled *De Alchemia*, which exhibits a distinct view of the state of chemistry at the time he lived. Roger Bacon, another monk, was born in the county of Somerset in England in 1214, and died in 1294. He was celebrated for many ingenious inventions and discoveries in chemistry and mechanics. Among these are mentioned the *camera obscura*, the *telescope*, and gunpowder. His works discover astonishing sagacity and acuteness, and, considering the age in which he lived, are composed with no small degree of elegance and conciseness. Some of them, however, bearing the character of the times, are mystical and obscure. Arnoldus

Introduction. noldus de Villanova was a native of Languedoc in France, and was born about the year 1240. He has mentioned the mineral acids, and joined to his chemical studies extensive knowledge in medicine. His writings are characterised by all the obscurity of the alchemistical authors. Raymond Lully, whose reputation raised him to the rank of *adept*, was born at Barcelona in 1235. He wrote on strong waters and metals. His last will and testament is one of the most celebrated of his writings; and these are not less obscure than those of his cotemporaries.

About the end of the 14th century, Basil Valentine, a German Benedictine monk, was the first who formally applied chemistry to medicine. He was the original discoverer of many of the virtues of antimonial medicines; and in his celebrated treatise on antimony, entitled *Currus triumphalis Antimonii*, are found many preparations which have since been announced to the world as new discoveries. About the same time lived Isaacus Hollandus, whose works have been greatly commended by Boerhaave.

26 Paracelsus. In the beginning of the 16th century arose Paracelsus, one of the most extraordinary men who ever lived. He was born in 1493, near Zurich in Switzerland. Of a bold and enterprising spirit, he despised the common rules of conduct by which men are usually guided. By his singularities he raised his reputation to a great height; he became an enthusiast in chemistry, and in the application of substances prepared by chemical processes to the cure of diseases. He was the first public teacher of chemistry in Europe, having been appointed to deliver lectures on that subject in the city of Basil: but his restless spirit did not permit him to remain long in this situation. In two years he was involved in a quarrel with the magistrates, from whom he had received his appointment, and left the city. Despising the common principles of medical practice, and succeeding wonderfully in some cures by the free use of opium and mercury, he thought he had discovered the universal medicine, and promised immortality to himself and to his patients. But while he thus made such flattering promises, his own fate furnished a sad proof of the futility of his doctrine. After an almost uninterrupted course of debauchery, having wandered a great part of his life from place to place, he died at an inn in Saltzburg, in the 48th year of his age.

27 the first public teacher of chemistry.

A great number of medical practitioners, in the course of the 16th century, adopted and propagated the principles of Paracelsus. Among the most distinguished of these was Van Helmont, a man of considerable genius, who was born in the year 1577. Many of the followers of Paracelsus were greatly devoted to the study of chemistry; and this, with the absurd and unprincipled conduct of their master, tended not a little to bring the views and speculations of the alchemists into disrepute. Chemistry, now freed from the trammels of alchemy, consisted only of a number of detached, unconnected facts. To have these facts brought together in one point of view, and arranged into classes, so that the knowledge of them might be applied to useful purposes, and the objects pointed out to which future researches might be advantageously directed, was now the great desideratum. This task was accomplished by Becher, who distinguished himself by the extent of his views, in a work entitled *Physica subterranea*, which was published at Frankfort in the year 1669. This was the first dawn of true chemical science, and in the history of which the publication of Becher's work formed an important æra.

28 Alchemy declines.

29 Chemistry assumes the form of a science.

30 Discoveries of the alchemists.

In taking a retrospective view of the progress of chemistry, previous to the publication of Becher's work, we find that a great number of important facts had been discovered and collected. To the class of acids, the sulphuric, the nitric, and the muriatic, were added; the alkalies were better known, and the volatile alkali was obtained from sal ammoniac by Basil Valentine, by decomposing it by means of soda or potass; the sulphate of potass, prepared in three or four different ways, received as many different names; the nitrate of potass was called *nitre*, a name which had been formerly applied to soda; Sylvius discovered the muriate of potass which he denominated *digestive salt*; and Glauber, the sulphate of soda, to which he gave the name *wonderful salt*, though better known by the name of Glauber's salt, by which it is still distinguished. Some of the earthy salts began to be known about this period, and among others the muriate of lime, which received the name of *fixed sal ammoniac*.

The earths themselves were also better known; lime water was prepared, and some of the alkaline sulphurets were pointed out and examined.

The properties of some of the metallic salts were studied and examined; the nitrate of silver was known under the name and form of *crystals of Diana*, and of *lapis infernalis*; the muriate of silver, under that of *luna cornea*. The two muriates of mercury were described, and employed for various purposes. The red precipitate, called *arcanum corallinum*, *saccharum-saturni*, or sugar of lead, the butter of antimony, and the powder of algaroth, were either discovered, or their properties more attentively investigated and ascertained.

During this period also, the distinction was made between the brittle and the ductile metals. Bismuth, zinc, antimony, and even arsenic were obtained in a metallic state. A number of oxides, some metallic dyes, fulminating gold, turpith mineral, the saline precipitates of mercury, or the mercurial oxides of different colours, minium and litharge, colcothar, the saffron of Mars, and diaphoretic antimony, were discovered, and the mode of preparing them sufficiently described.

During this period, the preparation of oils by distillation commenced, and the distinction was made between the volatile and empyreumatic. Ethers were discovered, and the spirit of wine was well known by the name alcohol, which it still bears.

31 Their history useful.

The extravagant history of the alchemists is instructive, as affording a useful lesson to moderate our expectations in the pursuit of knowledge, and to restrain them within the bounds which the Almighty has prescribed to the range of our investigations. This history is instructive also, as presenting a singular and extraordinary feature in the history of mankind. To our present purpose it is immediately useful, as showing us the commencement of chemical researches. Chemistry, it is true, in the hands of the alchemists, like every other department of knowledge during the dark ages, was involved in mystery, and the knowledge it communicated in a barbarous jargon, to be understood only by the initiated, and scarcely to be decyphered and

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Introduction. and comprehended at the present day, with the assistance of the extensive knowledge of chemical facts which we now possess. But with all the extravagance displayed in the objects they pursued, the means employed were ultimately useful to the progress of chemistry. By their incessant labours, discovery was added to discovery, facts were multiplied on facts, though unaccompanied by any regular train of research or reasoning.

32 Their discoveries comparatively few. It may appear surprising that these important discoveries were not more numerous. The alchemists had laboured incessantly in chemical pursuits for nearly a thousand years, and with all the zeal and ardour of enthusiasts; the labour of whole lives was exhausted, and immense fortunes were dissipated, in endeavouring to obtain the grand object of all their researches. But the spirit which prevailed among the alchemists was directly hostile to the free communica-

33 The reason. tion and accumulation of knowledge. The prominent feature of their character was secrecy. This indeed was closely connected with the nature of the object, to attain which all their pursuits and inquiries were directed: and so strongly was this impressed upon their minds, that they believed, or pretended to believe, that the dreadful wrath of Heaven would fall on him who should presume to disclose to any, but to the initiated, the secrets of the art. That spirit which arose from motives of avarice and self-conceit, became at last one of the leading principles of their conduct. With an object so important in view, as the discovery of the means of putting themselves in possession of unlimited wealth, it is little to be wondered at, if they should carefully conceal from the world, and even from one another, the steps in the progress which led to the accomplishment of this end. Thus, all their processes were carried on in private, all their discoveries were kept secret. In their pretended communication of knowledge with each other, they employed conventional signs and figures, and assumed a mysterious mode of writing, that they might be understood only by *adepts*, and might be totally unintelligible to the rest of mankind.

Thus it was scarcely to be expected that they should reveal to the world, either by speech or writing, discoveries which most of them probably believed were to be of such vast benefit to themselves. In this view, we should rather be surprised that any of their processes were ever made known. But here vanity, and even avarice, probably had considerable influence in calling forth what they pretended was an account of their attainments and discoveries. Some of the alchemists, perhaps by means of trick and imposture, had acquired a high reputation for knowledge, and had imposed a belief on many, that they were actually in possession of the philosopher's stone. They were therefore sought after, and often received great rewards for their labour, in proving the effects, or trying the success of this wonderful agent. To be thus employed was perhaps the object of many in the publication of their works. But, at the same time, they cautiously avoided revealing their knowledge, by employing mysterious and metaphorical language. Thus we may account for the impenetrable obscurity, as well as many of the absurdities which characterized their writings.

Considering the cautious concealment with which they carried on all their processes, it is not improbable that many important discoveries were never announced by the first observers; for the very appearance of any thing new or unexpected, would flatter their hopes that they had advanced another step toward the attainment of their objects, and that the next would put them in full possession of it. Thus, such a discovery would be held inviolably secret, and might in this way be lost for ever.

The work of Beccher, which gave the first scientific form to chemical knowledge, appeared about the middle of the seventeenth century, when the light of science began to spread over Europe, and chemistry received its share. The facts which had been accumulated by the labours of the alchemists, and to which Beccher had given a systematic form, were still farther methodised and extended by his pupil Stahl. Indeed, so 34 Stahl improves the theory of Beccher.
much was done by the latter, in simplifying and improving the theory of his master, that it was afterwards denominated from his name the *Stahlian* or *phlogistic theory*. This theory was then received and adopted by all chemists, and continued to flourish for more than half a century.

After the middle of the seventeenth century, the es- 35 Chemistry studied in
tablishment of philosophical societies in Europe greatly contributed to the diffusion of knowledge. It was about this time that the academy of sciences was established in France, and some of its members rose high in reputation by their experiments and discoveries in chemistry. The Royal Society of London was founded about the same period; but its members, following the example of Newton, were more occupied in mechanical philosophy, and paid less attention to chemical science. The latter, however, was not entirely overlooked. Newton himself threw out some important hints in this department, and took some general views of chemical phenomena; Boyle, along with his re- 36 Britain.
searches in mechanical philosophy, prosecuted the study of chemistry; and the experiments of Hooke and Mayow, on the nature of combustion and respirable air, discover a high degree of sagacity and skill in their investigations.

Towards the middle of the eighteenth century, the study of chemistry became fashionable in France. Before this time Homberg, Geoffroy, and Lemery, had distinguished themselves by their chemical discoveries. Geoffroy is still deservedly celebrated for his invention 37 In France.
of the tables of chemical affinities, an ingenious method of exhibiting, at one view, the principal results of experiments in this science. These tables were afterwards improved by several chemists, especially by Rouelle, Wenzel, and Bergman.

But the discoveries of Dr Black formed one of the 38 Black's discovery.
most important æras in the history of this science, and gave a new and unexpected turn to the views of chemists. It was the object of Dr Black's researches to discover the cause of the remarkable change which a piece of limestone undergoes when it is calcined or burnt, and to point out the reason of the great difference of the properties of this substance in its different states; and his investigations were crowned with success. In the year 1755, he ascertained that these changes were owing to the combination or separation of a peculiar kind of air, different in its properties from the

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the air of the atmosphere. Lime, when combined with this air, is in the mild state, or the state of limestone: when this air is driven off, which is done by the process of calcination or burning, the limestone has changed its properties; it is reduced to the caustic state, and has lost considerably of its weight; and this loss of weight, Dr Black proved, was exactly equal to the weight of the air driven off. To this air Dr Black gave the name of *fixed air;* because, when united to the lime and other substances, with which it enters into combination, it is in a fixed state. This discovery, one of the most important in chemistry, opened a new field for investigation: for it had not been once suspected, that aerial substances formed combinations with solid bodies.

From this time, the progress of chemistry became rapid and brilliant. Facts and discoveries were daily multiplied, and a spirit of enthusiasm for the study burst

39 Other important discoveries.

forth, and was widely diffused. In the year 1774, Dr Priestley, who had contributed largely to the stock of chemical knowledge, discovered pure or vital air, and its property of being exclusively fit for the purposes of respiration and combustion. In the year 1781, Mr Cavendish, another ingenious English chemist, proved that water is not a simple element, but composed of pure or vital air, and inflammable air; called now in chemical language, oxygen and hydrogen.

But, previous to this time, two chemists had appeared in Sweden, had distinguished themselves by their zeal, ingenuity, and indefatigable industry, and had obtained the highest reputation for their invaluable discoveries in chemical science. These were the celebrated Bergman and Scheele, whose names will not be forgotten, as long as modesty, candour, and truth, are honoured among mankind.

In the mean time, the French chemists were not idle. The celebrated Lavoisier, in conjunction with some of his philosophical friends, confirmed, by the most decisive experiments, the truth of Mr Cavendish's discovery of the composition of water, which was now received and adopted by almost every chemist. The same unfortunate philosopher, Lavoisier, whose bright career was cut short by the horrors of the French revolution, had, previous to the time alluded to, enriched chemical science with many valuable and important facts. He had greatly contributed to the overthrow of the phlogistic theory, by a series of accurate experiments and observations on the calcination of metals. It had now become a question, whether metals, during the process of calcination, gave out any substance; that is, whether they contained any phlogiston; and Lavoisier incontestably proved, that metals cannot be calcined, excepting in contact with pure air, and that the calx thus obtained was, in all cases, exactly equal to the weight of the metal, added to the quantity of air which had disappeared.

Chemistry had now, by its rapid and unexampled progress, so far extended itself, and had accumulated so large a body of facts, that the barbarous and arbitrary language which the alchemists employed to veil their mysteries, and part of which had been adopted and imitated in language equally obscure and arbitrary by the earlier chemists, rendered it extremely difficult to be acquired or understood. This disadvantage was loudly and justly complained of, but the difficulties in the way of remedying it seemed almost insurmountable. The French chemists, however, undertook the arduous task, and completely succeeded in their labours. To these illustrious philosophers we are indebted for the present language of chemistry, which is so constructed, that every word, and every combination, has an appropriate meaning, and clearly expresses the nature and composition of the substance which it represents. It is to this improvement in its language, that we are to ascribe the facility and precision with which the knowledge of chemistry can now be communicated, and which has materially contributed to its general diffusion and cultivation.

40 New nomenclature.

The career of chemical science has accordingly been of late years even more rapid than was then anticipated. It has been signalized by the brilliant discoveries of the composition of the alkalies and earths, the doctrine of definite combining quantities, or the atomic theory, by multitudes of elegant improved manipulations, new compound substances, new simple elements, and new practical applications of chemical knowledge. In this place we shall refrain from any formal eulogy on living chemists. The results of their labours will be recorded in the body of this article, with a minuteness proportioned to its general extent, and will form, we hope, an instructive improvement in the present, compared with the former editions of this work. On some subjects we shall refer to the corresponding article contained in the SUPPLEMENT, which is now in course of publication, exhibiting a separate view of the most recent improvements. It has been necessary, however, to alter this article materially, as our latest discoveries not only serve to enlarge our former views, but to correct them.

SECT. IV. *Of the First Principles of Bodies, and of the Methods of studying and arranging them.*

41 Elements of bodies among the ancients.

1. According to the ancient philosophers, all matter consisted of four principles or elements. These were fire, air, water, and earth. This opinion, under different modifications, seems to have universally prevailed. But the discoveries of modern chemistry have proved, that three of these elements, at least, are compound substances. Fire is a compound of light and heat; air, of oxygenous and azotic gas; and water, of oxygen and hydrogen.

The alchemists, not satisfied with this division of the principles of bodies, adopted another, which was more appropriate to the nature of their labours and experiments, and was better calculated to explain the appearances with which they were acquainted. The elements of all bodies, according to their theory, were *salt*, *sulphur*, and *mercury:* and these were long known among the alchemists by the appellation of the *tria prima*. These were admitted by all the alchemistical writers down to the time of Paracelsus, who adopted them, and added two more to the number. These five elements or principles were thus characterized. Every thing came under the name of *salt* which was soluble or sapid; all inflammable substances were called *sulphur;* and every volatile substance, which flies off without burning, was called *mercury* or *spirit*. Every thing liquid and insipid was called *phlegm* or *water:* every thing that was dry, insipid, fixed, and insoluble, was called *earth*, or

42 The alchemists.

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caput mortuum. The two last, which were added by Paracelsus, are synonymous with the water and earth of the ancients. According to the original theory of the alchemists, all bodies may be decomposed by fire, and resolved into their three constituent principles. The mercury, or spirit, escapes during combustion in the form of smoke; the sulphur is inflamed; and the salt, or fixed principle, remains behind.

43 Beccher's elements.

Beccher, whom we have already mentioned as the founder of chemical science, perceiving the vague and unsettled notions of the alchemists, with regard to the principles of bodies, generalized and simplified still more, the chemical facts which were then known. According to his theory, all bodies consisted of earth and water. Under the former he included every thing that was dry, and under the latter, every thing humid. He admitted three earthy principles, namely, the fusible earth, the inflammable earth, and the mercurial earth. The first was the principle of dryness, of infusibility and hardness. The fusible earth, combined with water, composed an acid, which was called the *universal acid*, because all other acids owed their properties to it. The inflammable earth was considered as the principle of combustibility; and the mercurial earth as the principle of volatility. The fusible and the mercurial earths, with water, composed common salt; and the inflammable earth, with the universal acid, formed sulphur. The metals were composed of these three earths in equal proportions. When the mercurial earth was in small proportion, the compound was *stone;* when the fusible was in greater proportion, the compound formed the *precious stones;* and the resulting compounds are the colorific earths, when the inflammable earth is in the largest, and the fusible in the smallest proportion.

44 Stahl's.

This theory of Beccher was considerably modified by his pupil Stahl. The inflammable earth of Beccher seems to have been changed by him into the principle of inflammability or fixed fire, which he called *phlogiston.* He admitted the universal acid, but rejected the mercurial earth. The number of elements in the theory thus modified by Stahl amounted to five. These were, *air*, *water*, *phlogiston*, *earth*, and the *universal acid.*

This mode of considering the elements of bodies, of their first principles, and of admitting such arbitrary and erroneous distinctions, is justly banished from chemical science. All substances are supposed to be simple, which have not been decomposed, without regard to primitive elements or principles, such as are hitherto not ascertained by experiment.

2. To acquire the knowledge of those properties of bodies, investigation of which is properly included under the chemical science, two methods are employed: The one is the method of analysis or decomposition; the other is that of synthesis, or composition. By the one, the different simple substances of which compound bodies consist, are separated, and their properties individually examined; by the other, the simple substances are combined together, and the properties of the new compound are investigated.

45 Analysis.

Different modes of analysis have been admitted and described by chemical writers. Some bodies, when exposed to the action of heat and air, undergo a total separation of their component parts. This is called *spontaneous* analysis. Thus, some minerals, and all vegetable and animal matters, when deprived of life in favourable circumstances, slowly separate into their component parts; and in the same way the principles of which some liquids are composed, re-act on each other, and spontaneously separate, thus giving an opportunity of investigating the nature of these substances.

Analysis by fire operates by the accumulation of caloric in bodies; and by the power which it has of separating their particles to favour their examination. But this instrument of analysis is to be considered only as one of the means which should concur with many others, to throw light on the real composition of bodies. For it will afterwards appear, that the different quantities of caloric accumulated in bodies, have the greatest effects in giving different results, and changing the order of decomposition.

Another mode of analysis is by means of re-agents. This is conducted by placing the compound body which is to be examined, in contact with various substances, which have the power of separating its constituent parts. This is always done by forming a combination with one of the constituents, to the exclusion of others. It is here that the genius and science of the chemist appear most conspicuous; for every substance in nature, and all the products of art, become valuable instruments in his hands, to ascertain the nature, and to examine the properties, of the substances which come under his examination. The different means of analysis which chemists have employed, to arrive at the knowledge of compound bodies, have been deemed of such importance and utility, that chemistry has been called *the science of analysis.*

Synthesis, or composition, is the union of two or more simple substances. This union, from whence a new compound results, has become an important step in prosecuting knowledge of the properties of bodies, and in forming a number of products useful in the arts, and necessary to our wants; and thus it is considered by chemists as in some measure the inverse of the method of analysis, as the perfection of their art, and one of the great instruments of their operations. The method of synthesis or composition, considered as a chemical process to acquire the knowledge of the intimate and reciprocal action of bodies, is in reality more frequently employed than that of analysis; and the name of the science, if we were to regard these two methods, should rather be called the *science of synthesis* than the science of analysis. In all cases of complicated analysis, the operations are synthetic. Compounds of an inferior order are formed, but more numerous than the first compounds which were subjected to analysis or examination. 46 Synthesis.

But besides, there are many bodies which have never yet been decomposed. It is only by composition or synthesis, that is, by combining them with others, and by examining the nature of the compounds which are formed by this combination, that the chemical properties of these can be investigated.

However various the operations of chemistry may be; however numerous and different from each other the results obtained; they may all be referred to analysis or synthesis, and be regarded either as combinations or decompositions.

3. It must be universally allowed, that it is of vast importance,

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importance, in acquiring or communicating knowledge, to have a clear view of the objects of our studies; and this becomes the more necessary, in proportion as the facts in any science are accumulated, and the objects which it comprehends become more numerous. In many of the arrangements of chemical knowledge which have been proposed to the world, the objects of this science have been classed together according to certain resemblances in one or two points, while they are totally distinct in all others. But an arrangement which is founded on the properties and characters of substances which have not been fully ascertained and generally admitted, must tend to obstruct, rather than facilitate the acquisition of science. If, for instance, the objects of chemical knowledge are to be arranged according to their combustibility or incombustibility, the nature of the process of combustion ought to be fully understood, and the effects of combustion on the substances to be classed in this way, clearly established. If all this has not been previously attended to, the principles of the arrangement must be false, and must unavoidably lead to error. As a proof of the truth of our remarks, the same substance has been considered by one chemist as a combustible body, and arranged by another in the class of combustibles; and even by the same chemist it is described as combustible at one time, and incombustible at another, according to the theoretic nomenclature which then prevails.

47 Arrangement

Without pursuing any method of arrangement founded on particular theories or systems, we shall endeavour, in the following treatise, to lay before our readers a full view of the present state of chemical science; and in arranging the great body of facts of which it consists, we shall observe the two following rules. 1. To introduce the substances to be examined according to the simplicity of their composition; and, 2. According to their importance as chemical agents. The plan which we propose to pursue, in treating of these different classes of bodies, is, 1. To consider their properties as simple substances, and, 2. The combinations which they form with those which have been described. By previously following out this plan, we hope to have less anticipation and repetition than would otherwise be occasioned.

In conformity with the principles now stated, the following table exhibits a view of the order which we shall observe in this treatise. In the present state of chemical science, and in its application to explain the phenomena of nature, or to improve the arts of life, the whole may be conveniently arranged into twenty chapters.

I. Affinity.
II. Light.
III. Heat.
IV. Oxygen Gas.
V. Azotic Gas and its combinations.
VI. Hydrogen, &c.
VII. Carbone, &c.
VIII. Phosphorus, &c.
IX. Sulphur, &c.
X. Acids, &c.
- 1. Sulphuric,
- 2. Nitric,
- 3. Muriatic, (Chlorine.)
- 4. Oxiodic and Hydriodic (Iodine,) &c.

XI. Inflammable Substances.
- 1. Alcohol,
- 2. Ether,
- 3. Oils.

XII. Alkalies.
- 1. Potash and its combinations.
- 2. Soda.
- 3. Lithina.
- 4. Ammonia.

XIII. Earths.
- 1. Lime and its combinations.
- 2. Barytes.
- 3. Strontites.
- 4. Magnesia.
- 5. Alumina.
- 6. Silica.
- 7. Yttria.
- 8. Glucina.
- 9. Zirconia.
- 10. Thorina.

XIV. Metals.
- 1. Arsenic and its combinations.
- 2. Tungsten.
- 3. Molybdena.
- 4. Chromium.
- 5. Columbium.
- 6. Titanium.
- 7. Uranium.
- 8. Cerium.
- 9. Cobalt.
- 10. Nickel.
- 11. Manganese.
- 12. Bismuth.
- 13. Antimony.
- 14. Tellurium.
- 15. Selenium.
- 16. Mercury.
- 17. Zinc.
- 18. Tin.
- 19. Lead.
- 20. Iron.
- 21. Copper.
- 22. Silver.
- 23. Gold.
- 24. Platina.
- 25. Rhodium.
- 26. Palladium.
- 27. Iridium.
- 28. Osmium.

XV. The Atmosphere.

XVI. Waters.
- 1. Sea water.
- 2. Mineral waters.

XVII. Minerals.
- 1. Component parts.
- 2. Analysis.

XVIII. Vegetables.
- 1. Functions.
- 2. Decomposition.
- 3. Component parts.

XIX. Animals.
- 1. Functions.
- 2. Decomposition.
- 3. Component parts.

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XX. Arts and Manufactures.
1. Soaps.
2. Glass.
3. Porcelain.
4. Tanning.
5. Dyeing.
6. Bleaching.

48 explained.

In the preceding arrangement, the first chapter treats of affinity, or the laws of chemical action. In the two following chapters, the properties of light and heat are detailed. These are considered as material substances; but their properties can only be known in combination with other bodies, as they have never been found in a separate state. They likewise so far elude the sense of touch as to be imponderable and unresisting. Oxygen, azote, and hydrogen, which are considered as the basis of oxygenous, azotic, and hydrogenous gases, are treated of in the 4th, 5th, and 6th chapters; but these substances are not generally cognizable by the sense of sight, as light and heat elude the grasp of touch. They are known in a state of combination, the aeriform or gaseous state, when they are combined with caloric, or the matter of heat. The three following substances, carbone, phosphorus, and sulphur, which are the subjects of the 7th, 8th, and 9th chapters, are considered as simple, because they have never been decomposed. They can be exhibited in the solid state. Two of them being very abundantly diffused in nature, and entering into an immense number of combinations with other bodies; and the third, namely, phosphorus, possessing very singular properties; it becomes of great importance that they should be early known.

The acids are treated of in the 10th chapter. They fall to be arranged in this place, because the constituent parts of some of the most important are derived from the substances which have been already treated of. The properties of the class of acid bodies ought also to be early known, because they are the most powerful instruments of analysis in the hands of the chemist. In many of them he can scarcely proceed a single step without their aid.

The bodies treated of in the 11th chapter, namely, alcohol, ether, and oils, under the head of inflammable substances, are now introduced, because the nature and properties of the substances which enter into their composition have been previously examined; because one of them is the result of a chemical action between the acids and alcohol; and because some of them are extensively employed as chemical agents. In the 12th, 13th, and 14th chapters, the properties and combinations of the alkalies, earths, and metals, are detailed. These three classes of bodies were formerly considered as alike, simple, undecompounded substances. That character, however, belongs only to the metals. Some of them have formed the subjects of the most important and interesting chemical researches. They are first to be treated of in their nature as simple or compound substances; and next, as they enter into combination with the different classes of bodies which are already known, particularly with that of the acids, forming the numerous classes of alkaline, earthy, and metallic salts, most of which are not only of vast importance, as objects of chemical research, but also of extensive utility in the arts of life.

In the six following chapters, our chemical knowledge is to be applied in explaining the appearances of nature, so far as they are supposed to depend on chemical action. The 15th chapter treats of the chemical changes and combinations which take place in the atmosphere. The waters, as they are found on the earth; the different ingredients with which they are impregnated; the nature and quantity of these ingredients, and the methods of discovering and ascertaining them, form the subject of the 16th chapter. The 17th chapter is employed in giving a view of the component parts of mineral productions, and in describing the methods of analyzing or separating the parts which enter into their composition. The functions of vegetables and animals, or those changes which take place in them in the living state, which seem to be dependent on chemical action; the changes which they undergo by spontaneous analysis, or separation into their constituent parts, and the nature and properties of these elements, will be the subject of discussion in the 18th and 19th chapters. The 20th chapter, in which chemical science is applied to the improvement of arts and manufactures, is not one of the least important and interesting; and a full view of this part of the subject would exhaust the whole of the useful detail of chemical knowledge. But, in the following treatise, it is not proposed to enter at full length into the different branches of the arts and manufactures, but only to give a slight view of their general principles, so far as they depend on chemistry, referring for the particular discussion of each to the different heads under which they will be found arranged in the course of the work.

Chap. I. Of AFFINITY.

Before we enter into the detail of those changes which take place by the action of bodies upon each other, producing compounds which are possessed of totally different properties, and thus exhibiting the characters of chemical action, it is necessary to take a view of the circumstances in which these changes are effected, or, in other words, the laws of combination or chemical affinity.

The term *affinity*, which is the expression of a force by which substances of different natures combine with each other, seems to have been pretty early employed by chemical writers. Barchusen seems to be among the first who employed it. "Arctam enim atque reciprocam inter se habent affinitatem." It was afterwards brought into more general use, and its application more precisely defined by Boerhaave*. His words are remarkable. "Particulæ solventes et solutæ, se affinitate suæ naturæ colligunt in corpora homogenea." And to explain his meaning still more clearly, he adds, "non igitur hic etiam actiones mechanicæ, non propulsiones violentæ, non inimicitiæ cogitandæ, sed amicitia." To avoid the metaphorical expression *affinity*, Bergman proposed the term *attraction*; and to distinguish chemical attraction, which exists only between particular substances, from that attraction which exists between all the bodies in nature, he prefixed the word *elective*. The word affinity, however, is now employed by all chemists.

49 History.

* *Elem. Chem.* part. 1.

The different tendencies of bodies to combine with

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each other, or the relative degree of affinity which exists between them, could not long be overlooked by those whose attention was occupied in observing chemical changes. And to explain this difference of action, a maxim of the schoolmen was adopted; *simile venit ad simile*.

50 Its action explained. The same doctrine was held by Becher, that substances which were capable of chemical combination, possessed a similarity of particles. Other attempts were made to explain chemical action, by considering solvents as consisting of points, finer or coarser, which were mechanically disposed to enter into the pores of certain substances which they were capable of holding in solution. But Stahl, as appears from his works, rejected the notion of mechanical force, and ascribed the power of solvents to contact, or

51 by Stahl. to the attraction of cohesion. "Combinationes quascunque non aliter fieri, quam per arctam appositionem." And afterwards, he speaks still more precisely when he says, "non per modum cunei, neque per modum incursus, in unam partidulam separandam, sed potius per modum apprehensionis, seu arctæ applicationis;" and then he adds, "est inde rationi quam maximæ consentaneum, quod effectus tales potius arctiore unione solventis cum solvente contingant, quam nuda et simplici formali instrumentali divisione †."

† *Specim. Beccher.* sect. i.

Having made this important step in the consideration of chemical action, the experiments and observations of the sagacious chemist led him to conclude that a combination between two substances, once formed, could not be destroyed, without effecting a more intimate union of one of the constituent parts with some other substance.

52 Tables invented, The next step in the method of observing and studying chemical affinity was made by Geoffroy the Elder. He collected the scattered facts, to determine the force or measure of their degrees of union, and to establish rules of analysis and composition. His first table of affinity was presented to the Royal Academy of Sciences at Paris in the year 1718. This consisted only of 17 columns, which were but imperfectly filled up, and exhibited rules, most of which have been changed; but with all its errors, it ought to be considered as one of the earliest true guides in medical knowledge.

53 enlarged, The first material improvement in Geoffroy's table was made by Gellert, professor at Freyberg. In his *Chemia Metallurgica*, published in 1750, there is a new table of affinity, which extends to 28 columns. At the bottom of each column is given a list of substances with which the body at the head of the column has no action. Rudiger, in the year 1756, inserted a table of affinity in his system of chemistry, in which he reduced the number of columns to 15. In this table he placed the fixed alkalies and lime parallel with each

54 and improved other, and before ammonia, the column of acids. He pointed out also with a good deal of accuracy, in a small separate table, those substances which refuse to combine without the agency of intermediate substances.

55 by Limbourg. The next important addition to the knowledge of affinities, was made by M. Limbourg. In his table the number of columns was extended to 33. This table was the fullest and most accurate of any that had yet appeared. He had justly observed that zinc, of all metallic substances, should be placed at the head in the column exhibiting the affinities of the acids, and that even in the dry way it precipitated them all. He asserted that lime and the caustic alkalies acted by affinity on animal matters: and besides, he stated some cases in which a change took place in the order of affinities, by a change of temperature, or by the volatility of one of the substances.

This subject, the importance of which was sufficiently obvious, was now assiduously investigated by many 56 By Bergman. chemists. The number of tables was multiplied, and the system of affinity more fully established. But the greatest improvement which it had hitherto received, was made by the celebrated Bergman, in his dissertation on elective attractions, published in the Transactions of the Royal Society of Upsal, in the year 1775. His tables, editions of which appeared in 1779 and 1783, have been justly regarded as commanding specimens of the sagacity and industry of the author. The affinities of 59 substances are ascertained with great accuracy: and the distinction between those that take place in the moist and dry way, is particularly stated, as well as the distinction between simple and compound affinities, which has led to the explanation of a great number of apparent anomalies. Since the time of Bergman, this subject has been prosecuted by many of the most distinguished philosophical chemists. Among these we may mention the industrious and indefatigable Kirwan of our country; and among the French philosophers, Morveau and Berthollet, more especially the latter, distinguished for his skill and sagacity, who, in his researches concerning the laws of affinity, and his Treatise on Chemical Statics, has opened a new field of inquiry, corrected many former errors, and pointed out some new laws in this interesting and important subject.

All bodies with which we are acquainted are influ- 57 All bodies attract. enced by a certain force, by which they are attracted towards each other. A stone, when unsupported, falls to the ground; the planets are attracted by the sun; two polished plates of metal, of glass, or of marble, when brought into close contact, adhere with a certain force; a piece of wood or stone requires a considerable degree of force to separate its particles; and lime and sulphuric acid enter into such close combination, that an equal degree of force is required to overcome that combination, or to separate the particles from each other. Whatever may be the nature of these attractions, or the cause of these different combinations, or whether they are all to be ascribed to the same universal law pervading matter, as some have supposed, they have been described by philosophers under different names. The attraction, which exists between all bodies in the solar system, was designated by Newton by the general term *attraction*; he demonstrated that this uniform and universal law was precisely the same as the law of gravitation, or the descent of heavy bodies towards the earth; that this attraction was an essential property of all matter; that the minutest particles, in proportion to their bulk, were equally influenced with the largest masses; that the same power which retained the planets in their orbits, gave form to the drops of rain.

That attraction which is exerted between two polish- 58 Different names of affinity. ed surfaces brought into contact, has been called *adhesion*. When particles of the same nature are attracted or held together, the expression of the force by which this is effected, has received the name of *cohesion*,

sion, *homogeneous affinity*, or the *attraction of aggregation*; but when dissimilar particles, or the particles of two substances of different qualities, combine together, the force or attraction which is here exerted has been called *heterogeneous affinity*, *the attraction of composition*, or, strictly speaking, *chemical affinity*. In the three following sections, we propose to give an account of the opinions and doctrines which have been held by philosophers with regard to the nature and force of these attractions. Of the two first we shall only take a short view; but shall enter more fully into the detail of the latter, namely, chemical affinity, which more strictly belongs to our present subject.

Sect. I. *Of Adhesion.*

By adhesion, is to be understood, that force which retains different substances in contact with each other. Thus, water adheres to the finger, which is said to be wet, and mercury brought into contact with gold, adheres with great force.

59 In what circumstances it happens.

Adhesion takes place, either between two solids, as marble or glass; or between solids and fluids, as when water rises in capillary tubes; or between two fluids, as water and oil. Dr Desaguliers found by experiment, that two plates of glass, of one-tenth of an inch in diameter, adhered with a force equal to 17 ounces. The adhesion of two fluids has been proved by the experiment of Lagrange and Cigna, as that of oil and water, between which it was formerly supposed there existed a natural repulsion; and the experiments on capillary attraction, and particularly the ascent of water between two panes of glass, which was ascertained by Dr Brook Taylor, have established the attraction between solids and fluids.

60 Accounted for.

This adhesive force, or the cause of this attraction, has been differently accounted for by philosophers. In a dissertation on the weight of the atmosphere, published in 1682 by James Bernoulli, he ascribes the resistance which two polished pieces of marble opposed to their separation to the pressure of the air; and in proof of this, he states as a fact, that the two plates could be easily separated *in vacuo*. But it has been supposed that he had either never attempted to verify this fact, or that the experiment had been accompanied by some fallacy. Dr Taylor concluded from his experiments, that the intensity of the adhesive power of surfaces might be measured by the weight which was required to separate them. About the same time Mr Hawksbee proved by experiment, that the adhesion of surfaces and capillary attraction were not to be ascribed to the pressure of the atmosphere, as Bernoulli had supposed: but Lagrange and Cigna, after having proved the adhesion between oil and water, thought that it was owing to a different cause from that of attraction. They supposed that it was occasioned by the pressure of the air, and that the opinion of Dr Taylor was not well founded. Such were the opinions held by philosophers on this subject, when Morveau, in the year 1773, instituted a series of experiments on adhesion, which he exhibited at Dijon. By these experiments he proved, that this attraction was not owing to the pressure of the air, but entirely to the mutual attraction of the two substances. To prove this, a polished plate of glass was suspended from the arm of a balance, and placed in contact with a surface of mercury. The weight necessary to separate the two surfaces was equal to nine gros and some grains. The whole apparatus was placed under the receiver of an air-pump, which was exhausted of the air as much as possible. Exactly the same force was still required to separate the surfaces. The same disk of glass brought into contact with pure water, adhered to it with a force equal to 258 grains; but from the surface of a solution of potash, it required only a force of 210 grains. This inequality of effects with equal diameters, and in the inverse order of the respective densities, seemed not only to be decisive in favour of Dr Taylor's method, but appeared to point out the possibility of applying it to the calculation of chemical affinities. For the force of adhesion being necessarily proportional to the points of contact, and the sum of the points of contact not varying in the adhesion of a fluid and a solid with equal surfaces, but by the figure of their constituent parts, the difference of the results points out to us precisely a cause analogous to that which produces affinity, the force of which it becomes easy, in these circumstances, to measure and compare.

61 Morveau's experiments.

To ascertain the accuracy of this method, plates of the different metals, of an inch in diameter, and of equal thickness, perfectly round, and well polished, were procured. They were furnished, each with a small ring in the centre, to keep them suspended parallel to the horizon. Each of the plates was suspended in turn to the arm of an assay balance, and accurately counterpoised by weights in the opposite scale. Thus balanced, the plate was applied to the surface of mercury in a cup, by sliding it over the mercury in the same manner as is practised for silvering mirrors, to exclude the whole of the air. Weights were then put into the opposite scale, till the adhesion between the plate and the mercury was broken. In each experiment fresh mercury was employed. The following table exhibits the results of these experiments.

	Grains.
Gold adheres to mercury with a force equal to	446
Silver	429
Tin	418
Lead	397
Bismuth	372
Zinc	204
Copper	142
Antimony	126
Iron	115
Cobalt	8

In considering the remarkable differences, we clearly see that the pressure of the atmosphere has little or no influence, since its effects must have been precisely similar in the different cases, nor do they depend on the difference of polish on the surface; for a plate of iron, simply smooth and filed, adheres more strongly than a plate of the same diameter which has received the highest polish. Nor are these differences owing to the difference of density; for in this case silver would follow lead; cobalt would adhere with a greater force than zinc, and iron with a greater than that of tin. On the contrary, the order of their densities is reversed. What then is the order in which the adhesion of these different substances takes place? It is precisely, says Morveau, the order of affinity, or the greater or less solubility

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Affinity.

lity of the metals in mercury. Gold, of all the metals, attracts mercury most strongly; but mercury dissolves neither iron nor cobalt, and therefore they are placed at the bottom of the list. This correspondence, he farther observes, cannot certainly be the effect of chance, but clearly depends on the general property of matter called attraction. This property, which is always the same, and always subject to the same laws, produces according to him very different effects, corresponding to the different distances between the particles occasioned by the variety of elementary forms; and thus it may be possible to estimate the force of chemical affinity by the force of adhesion. In the present case, for instance, the real affinities which tend to combine mercury with gold, silver, zinc, and copper, may be expressed by the above numbers 446, 429, 204, and 142.

62 Achard's.

Achard of Berlin, convinced by Morveau's experiments, of the accuracy of Dr Taylor's method, saw its importance in chemistry; and having examined the principle, made a great number of applications of it, which he published in 1780. The result of these observations, if accurately obtained, can alone guide us in estimating the points of contact by adhesion, and by calculating the points of contact, to ascertain the figure of the particles which touch, and the resulting affinities.

63 Requisites.

Three conditions are essential to the accuracy and uniformity of each experiment. 1. That the solid body whose adhesion with a fluid is to be estimated be so suspended as to be in a horizontal position, and that the force employed to detach it, should always act in a line which forms a right angle with the surface of the fluid. 2. That there be no air interposed between the surface of the solid and the fluid; and, 3. That the weights employed as a counterpoise may be added, especially towards the end, in very small quantity, not more than a quarter of a grain each; and to avoid any sudden jerk, they should be placed gently in the scale.

The first point which he wished to ascertain was, whether the difference of atmospherical pressure, the temperature remaining the same, caused any difference in the adhesion of surfaces. For he found that the adhesive force between a plate of glass and distilled water was the same at all pressures, but the uniformity of the results varied when he operated at different degrees of temperature, while the elevation of the barometer continued the same; and he found that this variation did not arise from the different temperatures of the surrounding air, but from that of the water. When the fluids are colder, the adhesion is the stronger; and the reason is obvious: containing more matter under the same volume, they must present a greater number of points of contact in the same space; and since the force of the adhesion is in proportion to the number of the points of contact, it ought to increase when the fluids are condensed by cold, and to diminish when they are rarefied by heat. Achard did not stop with observing these variations of the force of adhesion between glass and water heated to different temperatures; he subjected them to calculation, to verify his observations, and render their application easy to all degrees. We subjoin his table exhibiting the force of adhesion by observation, and also by calculation. He proceeded on the following data.

Let x be the temperature of the water, y the corresponding adhesion, b its coefficient, and a the constant force. We have then the equation $x=a-by$. To find the value of a and b, he employed two observations; the one in which water at 104° of Sulzer's thermometer, adhered to the glass disk with a force equal to 80 grains, and the other in which water at 56° adhered with a force equal to 89 grains. Proceeding from these two terms

$$104° = a - 80b$$
$$56 = a - 89b,$$
we have $a=530$
$$b = \frac{-48}{9}$$

And thus the relation of the temperature of water to its adhesion to glass may be thus expressed: $x=530-\frac{48}{9}y$; and from thence are deduced the corresponding values of x and y for all the adhesions of glass to water at any temperature. Such are the data from which, and the corresponding experiments, Achard formed the table which exhibits the adhesive force of a glass disk of $1\frac{1}{2}$ inch in diameter, to water at different temperatures; and shewing the difference of the results.

64 Adhesion of glass to water.

TABLE I.

Degrees of Sulzer's Therm.	Degrees of Fahren. Therm.	Adhesion by Experiment.	Adhesion found by Calculation.	Difference.
95	141.687	81.25 grs.	81.55	—0.3
90	135.914	82.5	82.5	0.
85	130.141	83.75	83.43	+0.34
80	124.368	84.5	84.37	+0.13
75	118.595	85.75	85.31	+0.46
70	112.822	86.	86.25	—0.25
65	107.049	87.25	87.18	+0.07
60	101.276	88.5	88.12	+0.38
55	95.503	89.	89.06	—0.06
50	89.730	90.25	90.	+0.25
45	83.957	90.75	90.93	—0.16
40	78.184	92.	91.87	+0.13
35	72.411	92.75	92.81	—0.04
30	66.638	93.75	93.73	+0.02
25	60.865	94.5	94.68	—0.18
20	55.092	95.75	95.62	+0.13
15	49.319	96.25	96.56	—0.31
10	43.546	97.5	97.5	0.

The temperature being supposed to continue the same, if this principle be well founded, the force of adhesion of any given body with water, ought not only to increase or diminish according to the extent of surface, but these differences ought to be as the difference of the surfaces.

If then p be the force with which a disk of glass whose diameter is a, adheres to water, and y the force of adhesion of another disk, whose diameter is b, we shall have the proportion $a^2 : b^2 :: p : y$ and $y=\frac{b^2p}{a^2}$.

To verify the order of this progression, either with water or other fluids, Achard employed disks of glass from $1\frac{1}{2}$ to 7 inches in diameter, having first ascertained their force of adhesion with these fluids, by the number

Affinity.

number of grains which were necessary to overcome it. He afterwards calculated the same by the above equation. The following Table exhibits the results of experiment and of calculation, which if the procedure be free from error, correspond as nearly as could be expected.

Affinity.

TABLE II.

The force of adhesion between glass disks of different diameters, and different kinds of fluids, determined by experiment and calculation.

65
To different fluids.

Diam. of the disk.	Distilled water.		Alcohol.		Liquid ammonia.		Solution of potash.		Oil of turpentine.		Linseed oil.	
Inches	Experim. grs.	Calcul. grs.	Exper. grs.	Calcul. grs.	Experim. grs.	Calcul. grs.	Experim grs.	Calcul. grs.	Experim. grs.	Calcul. grs.	Experim. grs.	Calcul grs.
1.5	364.		216.		328.		420.		240.		268.	
1.75	494.5	49.5	294.25	294.	447.	446.	571.	571.	326.5	326.	363.25	364.
2.	647.25	647.	384.	384.	582.	583.	746.	746.	425.	426.	475.	476.
2.25	818.75	819.	457.5	457.	738.	738.	945.	945.	539.	540.	604.	603.
2.5	1010.	1011.	600.	600.	912.	911.	1167.	1166.	667.	666.	744.	744.
2.75	1223.5	1223.	725.	726.	1103.	1102.	1410.75	1411.	806.	806.	901.	900.
3.	1457.	1456.	863.25	864.	1311.5	1312.	1680.5	1680.	961.	960.	1072.25	1072.
3.25	1709.	1708.	1015.	1014.	1538.25	1539.	1970.	1971.	1126.5	1126.	1259.	1258.
3.5	1981.5	1982.	1177.	1176.	1786.	1785.	2287.	2286.	1305.75	1306.	1458.5	1459.
3.75	2257.	2257.	1350.	1350.	2049.	2050.	2624.5	2625.	1500.	1500.	1675.25	1675.
4.	2587.	2588.	1538.	1536.	2332.	2332.	2986.	2986.	1707.	1706.	1905.	1905.
5.	4044.	4044.	2399.	2400.	3645.	3644.	4665.8	4666.	2666.	2666.	29.77	2977.
6.	5824.5	5824.	3455.5	3456.	5248.25	5248.	6721.	6720.	3839.5	3840.	4289.25	4288.
7.	7926.25	7927.	4703.	4704.	7143.	7143.	9146.	9146.	5227.	5226.	5835.75	5836.

Achard also instituted a series of experiments with different solid substances, formed into disks of equal diameters, and applied to the surface of different fluids. The following table shows the results of those experiments; but from these results it appears, that the force of adhesion does not depend on the specific gravity, either of the solid or the fluid; nor does it correspond with the order of chemical affinities. But besides, some of the results cannot be admitted as perfectly legitimate, on account of the chemical action which would necessarily take place when some of the substances were brought into contact; as some of the metals would be acted on by the acids, and others by the solutions of metallic salts.

TABLE

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TABLE III.

The force of adhesion of different solids, in disks 1.5 inch in diameter, with water and other fluids, at 70° Fahrenheit's thermometer, determined in grains.

66 Of different solids to different fluids.

FLUIDS. / SOLIDS.	Distilled water.	Sulphuric acid.	Concentrated vinegar.	Alcohol.	Acetite of lead.	Acetite of copper.	Deliquated potash.	Liquid ammonia.	Sulphuric ether.	Oil of turpentine.	Oil of almonds.
Specific gravity.	1000.	1868.4	1019.4	842.	1131.5	1000.	1368.4	1046.	828.9	881.5	907.8
Plate-glass	91.	115.	87.	54.	98.	96.	105.	82.	54.5	60.	66.
Rock-crystal	90.	112.	86.	52.	98.75	95.	103.	80.	53.	58.5	66.
Green oriental jasper		96.	120.5	96.25	99.8	88.5	91.	122.	85.5	84.	56.5
Gypsum	80.	199.75	78.	46.5	87.25	85.	93.	71.	48.	52.5	56.5
Sulphur	965.	123.	92.5	58.	107.	101.5	110.5	86.	57.5	64.	69.
Yellow wax	97.	120.5	92.75	56.5	106.5	103.	111.	88.	59.	64.	71.
Ivory	90.	114.	90.	92.	84.	86.	113.	80.	77.5	52.	
Horn	84.	104.75	85.	83.75	76.25	81.	106.	74.5	73.	48.75	
Iron	93.5	116.	88.	56.	104.	98.25	108.	83.5	55.5	61.	68.
Copper	96.5	123.	92.	57.25	106.	102.	112.	87.	58.	62.5	68.85
Tin	94.5		91.	55.5	103.5	100.	108.5	86.	54.75	61.	69.
Lead	100.25	129.25	98.	59.	111.	107.	115.	91.5	61.	67.	72.
Brass	99.	124.	96.	59.	110.	103.5	114.	90.	60.	65.	70.5
Zinc	96.		90.25	57.	106.25	102.	110.	85.75	56.75	61.25	69.

From all these observations, then, we may conclude, that the force of adhesion between different bodies is altogether independent of the pressure of the air; that it varies according to the number of points of contact of the touching surfaces; and that it is probably owing to the same cause as the force of affinity. It appears also, that the force of adhesion between solids and fluids is in the inverse ratio of the temperature indicated by the thermometer, and the direct ratio of the squares of their surfaces; that different solids adhere with different degrees of force to the same fluid; but still it must be allowed, that experiments and observations are yet wanting, to derive any advantage from the results of adhesive force which have been obtained, in the cultivation of chemical affinities.

SECT. II. *Of the Attraction of* AGGREGATION.

67 Cohesion. That force which is inherent in the particles of matter, by which they are held together, and form masses, is called *cohesion;* and when particles of the same kind are united together, it is denominated the *attraction of aggregation*, or *homogeneous affinity*. It is probably the same in kind with that which we have already considered, but differing in degree. Thus, it requires a much greater force to separate the particles of a mass of marble, than two polished surfaces of the same substance brought into contact.

As the force of cohesion often opposes itself to chemical action, and must in the researches of the chemist be destroyed or overpowered, it becomes a matter of considerable importance to be able to estimate it. This force differs greatly in different bodies. A very great force is necessary to overcome the power of cohesion among the particles of an iron or gold wire, while a small degree of force can separate the particles of a piece of wood or stone. To ascertain this force, experiments have been made by different philosophers, and particularly by Muschenbroeck, on that of the cohesion of solid bodies. A rod of the substance whose 68 Difference of force.

Affinity.

cohesive force was to be estimated, was suspended perpendicularly, and weights attached to the lower extremity. The weight necessary to destroy the cohesive force of the particles of matter in the rod, or to tear it asunder, was considered as the measure of that force. The following are the results of his experiments made on different substances. The substances employed were rods of an inch square, and the numbers in the table indicate pounds avoirdupois.

METALS.

Steel, bar	135,000
Iron, bar	74,500
Iron, cast	50,100
Copper, cast	28,600
Silver, cast	41,500
Gold, cast	22,000
Tin, cast	4,440
Bismuth,	2,900
Zinc,	2,600
Antimony,	1000
Lead, cast	860

METALLIC ALLOYS.

Gold 2 parts, silver 1 part,	28,000
Gold 5, copper 1,	50,000
Silver 5, copper 1,	48,500
Silver 4, tin 1,	41,000
Copper 6, tin 1,	55,000
Brass,	51,000
Tin 3, lead 1,	10,200
Tin 8, zinc 1,	10,000
Tin 4, antimony 1,	12,000
Lead 8, zinc 1,	4,500
Tin 4, lead 1, zinc 1,	13,000

WOODS.

Locust tree,	20,100
Jujeb,	18,500
Beech and oak,	17,300
Orange,	15,500
Alder,	13,900
Elm,	13,200
Mulberry,	12,500
Willow,	12,500
Ash,	12,000
Plum,	11,800
Elder,	10,000
Pomegranate,	9,750
Lemon,	9,250
Tamarind,	8,750
Fir,	8,330
Walnut,	8,130
Pitch pine,	7,656
Quince,	6,750
Cypress,	6,000
Poplar,	5,500
Cedar,	4,880

BONES.

Ivory,	16,270
Bone,	15,250
Horn,	8,750
Whalebone,	7,500
Tooth of sea-calf,	4,075

Various opinions have been entertained of the nature of this cohesive force. According to Newton, as we have already observed, it is properly essential to all matter, and the cause of the variety observed in the texture of different bodies. "The particles," says he, "of all hard homogeneous bodies which touch one another, cohere with a great force; to account for which some philosophers have recourse to a kind of hooked atoms, which, in effect, is nothing else but to beg the thing in question. Others imagine that the particles of bodies are connected by rest; that is, in effect, by nothing at all; and others by conspiring motions, that is, by a relative rest among themselves. For myself, it rather appears to me, that the particles of bodies cohere by an attractive force, whereby they tend mutually towards each other: which force, in the very point of contact, is very great; at little distances is less, and at a little farther distance is quite insensible."

69 Opinions on the nature of cohesion.

70 Newton's

71 Desaguliers.

"If compound bodies," Dr Desaguliers observes, "be so hard as by experience we find some of them to be, and yet have a great many hidden pores within them, and consist of parts only laid together; no doubt those simple particles which have no pores within them, and which were never divided into parts, must be vastly harder. For such hard particles gathered into a mass cannot possibly touch in more than a few points; and therefore, much less force is required to sever them, than to break a solid particle whose parts touch throughout all their surfaces, without any intermediate pores or interstices. But how such hard particles only laid together, and touching only in a few points, should come to cohere so firmly, as in fact we find they do, is inconceivable; unless there be some cause by which they are attracted and pressed together. Now, the smallest particles of matter may cohere by the strongest attractions, and constitute larger, whose attractive force is feebler: and again, many of these larger particles cohering, may constitute others still larger, whose attractive force is still weaker; and so on for several successions, till the progressions end in the largest particles, on which the operations in chemistry, and the colours of natural bodies, do depend; and which, by cohering, compose bodies of a sensible magnitude."

72 Boscovich's

A theory, which possesses great ingenuity and plausibility, has been proposed by Boscovich, to account for cohesive attraction; and some suppose, that it is on immaterial means or powers that this attraction, according to this theory, depends. Dr Hutton * seems to think, that Dr Priestley applies it in this view, in the following passage, in which he attempts to solve some difficulties with regard to the Newtonian doctrine of light. "The easiest method," says Dr Priestley, speaking of this subject, "of solving all difficulties, is to adopt the hypothesis of Mr Boscovich, who supposes that matter is not impenetrable, as has, perhaps, been universally taken for granted; but that it consists of physical points only, endued with powers of attraction and repulsion, in the same manner as solid matter is generally supposed to be: provided, therefore, that any body move with a sufficient degree of velocity, or have a sufficient momentum to overcome any powers of repulsion that it may meet with, it will find no difficulty in making its way through any body whatever:

* Math. Dict. 257.

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ever: for nothing else will penetrate one another but powers such as we know do in fact exist in the same place, and counterbalance or overrule one another. The most obvious difficulty, and indeed almost the only one, that attends this hypothesis, as it supposes the mutual penetrability of matter, arises from the idea of the nature of matter, and the difficulty we meet with in attempting to force two bodies into the same place. But it is demonstrable, that the first obstruction arises from no actual contact of matter, but from mere powers of repulsion. This difficulty we can overcome, and having got within one sphere of repulsion, we fancy that we are now impeded by the solid matter itself. But the very same is the opinion of the generality of mankind, with respect to the first obstruction. Why, therefore, may not the next be only another sphere of repulsion, which may only require a greater force than we can apply to overcome it, without disordering the arrangement of the constituent particles, but which may be overcome by a body moving with the amazing velocity of light †."

† *Hist. of Vision*, vol. i. p. 392.

73 Explained. According to the theory of Boscovich, the first elements or atoms of matter are indivisible, unextended, but simple, homogeneous, and finite in number. They are dispersed in one immense space, in such a manner, that any two or more may be distant from each other any assignable interval. This interval may be indefinitely augmented or diminished, but cannot entirely vanish. Actual contact of the atoms is therefore impossible, seeing that the repulsive power which prevents the entire vanishing of the interval must be sufficient to destroy the greatest velocities by which the atoms tend to unite. The repulsive power must encircle every atom, must be equal at equal distances from the atoms, and, moreover, must increase as the distance from the atoms diminishes. On the contrary, if the distance from the atoms increases, the repulsive power will diminish, and at last will become equal to nothing or vanish; then, and not till then, an attractive power commences, increases, diminishes, vanishes. But the theory does not stop here; for it supposes, that a repulsive power succeeds to the second or attractive, increases, diminishes, vanishes; and that there are several alternations of this kind, till at the last an attractive power prevails; and though diminishing sensibly, as the squares of the distances increase, extends to the most distant regions of our system. All the varieties of cohesion, Boscovich has shown, may be satisfactorily accounted for from the diversity of size, figure, and density of the cohering particles.

74 Matter in three states. Bodies exist in three different states, which are quite distinct from each other; in the solid state, the liquid, and in the state of elastic fluid. Solidity, he supposes, is the consequence of the irregular figure of the particles, and their great deviation from the spherical form, 75 Solid. by which free motion among them is prevented. And thus, in solid bodies, the motion of one particle is followed by that of the whole mass; or if the motion of the whole mass requires a greater force to effect it than what is necessary to destroy the cohesion of the particles, the latter takes place. The diversity in solids arises from the various degrees of force in the limits of cohesion.

76 Fluid. The particles of fluid bodies, according to Boscovich, are spherical, and their forces are more directed to their centres than to their surfaces; by which motion is freely allowed when any force is applied. Fluids, he supposes, are of three kinds; one in which the particles have no mutual power, as sand and fine powders; one in which they have repulsive power; such are the elastic fluids, as air: and the third in which they have an attractive power, as water, mercury, &c. And these three kinds are produced by the primary differences in the particles which compose them. 77 Of three kinds.

There is a class of bodies which are intermediate between the solids and fluids; the nature of which may be explained on the same principles. These are the viscid substances, the particles of which attract each other more strongly than the fluids, but not so strongly as the solids. In these bodies the particles deviate so far from the spherical form, as to produce a certain resistance among each other, and to impede their relative motion. 78 Viscid substances.

According to this theory, chemical phenomena may be traced to the same principle, namely the law of the forces and the differences in the particles which thence arise. Solution, for instance, is thus explained. The particles of some solid bodies have less attraction for each other than for the particles of some fluids, and consequently when these are applied to each other, the particles of the solid separate, and combine with those of the fluid; and thus a mixture of the two is formed. But the separation of the particles of the solid can only take place so long as the particles of the fluid are in the sphere of their attraction; and when either of them get beyond it, or when the attraction of the mixture thus formed becomes equal to the attraction of the particles of the solid for each other, no farther solution takes place, and the fluid is said to be saturated. But if, into this mixture, another solid, whose particles have a greater attraction for the fluid, be introduced, the fluid will leave the former solid and combine with the particles of the latter. The particles of the former will fall to the bottom, i. e. *precipitation* will take place. 79 Solution.

Substances which are dissolved, may not only be obtained again by precipitation, but also by slowly abstracting part of the fluid in which they are dissolved. This is called *evaporation*, and the solid bodies which are thus slowly formed, generally assume some regular shape, and are denominated *crystals*. As the fluid is removed, the particles come gradually into the sphere of the attractive power of each other, and thus attain to some limit of cohesion, when the fluid which kept them asunder is removed. But when a solid is obtained by precipitation, the fluid is suddenly removed from betwixt the particles, which are consequently left beyond the sphere of attraction of each other, and do not therefore assume any regular form. And thus it will follow, that the more slowly the process of evaporation goes on, the more regular will be the crystals which are formed; and this corresponds with experiment and observation *. 80 Evaporation.

* See *Boscovich's theory*.

Thus, solid bodies are found, either in irregular masses, or assuming regular forms by crystallization; and the same substances which are capable of assuming regular figures, uniformly affect the same form; subject, however, to certain variations from particular circumstances. No bodies can assume the form of crystals, 81 Crystallization.

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crystals, excepting such as can be reduced to the fluid state. This, as is well known, is the usual method of crystallizing salts. The substances to be crystallized are dissolved in water, which is then slowly evaporated; and as the bulk of the fluid is diminished, the particles gradually come nearer to each other, combine together, and form crystals. These crystals, which are at first small, receiving the addition of other particles, become larger, and fall to the bottom by their gravity.

Some saline bodies, which are very soluble in hot water, are dissolved but in small proportion in cold water. Hot water, which is saturated with any of these salts, is no longer capable of holding them in solution when it cools. The particles then gradually approach each other, and arrange themselves according to certain determinate forms, or in other words, they crystallize. Many of the saline bodies which crystallize in this manner, when they assume the solid form, combine with a considerable portion of water, which is called the *water of crystallization*. There is another class of saline bodies which assume regular forms according to a different law. Being equally soluble in hot and in cold water, they cannot be crystallized by cooling the fluid in which they are dissolved, but by diminishing its quantity; and this is effected by continuing the application of heat; that is, by the process of evaporation. Salts which are crystallized in these circumstances, contain but a small quantity of water of crystallization. This is the case with common salt, which is crystallized by boiling the fluid which holds it in solution.

Many substances assume regular forms which are not soluble in any liquid. Such, for instance, is the case with metallic substances, and with glass, as well as some other bodies. To crystallize substances of this nature, they must be subjected to fusion, and thus by combining with caloric, they are reduced to the liquid state, and the particles being separated from each other, are left at liberty to arrange themselves into regular crystalline forms, and by slow and gradual cooling, the crystals are obtained more perfect.

82 Accounted for by

But what is the cause that the particles of bodies in these circumstances arrange themselves in this manner? or what is the cause of the same bodies in the same circumstances assuming regular figures? Some of the ancient philosophers considered the elements of bodies as consisting of certain regular geometrical figures; but it does not appear that they employed this theory to explain crystallization. The regular figure of crystals was ascribed by the schoolmen to their substantial forms; while others supposed that it was owing merely to the aggregation of the particles, without explaining the reason of this aggregation, or of the regular figures which it formed.

83 Newton,

According to Newton, and the theory of Boscovich which we have quoted, the particles of bodies which are held in solution by a fluid, are arranged in regular order, and at regular distances. When the force of cohesion between the particles and the fluid is diminished, that between the particles themselves is increased; they therefore separate from the fluid, and combine together in groups, which are composed of the particles nearest to each other. If it be supposed, that the particles which compose the same body have the same figure, the aggregation of any determinate number of such particles will produce similar figures. According to the ingenious theory of the Abbé Hauy, the integrant particles always combine in the same body in the same way; they attach themselves together by the same faces or the same edges; but these faces and edges are different in different crystals. And although the same substances are observed to crystallize in a great variety of different forms, yet they all contain what Hauy calls the *primitive* form, or have it within them as a nucleus; and this nucleus or primitive figure may be extracted by careful mechanical division. If then the figure of crystals is owing to the figure of the integrant particles, and to the peculiar mode of their arrangement in combination, these particles, when they are left at full liberty, as is the case when they are dissolved in a fluid, will combine in the same way, and thus the crystals of the same body will always exhibit similar forms.

84 by Hauy,

85 who ascribes it to

86 the primitive forms.

In prosecuting this subject, Hauy found that all the primitive forms of crystals which he had observed, might be reduced to six; namely,

1. The parallelopiped.
2. The tetrahedron.
3. The octahedron.
4. The regular six-sided prism.
5. The dodecahedron, terminated by equal rhombs.
6. The dodecahedron, with triangular faces, composed of two pyramids, united base to base.

But the nucleus or primitive form of a crystal, he observes, is not the last term of its mechanical division. It may be subdivided parallel to its different faces, and sometimes also in different directions. If the nucleus or primitive form be a parallelopiped, which cannot be subdivided, but in a direction parallel to its faces, as takes place in carbonate of lime, it is obvious that the integrant particle or molecule is similar to the nucleus itself. And he has found by experiment, that the figure of the integrant particles of all crystals may be reduced to the three following. These are,

87 Figure of the integrant particles.

1. The tetrahedron, or the simplest of all pyramids.
2. The triangular prism, or the simplest of all the prisms.
3. The parallelopepid, or the simplest of the solids which have their faces parallel two and two.

From these primitive forms, the difference of size, proportion, and density of the different particles of bodies, he supposes, may account for all the differences of attraction which take place in simple aggregation and composition of bodies. The integrant particles sometimes unite by their faces, and sometimes by their edges, in forming the primitive crystals; and this accounts for the different figures of the primitive crystals, which are composed of integrant particles of the same form. But bodies when they are crystallized do not always exhibit the same primitive form. The deviations from this, and the varieties of forms which are produced, are called by Hauy *secondary forms*. In some salts, for instance, the primitive form is the octahedron; but in deviating from this form, they assume, when crystallized, that of the cube or the dodecahedron.

88 Secondary forms

These secondary forms seem to depend sometimes on variations in the ingredients which compose the integrant particles of particular bodies, the solvent in which

Affinity. which the crystals are formed, or the different decrements of the laminæ of the crystals. But for a full view of this ingenious theory, see CRYSTALLIZATION.

SECT. III. *Of the Attraction of* COMPOSITION.

Bodies which are composed of particles of the same nature cohere with a certain force, as in the particles of water or of mercury, and those of wood or of metal; and this force, we have seen, acts with very different degrees of intensity. In the two former, the water and the mercury, it is comparatively weak, but in the two latter it is very powerful.

89 explained. But the particles of dissimilar bodies also enter into combination; and thus combined, form homogeneous substances, the parts of which cohere with great force; and wherever these combinations take place, the force of cohesion formerly subsisting between the particles of each of the bodies must be destroyed or overcome, before the new combination can take place. Thus a piece of marble is dissolved in muriatic acid; but before this can take place, the force of cohesion which existed between the particles of the marble must be overcome; or, in other words, the force of attraction between the particles of muriatic acid and the particles of the marble must be greater than that between the particles of marble themselves. This attraction then which exists between the particles of substances of a different nature, has been called the *attraction of composition, heterogeneous affinity*, or more properly *chemical affinity*.

90 This affinity limited. An attraction or affinity, thus efficient, does not exist between the particles of all bodies. Thus there is no affinity between a piece of marble and water, as is the case between marble and muriatic acid, or it is not sufficient to overcome the attractions opposed to it; and it has been thought that there is no affinity between oil and water, because the particles of the one do not enter into combination with those of the other.

91 Importance of it. Chemistry may be said to be the history of affinities, as it consists in the detail of the numerous compositions and decompositions which take place among natural bodies. Without attending to the phenomena which arise from affinity, the chemist could carry on no process, either of synthesis or analysis; for it is by means of their affinities that the chemical nature of bodies can be discovered.

In taking a general view of the phenomena which depend upon chemical attraction, the changes or events which are the results of this action, have been divided into certain classes, and from their being constant and uniform, they have been characterized by the name of *laws of chemical affinity*. These may be considered as chemical axioms, which are the principles or foundation of the science, and therefore it is necessary that they should be well understood, before we enter into the detail of the facts which it embraces.

92 Laws. Fourcroy has arranged the facts which depend on chemical affinity under ten different heads, which he has denominated *the laws of affinity*. In illustrating this interesting part of chemical science, we shall observe the same arrangement.

FIRST LAW.

Chemical affinity takes place only between bodies of a different nature, or between dissimilar particles. 93 Affinity between dissimilar particles.

This law, when considered as a law of chemical affinity, may be regarded as negative; for when the particles of bodies of the same nature combine together, it is by the force of cohesion, and therefore comes under that species of affinity called the attraction of aggregation. No chemical action has taken place, no new compound is formed; which are the characteristics of chemical affinity.

But as an instance of the effect of chemical affinity between two bodies of a different nature, we may refer to the experiments above alluded to, of the combination which takes place between a piece of marble and muriatic acid; for by mutual action between these two bodies the marble has disappeared, and the acid has totally changed its properties. The compound, which is the result of this combination, proves that the heterogeneous bodies have entered into intimate mutual union.

Chemical affinity may act between two bodies, and a combination take place, when these bodies are totally uncombined with all others. In this case the combination is produced by the force of affinity between the two bodies; but when one or both of these bodies is in a state of combination with others, the bodies which are said to have the greater affinity for each other, do not entirely combine together, and leave the bodies with which they were first in combination. Suppose A and B are two bodies which have an affinity for each other, and are in a state of combination; and suppose C is a third body which has a stronger affinity for the body B than the affinity which exists between A and B. Now, the body C having a greater affinity for the body B than what exists between the compound body AB when it is brought into circumstances where the force of that affinity can be exerted, the compound body AB will be decomposed, that is, the body C will combine with the body B, and will leave the body A. It was formerly supposed by chemical philosophers, that this decomposition was complete; that is, as in the case stated above, the affinity between C and B being greater than the affinity between A and B, the body C, when in sufficient quantity, abstracted every particle of the body B from its combination with the body A. But the experiments and observations of the sagacious Berthollet have placed this matter in a new light. This will be best illustrated by detailing some of the experiments by which this ingenious philosopher has clearly ascertained many curious facts with regard to chemical affinity (D).

The sulphuric acid has a very strong affinity for the earth

(D) The reader, it is hoped, will find no difficulty in understanding the general reasonings on this subject; but if he should, he will be able to comprehend it fully by reverting to them, after the substances whose affinities are given as examples, are treated of in detail in their proper places.

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Affinity.

earth called barytes, forming with it a compound which is insoluble either in hot or cold water. Sulphuric acid
94 Examples. also has an affinity for potash, but it is much weaker than that which exists between the acid and barytes; yet the potash, although possessed of the weaker affinity, abstracts part of the sulphuric acid from the barytes, and combines with it. This is proved by Berthollet in the following experiments.

1. He took equal quantities of pure potash, and sulphate of barytes (E), and boiled them together in a small quantity of water. According to the views which former chemists entertained of chemical affinity, no decomposition should take place, because the affinity between the sulphuric acid and the barytes was stronger than that between the acid and the potash. But from the result of this experiment it appears, that the sulphate of barytes was partially decomposed by the potash, and that the sulphuric acid was divided between the two bases; that is, between the barytes and the potash.

2. The oxalic acid has a greater affinity for lime than for potash; but if oxalate of lime, that is oxalic acid combined with lime, be boiled along with potash in a small quantity of water, in the proportion of one part of the oxalate of lime to two of the potash, a partial decomposition of the oxalate of lime will take place, part of the oxalic acid is abstracted from the lime, and combines with the potash*.

* Researches, Transl.

95 Affinity increased by the mass. 3. One part of phosphate of lime was boiled together in a small quantity of water with two parts of potash. The phosphoric acid has a greater affinity for lime than for potash; but from this experiment it appeared that the phosphate of lime was partially decomposed, and part of the phosphoric acid having combined with the potash, formed a new compound, phosphate of potash.

From these experiments Berthollet observes, that the bases which are supposed to form the strongest combinations with the acids may be separated from them by others whose affinities are supposed to be weaker, and that the acid divides itself between the two bases. Where a small quantity only of the decomposing substance is employed, the effect is not perceptible: but if a large quantity be employed, as in one of the above exeriments, if the sulphate of barytes had been treated with successive portions of potash, it would have been ultimately and almost entirely decomposed; for the weaker affinity of any body is made up by increasing the quantity of that body.

Bergman has remarked, that if six times as much of the decomposing substance be employed as is sufficient to saturate the base, a decomposition will be effected, which may be considered as total, because the opposing substance retains so small a part of that with which it was combined, that it may escape the observer's notice, and be considered as an evanescent quantity. But the above experiments shew, that a similar decomposition could be produced, if the reverse of the experiment which Bergman recommends had been attempted.

When one substance acts on another in combination with a third, the subject of combination divides itself between the two others, not only in proportion to the energy of their respective affinities, but also in proportion to their quantities. The two substances which act on the combination may be considered as opposing forces acting on the subject of combination, and sharing it between them in proportion to the intensity of their action; and this intensity may be estimated by the quantity of the substance and the energy of its affinity. The effect, therefore, must increase or diminish as the quantity increases or diminishes. Thus it appears that elective affinity in general does not act as a determinate force by which one body can completely separate another from a combination; but that in all compositions and decompositions produced by affinity, there is a partition of the subject of the combination between the two bodies, the energy of whose affinities is opposed, and the proportions of this partition depend not solely on the difference of energy in the affinities, but also on the difference of the quantities of the bodies; for it has been observed that an excess of the quantity of the body whose affinity is the weaker, compensates for the weakness of affinity.

Second Law.

Chemical affinity takes place only between the ultimate particles of bodies. 96 Affinity between the ultimate particles.

The attraction of aggregation or cohesion which is exerted between the integrant particles of bodies, is opposed to the action of chemical affinity. For, as in the case just mentioned, of the combination that takes place between a piece of marble and muriatic acid, the force of cohesion between the particles of the marble must be overcome before chemical action begins, and a new compound can be formed. The new compound consists of the constituent particles of the two bodies, which are now intimately united by the force of affinity existing between them.

Third Law.

Chemical affinity takes place between several bodies. 97 Between several bodies.

It is not merely compounds consisting of the particles of two bodies, that are formed by chemical affinity, for we shall find that there are numerous instances of three or four substances entering into chemical combination. Alum, a well known substance, is a compound of three substances which have entered into chemical union. These are, sulphuric acid, alumina or pure clay, and potash. The same thing happens also in all those compounds which were formerly called triple, now double salts, which consist, like alum, of three different substances, i. e. a double base to the acid; but the most remarkable instances of the effects of chemical affinity on several bodies are observed in the alloys of some of the metals. The temperature at which the metals are fused is generally pretty high, but the alloys of some of them may be brought to a state of fusion at
a low temperature. This is the case with the alloy of 98 Alloy of metals.
bismuth, lead, and tin, which may be melted at the temperature of boiling water, which is far below the fusing

(E) This is the compound of sulphuric acid and barytes, according to the new chemical nomenclature, the principles of which will be afterwards explained.

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Affinity. fusing point of any of the uncombined metals, and shews by this change of their properties, that a chemical union has been effected.

FOURTH LAW.

99 One body must be fluid. *That chemical affinity may take place between two bodies, it is necessary that one of them be in the liquid or fluid state.*

This law is not strictly universal. In some instances solid bodies presented to one another combine to form a fluid. This is the case with ice and snow.

The solution of a solid body in a fluid, may be considered as the destruction of the cohesion of its particles, and their equal diffusion in that fluid. It is the combination of the particles of the solid with those of the fluid; and the compound still possesses the characteristic physical properties of the fluid. Thus, in the first place, the force of cohesion between the particles of a solid body is destroyed, by its solution in a fluid; which force must always be overcome before a new compound can be formed by the action of chemical affinity. But, 2dly, The particles of a body dissolved in a fluid are in their ultimate, or at least a very minute, state of division; by which means the points of contact between the particles of the body held in solution, and those of any other with which it may combine, are greatly multiplied, and thus the operation of chemical action between these particles is greatly extended. Many familiar processes are examples of the effects of solution, as sugar dissolved in water; common salt in the same fluid; or the experiment mentioned above, of marble in muriatic acid. In the process of making glass we have another example of the same nature. The two substances which enter into the composition of glass are in the solid state. These are siliceous earth or sand, and an alkali. But to effect the combination of the two solids, one of them is brought to the fluid state by the application of heat. The alkali first melts, and in the state of fusion the sand or siliceous earth combines with it, and forms an uniform compound, which is glass.

100 Effect of solubility. But Berthollet has shewn, that the solubility of bodies has a very great influence in modifying the action of chemical affinity. For, he observes, when a body is in some degree soluble, its action is composed of that of the part dissolved and of that of the part which has retained its solidity. It follows that its action does not increase in proportion to the quantity employed. Lime, for instance, acts by the part dissolved, and by that which remains solid; but it is probably the dissolved part which contributes principally to the effect produced. If the quantity of lime employed in an experiment be doubled, without increasing the quantity of the liquid, the quantity of lime dissolved will rather be diminished than increased, because a part of the liquid is absorbed by the lime which has been added.

When an insoluble combination can become soluble by being deprived of a part of its composition, the inconvenience of insolubility is easily removed. Thus it is when the phosphate of lime is acted on by an acid. The part of it which is within the sphere of action is instantly converted into super-phosphate, and the other part successively, until both the opposed substances be reduced to a liquid state.

"When an eliminated substance becomes insoluble, the precipitate which is formed retains a portion of the substance with which it was combined, in proportion to the individual forces which acted in the moment of the precipitation. The operation is no farther influenced by this portion, so that the quantity of the precipitating body adequate to the precipitation is all that is necessary until the end of the operation. But the case is different when the eliminated substance assumes the liquid state, for then the resistance increases according to the progress of the decomposition; and hence it follows, if a substance nearly insoluble be opposed to a combination, and its action be consequently only partial, whilst the substance eliminated remains liquid, that the decomposition must be quickly stopped, whatever may be the force of the affinities. Because it has been already shewn, that the decomposing action depends not merely on the affinities, but also on the relative quantities in action. When the sulphate of potash was decomposed by means of lime, the operation was necessarily stopped as soon as the sulphuric acid was entirely divided between the potash and lime, in proportion to their respective affinities, and to the quantity of each which had acted on the sulphuric acid; that is, in proportion to their respective masses *."

* *Berthollet's Researches.*

But fluids in the elastic state, or the state of gas, are subjected to forces which are the reverse of the force of cohesion; and thus modify in a different manner the effects of the particular affinity of each substance. Elasticity acts, either by the removal of some substances from the action of others, or by diminishing the proportion of them that comes within the sphere of action. But if all the substances in action be in the elastic state, this effect will not follow, because then they all exist in a similar condition. When a substance, on separating from a state of intimate combination, assumes the state of gas, it becomes elastic, and then it can oppose no further resistance to the decomposing action. And thus it appears that substances of this nature do not act by their mass. A complete decomposition can then be effected by the decomposing substance, and no greater quantity of it is required than what would have been necessary to form the compound by direct combination. Thus, carbonic acid, which is an elastic fluid, may be disengaged from its combination by another substance whose affinity for the base may be less, because that other substance can act by its mass, and can therefore overcome the affinity of the carbonic acid by its successive action. But if the whole of the carbonic acid is to be expelled, the decomposing substance must be used in greater quantity than what is strictly necessary to produce saturation. 101 Elastic fluids.

The action which takes place when concentrated sulphuric acid is poured on dry common salt, that is, both substances being as much as possible deprived of water, affords a good illustration of the effect of the elasticity of one of the substances. Common salt is composed of muriatic acid and soda. The affinity of the sulphuric acid for soda is greater than that of muriatic acid. When, therefore, the sulphuric acid is poured on the common salt, it combines with the soda, and the affinity of the muriatic acid is diminished. It consequently assumes the gaseous state, and acts no longer by its mass. But if a solution of common salt in 102 Example.

Affinity. in water be employed, or a diluted acid, then the muriatic acid may be retained in the water, and in this case it can act by its mass.

When, therefore, a substance is in the state of gas, its elasticity is to be considered as a force opposed to the affinity of liquid substances. When the elasticity of gaseous substances is diminished, as happens by compression, they then combine in greater quantity with liquids. When water is brought into contact with carbonic acid, which is in the state of gas, it does not become saturated with that acid, because the elasticity of the gaseous acid opposes the dissolving power of the water: and before its dissolving force is exhausted, the two forces are balanced. But when the opposing elastic force is diminished, as by compression, the dissolving power of the water continues its action, and thus it is more fully saturated with the acid.

Fifth Law.

103 Change of temperature. *When bodies combine together, they undergo a change of temperature.*

All bodies contain a certain quantity of caloric, or the matter of heat; but when any change takes place in the nature or constitution of any body, its power of retaining that portion of caloric is also changed. During these changes heat is either given out or absorbed; and this increase or diminution of temperature becomes obvious to our senses, or may be measured by the thermometer.

The effects of this variation of temperature will be greater or less, in promoting or retarding the action of chemical affinity, according to the change which takes place on the substances which are decomposed, or according to the state of the compound which is formed. When there is a great elevation of temperature, in consequence of the heat produced by the combination of substances, it is necessary to attend to the difference of volatility of which the substances are susceptible by that elevation of temperature. If the substances are not all in the liquid state, or if one of them only be soluble, the effect of heat is to favour their mutual action; because the force of cohesion, which acts even between the particles of bodies in the liquid state, is thus diminished. If the expansion by heat of the one of two substances be greater than that of the other, the more expanded substance acquires a greater degree of elasticity, and this, as has been already observed, must be considered as a force opposing the affinity which existed between the two bodies.

104 Examples. In chemical combinations, according to this law, the temperature changes. The increase or diminution of temperature, according to the nature of the combination which is effected, will be best illustrated by an example or two.

1. When lime is slaked, that is, when water is thrown upon burnt lime, a great elevation of temperature takes place. The water enters into combination with the lime; it passes from the fluid to the solid state; and during this change, a great quantity of caloric, or the matter of heat, is given out, which is the cause of the increase of temperature (F). Affinity.

2. As an example of two fluids when mixed together producing a similar effect, take four parts of concentrated sulphuric acid, and pour it on one part of water; the temperature of the combined fluids will be elevated to the boiling point of water.

In the solution of solid bodies in a fluid, there is a great change of temperature: but in this case it is diminished. This is particularly the case when salts are dissolved in water.

1. Take muriate of ammonia, or sal ammoniac, and dissolve it in water, and while the solution is going on, if a thermometer be plunged into it, a considerable fall of the mercury will be found to take place in consequence of the absorption of caloric, or the diminution of temperature.

2. If a quantity of water, at the temperature of 50° or 60° of Fahrenheit, be poured on an equal quantity of ice, the temperature of the water will be diminished to the freezing point, or 32°.

3. A very low temperature is produced by a mixture of ice and common salt; and a still lower by a mixture of snow and powdered muriate of lime. We shall become better acquainted with the effects of these substances in explaining the method of producing artificial cold.

Sixth Law.

The compounds formed by chemical affinity possess new properties, and different from those of their constituent parts. 105 Compounds have new properties.

We are too little acquainted with the nature of chemical affinity, to be able to determine, *à priori*, what is to be the result of a combination between two substances. No information can be obtained what the nature of the union will be, from knowing the properties of the substance which are to be combined. It is only by experiment that the nature and properties of the new compound can be ascertained.

Unwilling to suppose, or unable to conceive, that the properties of the two substances which enter into combination, had totally disappeared in the new compound, the earlier chemists imagined that the properties of the latter were of a middle nature, consisting of the mixed properties of the composing substances. Hence the compounds of the acids and the alkalies were denominated *middle salts*, *sales medii*, from possessing the combined properties of their component substances.

But the truth of this doctrine, with regard to the nature of compound substances, has been fully disproved by the more accurate observations of modern chemists; for it is found by experiment, that the compound formed often exhibits not a single property of any of the substances of which it is composed. From two mild and insipid substances, a compound is formed which is highly acrid and corrosive; and the result of the combination of two powerfully corrosive substances, is frequently a mild and insipid compound.

It

(F) The explanation of this phenomenon will be given when we come to treat of heat.

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Affinity. It is one of the usual characteristics of chemical affinity, that there be a change in the properties of the substances which enter into combination. This change takes place in the sensible qualities of many of the compounds; and some of these, as an illustration of this law, may be mentioned.

(1.) Changes of colour. The colour of lead is a bluish white, but when combined with oxygen it assumes a bright yellow or red colour, in proportion to the quantity of oxygen. Cobalt, which is of a gray colour, becomes, when combined with oxygen, of a fine blue; and copper, which is red, exhibits, combined in the same way, a green colour.

(2.) Changes in smell. The smell of muriatic acid is highly pungent; ammonia, or the volatile alkali, is not less so; but when these two are combined, forming muriate of ammonia, or sal ammoniac, the new compound is perfectly inodorous. This last is a remarkable instance of two highly volatile and odorous substances becoming fixed in the compound, and destitute of smell, and thus exhibiting a total change of properties.

(3.) Changes in taste. 1. The taste of sulphur is nearly insipid; and oxygen, which is one of the component parts of the atmosphere, is not only innocent, but necessary for the existence of animals: but when these two enter into union, the compound formed, which is sulphuric acid, is one of the most corrosive substances. —2. Sulphuric acid, which is sour and corrosive, forms a combination with soda, which is also of a corrosive nature; the result, which is Glauber salt, or sulphate of soda, is a compound of a bitter nauseous taste, but possessing none of the corrosive properties of its component parts.

Seventh Law.

106 Force of affinity *The force of chemical affinity is estimated by the force which is necessary to separate the substances which enter into combination.*

In treating of cohesion, or the attraction of aggregation, it was stated, that the method employed by philosophers to estimate that force, was to measure the opposite force, or that which was necessary to overcome the cohesive force. Thus, the weight attached to the lower extremity of a metallic wire perpendicularly suspended, which was just sufficient to tear it asunder, is considered as the measure of its power of cohesion. But it will appear, from what follows, that this law must be adopted with considerable modification.

107 estimated by the time of solution; In estimating the force of chemical affinity, various methods have been proposed by different philosophical chemists. It was thought by Wenzel, that the time which one body required to dissolve another, might be considered as the measure of the force of affinity between these two bodies; but it must appear from what has been already said, that the time of solution must depend greatly on the cohesive force of the body to be dissolved, and the nature of the compound which is formed; and, these being various, no certain measure can be obtained from this method.

According to some, the measure of the force of chemical affinity may be estimated by the difficulty of separating the substances which have entered into combination; or by taking the compound ratio of this, and the facility with which they are combined. But as no method has been invented to ascertain either the one or the other, which are the necessary previous steps in the method proposed, it is impossible, in this way, to estimate the force of chemical affinities. 108 by the difficulty of separation;

Observing the effects of the union and the abstraction of caloric, in the operations of chemical affinity, Lavoisier and La Place, in a memoir published in 1783, proposed this as the method of estimating the force of affinity. But it seems scarcely possible to measure the force of chemical affinity between two substances by the degree of temperature which is required to overcome the force of cohesion; as this degree of temperature has no measurable proportion with the force of chemical affinity, it can afford no data for estimating this force. And this quantity being variable and unknown, a fixed term is wanting to form a scale of comparison. 109 by the affinity for caloric.

We have already mentioned, in treating of adhesion, the experiments of Dr Taylor on the adhesion of surfaces, and the experiments and conclusions of Morveau and Achard on the same subject. From these Morveau has proposed to deduce a method of estimating the force of chemical affinities. But for an account of this, we refer the reader to the first section.

A different method has been proposed by Mr Kirwan, in his experiments and observations on the attractive powers of mineral acids *. He observes, that the principal end which he had "in view was, to ascertain and measure the degrees of affinity or attraction that subsist between the mineral acids and the various bases with which they may be combined; a subject of the greatest importance, as it is upon this foundation that chemistry, considered as a science, must finally rest; and though much has been already done, and many general observations laid down on this head, yet so many exceptions have occurred, even to such of these observations as seem to have been most firmly established, that not only a variety of tables of affinity have been formed, but many very eminent chemists have been induced to doubt whether any general law whatsoever could be traced †." 110 Kirwan's method.

* Phil. Trans. vol. lxxiii.

† Ibid. p. 34.

"The discovery of the quantity of real acid in each of the mineral acid liquors, and the proportion of real acid taken up by a given quantity of each basis at the point of saturation, led me unexpectedly to what seems to me the true method of investigating the quantity of attraction which each acid bears to the several bases to which it is capable of uniting. For it was impossible not to perceive,

1st, That the quantity of real acid necessary to saturate a given weight of each base, is inversely as the affinity of each base to such acid.

2dly, That the quantity of each base requisite to saturate a given quantity of each acid, is directly as the affinity of each acid to such base.

Thus, 100 grs. of each of the acids require for their saturation a greater quantity of fixed alkali than of calcareous earth, more of this earth than of volatile alkali, more of this alkali than of magnesia, and more of magnesia than of earth of alum: as may be seen in the following table.

Quantity of base taken up by 100 grs. of each of the three acids.

	Potash.	Soda.	Lime.	Ammonia.	Magnesia.	Alum.
	grs.	grs.	grs.	grs.	grs.	grs.
Sulphuric acid	215	165	110	90	80	75
Nitric acid	215	165	96	87	75	65
Muriatic acid	215	158	89	79	71	55

" As these numbers," Mr Kirwan observes, " agree with what common experience teaches us concerning the affinity of these acids with their respective bases, they may be considered as adequate expressions of the quantity of that affinity. Thus, the affinity of the sulphuric acid to potash, that is, the force with which they unite to each other, is to the affinity with which the same acid unites to lime, as 215 grs. to 110; and to that which the nitric acid bears to lime, as 215 to 96."

111 Objections. But to this method of Mr Kirwan, objections have been made by Morveau and Berthollet. It is stated that the essential principle, of the force of affinity being in the direct ratio to the quantity of base, is not fully established. According to the experiments of Morveau, a quantity of sulphuric acid containing 100 grs. of real acid, required for saturation 201 grs. of crystallized carbonate of potash : a quantity of nitric acid which contained 100 grs. of real acid, required 302 grs. for saturation; and a quantity of muriatic acid containing 100 grs. of real acid, required no less than 905 grs. of the same salt for saturation. From these experiments it appears, that Mr Kirwan's calculations are erroneous, or that the principle on which he has proceeded is false; for equal quantities of real acids require for saturation different quantities of potash; and besides, the quantity of base required is in the inverse ratio to the force of affinity, which is the reverse of Mr Kirwan's principle.

Mr Kirwan, however, has acknowledged the force of these objections, and has deduced the proportion of real acid in the nitric and sulphuric acids, from less exceptionable principles. His table, therefore, which expresses in numbers the strength of affinities, was considered as more correct than any previously published; but his general principle, that the quantity of base required to saturate a given quantity of real acid, is the expression of the force of affinity between the acid and the base, is a mere assumption of a peculiar language. Affinity is mutual between the combining bodies. It is incongruous to make the expression of it as applied to an acid the reverse of what it is in an alkali.

Mr Kirwan has corrected the quantity of base taken up by 100 parts of sulphuric, nitric, muriatic, and carbonic acids, as will be seen in the following table *.

* Anal. of Min. Waters.

100 pts.	Potash.	Soda.	Ammonia.	Barytes.	Strontites.	Lime.	Magnesia.
Sulphuric	121.48	78.32	26.05	200.	138.	70.	57.92
Nitric	117.7	73.43	40.35	178.12	116.86	55.7	47.64
Muriatic	177.6	136.2	58.48	314.46	216.21	118.3	89.8
Carbonic	95.1	149.6		354.5	231.+	122.	50.

But in addition to the objection now stated to his theory, the force of affinity, according to the experiments and observations of Berthollet, varies in proportion to the mass of any body, and therefore no method, however accurate in other respects, will afford a certain rule for estimating the force of chemical affinity.

Eighth Law.

112 Different affinities among bodies. *Bodies have different degrees of affinity for each other.*

On the different force of affinity which exists between different bodies, depend many of the most important operations in chemistry; and it is by multiplying the facts which fall under this law, that chemical science can be improved and extended.

113 Two kinds. Affinity has been divided into two kinds, *simple* affinity, and *compound* affinity; producing simple elective attractions, and double elective attractions.

114 Between two bodies. *Simple affinity.*—The first of these includes all those combinations which directly take place between two bodies, as when muriatic acid and lime are combined together. We have also a case of simple affinity, or single elective attraction, when to a solution which contains two substances, a third is added which produces the separation of one of the dissolved bodies. This takes place when potash is added to the solution of lime in muriatic acid. The potash has a stronger affinity for the muriatic acid than the lime; it therefore separates the acid from the lime, combines with it, and remains in the solution. The lime, thus separated from its combination, appears in the solid form, falls to the bottom, and is called a precipitate.

In practical chemistry precipitates are distinguished into several kinds. It is said to be a real or true precipitate, when the body which is disengaged from the combination falls to the bottom, as in the case above, where the lime fell to the bottom, after being separated from the muriatic acid. A false precipitate is when the new compound which is formed falls down, as when sulphuric acid is added to any solution of lime; for the compound being insoluble, it appears in the form of a precipitate. A precipitate is said to be pure, when the body which has been decomposed can be formed again 115 Precipitates.

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again from the separated constituent parts; and impure, when this cannot be effected; which is probably occasioned from the decomposition not being complete. It sometimes happens, when a body which consists of two substances is decomposed by means of third, that the disengaged substance assumes the elastic form. This is the case when muriate of ammonia is decomposed by quicklime. The muriatic acid, which is in combination with the ammonia, unites with the lime, for which it has the greater attraction; and the ammonia, set free, is instantly volatilized.

116
Between more than two.

Compound affinity.—But there are substances which cannot be decomposed when a third substance is presented. The affinity of two substances A and B in combination, may be so much stronger than the affinity of a third C for either A or B, that no decomposition will take place when the body C is presented to the compound of A and B. Suppose the two substances A and B are held united with a force equal to 12, and the force of affinity between the body C and B is equal only to 8, it is obvious that no change can be effected, because the force of affinity between C and B cannot overcome the cohesive force that exists between A and B. But if a fourth body D is presented to the compound A and B, and acts with a force on the body A equal to 6, while the body C acts on B with a force equal to 8, it is evident that the combined action of these two forces will overcome the force of affinity between A and B, which was supposed to be equal to 12, because the measure of a force equal to 14 is greater than one equal to 12; and in this way the decomposition of the body A and B is effected by the united action of two other bodies, which would not have succeeded had any one been presented to it singly. From this double action, a decomposition of this kind is called a *double elective attraction*, a name given by Bergman, or a case of compound or complex affinity, as it has been proposed to be denominated by later chemists.

Bergman invented a method of exhibiting these attractions, in such diagrams as the following.

		Nitrate of Potash.		
	Potash.		Nitric acid.	
Sulphate of potash.				Nitrate of silver.
	Sulphuric acid.		Oxide of silver.	
		Sulphate of silver.		

In this example the substances to be decomposed are placed on the right and left sides of the diagram. These are the sulphate of potash, composed of sulphuric acid and potash on the left side; and the nitrate of silver, which consists of nitric acid and the oxide of silver. When these compounds are combined together, a decomposition is effected by the mutual affinities between the constituent parts of the compounds. Thus the sulphuric acid in combination with the potash, forms a new compound with the oxide of silver, and the nitric acid in combination with the silver, forms a new compound with the potash; because the sum of the force of affinities between the nitric acid and the potash, and the suphuric acid and the oxide of silver, is greater than the sum of the affinities between the sulphuric acid and the potash, and the nitric acid and the oxide of silver; and thus an exchange of principles takes place, and the new compounds are represented at the top and bottom of the diagram, namely the nitrate of potash and the sulphate of silver.

Mr Elliot in the year 1782 proposed, as an improvement on Bergman's method, to represent the force of these attractions by numbers. The same case, in Mr Elliot's method, is represented in the following diagram.

		Nitrate of potash.		
	Potash.	8	Nitric acid.	
Sulphate of potash.	9		2	Nitrate of silver.
	Sulphuric acid.	4	Oxide of silver.	
		Sulphate of silver.		

As it thus represented, the sulphuric acid and the potash are supposed to act with a force equal to 9; and the nitric acid and the oxide of silver attract with a force equal to 2. The affinity of the potash for the nitric acid is equal to 8; and the affinity between the sulphuric acid and the oxide of silver is equal to 4. But $9+2=11$, and $8+4=12$; consequently the sum of the affinities between the nitric acid and the potash, and the sulphuric acid and the oxide of silver, exceeds the sum of the affinities between the nitric acid and the oxide of silver, and the sulphuric acid and the potash, and thus a decomposition is effected.

But "in all decomposition," says Mr Kirwan, "we must consider, 1st, The powers which resist any decomposition, and tend to keep the bodies in their present state; and, 2dly, The powers which tend to effect a decomposition and a new union. The first I shall call quiescent affinities, and the second, divellent. 117 Two forces to be considered.

"A decomposition will always take place when the sum of the divellent affinities is greater than that of the quiescent; and, on the contrary, no decomposition will happen when the sum of the quiescent affinities is superior to, or equal to that of the divellent; all we have to do, therefore, is to compare the sums of each of these powers. Thus, if the solutions of sulphate of potash and nitrate of lime be mixed together, a double decomposition will take place." This may be illustrated by the following diagram.

		Nitrate of potash.		
	Potash.	215 +	Nitric acid.	
Sulphate of potash.	215 + Quiescent	Divellent affinities =	affinities 96 = 311.	Nitrate of lime.
	Sulphuric acid.	110 / 325	Lime.	
		Sulphate of lime.		

The

The affinities between the nitric acid and lime, and between the sulphuric acid and the potash, which taken together amount to 311, are the quiescent affinities. The affinities of the sulphuric acid and the lime, and of the nitric acid and the potash, are the divellent affinities which are opposed to the first. But the amount of the latter is equal to 325, that is, the combined affinities of the substances which tend to form a new combination, and thus they overcome the force of the resistance of the quiescent affinities, as 325 exceeds 311.

Another example will serve to make this decomposition by double or compound affinity still more familiar.

Muriate of potash.

	Muriatic acid.	32	Potash.	
Muriate of barytes.	36	+	9=45	Carbonate of potash.
	Barytes.	14 46	Carbonic acid.	

Carbonate of barytes.

118 This force not constant.

In this case a solution of muriate of barytes is mixed with a solution of the carbonate of potash. The affinity of the muriatic acid for the barytes, and that of the potash for the carbonic acid, are the quiescent affinities, which are opposed to any decomposing force. But, on the contrary, the affinity of the muriatic acid for the potash, and that of the barytes for the carbonic acid, are the divellent affinities. The quiescent affinities are only equal to 45, while the sum of the divellent affinities is equal to 46; the latter must therefore prevail. The former combinations are broken, and instead of muriate of barytes, and carbonate of potash, we obtain muriate of potash and carbonate of barytes, which latter is insoluble, and is therefore precipitated.

But Berthollet has shewn that the force of affinity between the same substances is not constant and uniform, but is greatly influenced by the quantity and the state of saturation. As, for instance, when two bases act in opposition on an acid, the acid divides its action in proportion to their respective masses. If there be two acids instead of one, and no separation take place, either by precipitation or crystallization, both acids will act equally on both bases, in proportion to their masses. If each of the acids be previously combined with a base, and the solutions of their salts be mixed, the sum of the reciprocal forces will be the same as before. No muriate of potash or sulphate of lime will be formed; but there will be a combination of potash, of lime, of sulphuric and muriatic acid, which will have the same degree of saturation as before the mixture. And hence it happens, that when two salts are mixed together, the mutual decomposition of which would produce combinations of very different proportions, the separation of the component parts, which should result from such decomposition, is not perceptible. No change of bases therefore takes place.

The force of cohesion causes the separation which takes place by precipitation or crystallization. Berthollet observes, that a similar effect is produced by the same cause, in the action of complex affinities. If a solution of sulphate of potash be mixed with muriate of lime, dissolved in a small quantity of water, the lime brought into contact with the sulphuric acid will be more powerfully influenced by the force of cohesion than the potash. This is therefore to be considered as an additional force to those which pre-existed, and determines the combination of the sulphuric acid with the lime, and the precipitation of the new compound.

In all decompositions effected by compound affinity, the prevailing affinity has been ascribed to those substances which have the property of precipitating, or of forming a salt which can be separated by crystallization. Thus the knowledge of the solubility of salts which may be formed in a liquid, will point out those substances which are least soluble, and therefore most apt to precipitate. To these substances chemists formerly ascribed the strongest affinity.

119 Most insoluble compounds precipitate.

Lime, magnesia, strontites, and barytes, form insoluble salts with carbonic acid. When therefore any of the soluble salts of these earths are mixed with alkaline carbonates, an exchange is produced, from which result the formation and precipitation of an earthy carbonate. The compound of sulphuric acid and barytes forms an insoluble salt. When, therefore, a solution of a sulphate is mixed with that of a salt of barytes, a precipitation of sulphate of barytes, which is insoluble, will be effected. The sulphate of lime has also but little solubility, and consequently is much disposed to precipitate. Lime therefore decomposes all the soluble sulphates. But the sulphate of lime being much more soluble than the sulphate of barytes, the salts of barytes, which are more soluble than the sulphate of lime, decompose it.

120 Temperature to be considered.

There are other circumstances which tend to change the action of compound affinities. The solubility of salts, which has so much influence in this action, is varied by temperature. In estimating the result of compound affinities, therefore, the degree of temperature must be considered and taken into the account. To give an instance of this effect, nitrate of potash mixed with muriate of soda, crystallizes at a low temperature. During the evaporation the muriate of soda is separated. No change of bases will take place, because the nitrate of soda is somewhat more soluble when cold than nitrate of potash; and muriate of potash is more soluble when hot than muriate of soda.

The action of complex affinities may also be changed by the formation of a triple salt which precipitates; but if the solubility of the combination be known, the decomposition which is effected, and the resulting compounds, may also be foreseen.*

* *Berthollet's Researches*, art. 13.

121 Reciprocal action.

According to the theory of Berthollet, all substances in the liquid state exert a reciprocal action. In a solution of sulphate of potash and muriate of soda, these two salts are not distinct, nor do they become so, until some extraneous cause produces their separation. Sulphuric and muriatic acids, potash and soda, are contained in the liquid. To ascertain what combinations are produced by the force of crystallization, he made the following experiments.

122 Force of crystallization.

"*Experiment* 1.—A mixture was made of equal parts of nitrate of lime and sulphate of potash: after the separation

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paration of the sulphate of lime formed in the commencement, (and of which no farther mention is to be made in the following experiments), the liquid was evaporated, and nitrate of potash and sulphate of lime were alone obtained by successive operations. Yet, after the last evaporation, some crystals of sulphate of potash were obtained: there was but a small residue of uncrystallizable liquid, in which carbonate of soda and nitrate of barytes produced precipitations; whence it appears that it consisted of a small quantity of sulphuric acid and lime, and very probably of a larger portion of nitrate of potash.

"The quantity of sulphate of lime which precipitated during this evaporation, was much greater than what could be dissolved in an equal quantity of water; whence it appears that its solubility was augmented by the action of the other substances.

"*Experiment* 2.—Two parts of sulphate of potash, and one of nitrate of lime, yielded, by the first evaporation, sulphate of potash and sulphate of lime; and by the following, nitrate of potash with the two sulphates, the proportions of which continued to diminish until the salts ceased to crystallize: only a few drops of uncrystallized liquid remained, in which no precipitate was formed on adding to it some carbonate of soda, but this effect was produced by the nitrate of barytes; whence it appears probable, that the liquid consisted of sulphate of potash, and a small proportion of nitrate of potash.

"*Experiment* 3.—Two parts of nitrate of lime, and one of sulphate of potash, yielded by the first evaporation a small quantity of sulphate of lime, and on cooling, some nitrate of potash; by the succeeding evaporations nothing but nitrate of potash was obtained. After the last, however, some crystals of sulphate of lime were perceivable on the surface of the liquid. Though the residue, which was abundant, was repeatedly put to evaporate and cool, no crystallization was effected. This uncrystallizable residue, treated with alcohol, yielded an abundant precipitate, in the solution of which in water no precipitate could be produced by nitrate of barytes; whence it appears that it contained no sulphuric acid, and that it was composed of pure nitrate of potash. What had been dissolved in the alcohol was nitrate of lime, with a small proportion of nitrate of potash: the uncrystallizable residue consisted, therefore, of nitrate of potash and nitrate of lime.

"It appears that the sulphate of lime was rendered much less soluble in this than in the preceding experiments; and that the action of nitrate of lime prevented a considerable quantity of the nitrate of potash from crystallizing.

"Sulphate of lime was necessarily formed in these three experiments, because its component parts were in contact; and the insolubility of the compound formed by them, occasioned its precipitation to a certain extent.

"In the first and second experiments, the sulphate of lime was rendered much more soluble than it naturally is, by the action of the substances in solution; but in the third experiment, its solubility was not perceptibly increased, for this reason, probably, that the nitrate of lime and nitrate of potash, which existed in the uncrystallizable liquid, had mutually saturated each other so much as to diminish their action on the sulphate of lime*.

From these considerations, he deduces the theory of uncrystallizable residues: which the succeeding observations tend to confirm.

"Saline substances exert a mutual action, which augments their solubility; as has been proved by the experiments published by my learned colleague Vauquelin. This reciprocal action varies in different salts; it was once supposed that the solubility of the nitrate of potash was not augmented by the action of earthy salts; and yet it is augmented more by them than by any others.

"There must be doubtless, in this respect, some difference arising from the nature of the salts, in the effect which they produce; but this difference is, in general, very trifling, compared to that resulting from the force of crystallization.

"*Experiment* 4.—A mixture of equal parts of nitrate and sulphate of potash, yielded by evaporation, and successively, according to their solubility, sulphate of potash and nitrate of potash, without leaving any uncrystallizable residue; but having made a similar experiment with a mixture of nitrate and sulphate of soda, each of which has but a feeble tendency to crystallize, and nearly an equal degree of solubility, there was separated by crystallization but a small portion of the sulphate of soda, the other parts of the mixture continuing in the liquid state, incapable of being crystallized by any means. Muriate of soda and sulphate of alumina, submitted to the same treatment, were perceived to become more soluble; but they were totally separated in the end by alternate evaporatiou and cooling.

"It appears, then, that substances which are endued with an active tendency to crystallize, though rendered more soluble than they naturally are, separate however in the order of their insolubility, without leaving any, or but very little, uncrystallizable residue.

"But when a mixture consists of salts which have but a weak tendency to crystallize, their mutual action counteracts that tendency, so that a large portion of uncrystallizable liquid remains: this effect is still more complete when the mixture contains a substance naturally uncrystallizable, as in the third experiment, in which there was an excess of nitrate of lime, the action of which excess on the nitrate of potash rendered a great part of it uncrystallizable" †.

From this it appears, Berthollet observes, that the formation of salts obtained by crystallization, depends on the proportions of the substances which act on each other: and combinations may be formed which vary according to the proportions of the substances employed, or the stage of the operation; that is, according to the proportions which continue in action, when the combinations which might take place are not endued with a force of cohesion sufficient to withdraw them from the sphere of action.

Ninth Law.

Affinity is the inverse ratio of saturation.

123 Affinity diminishes towards the point of saturation.

In most of the combinations which take place between bodies, there exists a certain determinate proportion of the quantity of the substances which form the compound. On this indeed depend the constancy and

* *Berthollet's Researches*, art. 13.

† *Ibid.*

Affinity. and permanency, both of natural and artificial compounds. It is to this uniformity and permanency that their characteristic properties are owing; for when the proportions in compound bodies vary, although the constituent parts be of the same nature, the properties of the compound are materially changed. Thus, in a case already mentioned, the different proportions of oxygen with lead, different compounds are produced; with a smaller proportion of oxygen, the resulting compound is yellow, but with a greater it is red.

124 Saturation As there are certain limits to the proportions in which bodies combine together, beyond which they cannot pass, these are called the points of *saturation;* and when two bodies, in uniting together, have reached this point, they are said to be saturated, or the one body is said to be saturated with the other: in other words, the change has taken place, and a new compound is formed. When, for instance, common salt is dissolved in water, the water combines only with a certain proportion; and whatever quantity of salt is added beyond this proportion, it falls to the bottom undissolved. The reason of this is, that the particles of the salt are held together by their affinity for each other; that is, by the force of cohesion. Now, before any combination can be effected between the particles of the salt and the water, this force must be overcome. The force of affinity, therefore, between the water and the particles of salt, is greater than that between the particles of salt themselves, and thus they are separated and dissolve in the water: but this force of affinity between the water and the salt is limited; and when it has arrived at its utmost limit, the action between the two bodies ceases. The two forces which were opposed to each other, that is, the force of affinity between the water and the salt on the one hand, and the force of cohesion between the particles of the salt on the other, are balanced. The water in this case is said to be saturated with salt.

In a sense somewhat similar, the werd *neutralization* has been employed. When to an acid there is added the solution of an alkali to a certain point, they combine together, and form a compound, in which the properties both of the acid and of the alkali totally disappear. They are then said to have neutralized each other; and hence the name of *neutral salts*, which has been given to these compounds.

in different proportions. Some bodies, it would appear, enter into combination with others, only in one determinate proportion, and some in two proportions, and these proportions are denominated their *maximum* and *minimum* of saturation; that is, the smallest and greatest proportions in which they combine with each other. There is another set of bodies which combine in any proportion between the highest and the lowest points, while a fourth set combine only in certain determinate proportions between these points.

Now, from these observations, let us endeavour to illustrate the meaning of this law, by attending to what takes place in the different combinations of bodies with each other. A smaller quantity of salt dissolved in a given quantity of water, is held in combination by a greater force of affinity, than a greater quantity; because this force is to be estimated by the affinity which exists between the salt and the water, and its mass. The nearer, therefore, it comes to the maximum or highest point of saturation, the weaker is the affinity between the water and the salt, and in approximating to this point, this force is gradually diminished.

When two bodies combine together in two different proportions, or what are called the maximum and minimum points of saturation, the force of affinity is greatest between the two bodies at the lowest point. Suppose that two bodies, A and B, can enter into combination with each other, in two different proportions. Suppose the quantity of A is =20 grs. and the first portion of B which combines with it is = 10 grs.; it is evident from this combination, that part of the force of the affinity of A is exhausted, but still it combines with another portion of B; suppose this is =5 grs. and then it has reached its highest point of saturation, or the maximum. But as the last portion of B, which combined with A, is retained in the compound by the force of affinity in A, which remained after its combination with the first portion of B, it is obvious that this force must be greatly diminished, and therefore the last portion of B will be most easily separated from its combination with A. This accordingly is found to to hold in all cases.

Tenth Law.

Between two compound bodies which are not acted on by compound affinities, decomposition may take place, if the affinity of a compound consisting of two of the principles for a third be greater than that which unites this third to one of the two first, or to the fourth principle, although, at the moment of action, the union between the two first does not exist.

This is called *disposing* or *predisposing* affinity, because no change takes place without the influence or action of a third body on some of the compounds; for it is this action which operates the formation of the compound, and the decomposition of another compound, without the formation of the first. To have a clear conception of this disposing affinity, let us suppose that there are two compounds, AB and CD; the affinity of whose constituent parts, that is, the affinity between A and C, and the affinity between B and D, is not greater than the affinity which exists between AB and CD. In this case, it is obvious that no decomposition can be effected by compound affinity, because the sum of the quiescent affinities exceeds the sum of the divellent; but if the force which tends to combine B and C together, added to that which tends to unite the compound BC to D, be greater than the force of cohesion between the compounds AB and CD, the result of this action will be a decomposition, the formation of a new compound BCD, and the separation of the first component part A. 125 Disposing affinity.

Water is composed of two substances, which have received the names of oxygen and hydrogen. Sulphur has no direct action on water. This shows that the affinity between sulphur and any of the constituent parts of the water, is not so great as the affinity of the oxygen and hydrogen for each other; but if sulphur be united with an alkali, the water is decomposed by this combination, although there is supposed to be no affinity between the alkali and the oxygen. But the attraction of the alkali for the sulphuric acid gives rise to the formation of that acid, and causes the sulphur to combine

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Of Light. bine with the oxygen of the water. It is now, however, since the luminous researches of Berthollet, allowed to be an absurdity, to maintain that the affinity of any body for a compound not yet existing, should be adequate to cause the formation of that compound (in this case the acid): and it is allowed, that the substance causes such a formation, by the affinity which it has for its two constituent parts (*e. g.* the oxygen and the sulphur), although such affinity may be prevented from showing itself on other occasions, by its weakness and the opposing influence of extraneous circumstances. The alkali has a real affinity for the oxygen of the water, which is exerted in the present instance, though too weak to be efficient for producing a separate binary combination of these two bodies.

126 Law of fixed combining weights, or the atomic theory.

ELEVENTH LAW.

Another very important law must now be added to the preceding, and it is one which has been of comparatively recent establishment.

That every combining substance has a certain relative weight, in which, or in simple multiples of which, it unites chemically with an equally fixed weight of every other.

Let us suppose, for the sake of illustration, that we have 24 simple bodies, named from the 24 letters of the alphabet: one of them has a combining weight double that of another, or two-thirds, or in proportions more minutely fractional. Suppose A to be as 10, B as 12, C as 8; then 10 grains of A combine always with exactly 12 of B, to form a definite compound. So far the doctrine had been always maintained. But, further, if there is another compound of the same bodies in another proportion, this will always be twice, three times, or some other multiple of the lowest proportion: 10 grains of A combine with 24, 36, &c. of B; with C, it combines in proportions as 10 to 8, to 16, to 24, or some multiple. Or, on the other hand, 12 grains of B or 8 of C will combine with 10, 20, 30, or some other multiple of the combining weight of A. What is of greater importance still, it is found, that if B and C also form definite compounds, they in their turn combine in proportions as 12 to 8, or the one of these numbers to a multiple of the other. This is the case in most instances. Where it is not, it is still in simple arithmetical proportions of them, as twice the combining weight of the one, with three times that of the other.

This law does not apply to that kind of chemical union which consists in the solution of a solid body in a liquid menstruum. In this case the gradations are indefinite, and the proportions necessary to saturation vary with the temperature. But it applies to the formation of all compounds in which a change takes place in the state of aggregation of the constituent parts, and in which their previous chemical agencies are prevented from appearing, and others entirely new are elicited. For example:

1. Wherever two gases unite to form a solid or a liquid, the proportions of these combining weights are observed.

2. Also, wherever a gas combines with a solid to form a new gas, which shews none of the agencies which marked the simpler gas, but others which are entirely peculiar to it. Of Light.

3. Also, wherever a gas, in combination with a solid substance, forms a definite liquid peculiar in its chemical relations, or forms a solid equally peculiar, and which resists entirely those powers by which the simple solid was readily affected.

4. Finally, Two gases may unite, and the compound formed may be a third gas, possessing a peculiar character, and exhibiting a much more extensive activity than either of the constituents in a simple state.

In these, and other analogous cases, the compound may, by various manipulations, be purified from the admixture of any portion of either of the constituents still remaining uncombined; and when this is done, the proportional weights of the combining substances are invariably observed.

This doctrine, as the expression of a general fact, was suggested by certain remarkable uniformities which occurred as the results of chemical analysis extensively compared. The minutiæ of it were investigated by subsequent experiments, by which it has been established to a great extent. In some particulars it labours under difficulties, and discordant reports, arising from the difficulty of chemical analysis. Several anomalies which appeared when the doctrine was new, have been cleared up by subsequent discoveries. If a few others remain, these only shew us that the details are not yet perfected, and that room is left for varied experiments.

For the particulars we refer to the article ATOMIC THEORY in the SUPPLEMENT of this work. That designation has been given to the doctrine, in consequence of the explanation of the facts assigned by Mr Dalton; that every simple body consists of chemical atoms, which possess in each one constant weight. These substances, in combining chemically, unite generally atom to atom, or as 1 of the one to 2, 3, 4, &c. of the other. Sometimes as 2 to 3.

This doctrine gives necessarily a new aspect to the whole of Chemistry. The combining weights are found out by accurate experiments. And these, when compared as made on the same substances in the varieties of their combination with others, agree admirably with one another. Even those which were obtained previously, approximate in a wonderful degree to those which are in conformity to the atomic theory. The other doctrines of chemistry, and the other chemical properties of different kinds of matter, may be understood without it, and advantages will be derived from the study of it as free from this doctrine, which to a beginner sometimes appears a little intricate. We therefore shall still proceed in this article, independently of that theory, except in so far as some of the facts on which it rests force themselves on our notice as in other respects of leading importance.

We now proceed, in the following chapters, to examine the properties of those bodies, the knowledge of which belongs to chemical science; the changes which take place by the action of affinity, and the new compounds which are the result of these changes; and, at the same time, to point out some of their applications, and uses.

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Chap. II. Of LIGHT.

Light and heat, which are to be treated of in this and the succeeding chapters, are highly interesting, not only as curious subjects of speculation, but as acting a very important part in the changes which are constantly going on among natural bodies. Indeed no change happens, in which the one or the other is not either absorbed or extricated, and sometimes both are concerned.

Light, of which we are now to treat, is the principal agent in many chemical processes: and this consideration, as well as the astonishing velocity of its motions, and the properties which it has of penetrating and traversing substances with which it comes in contact, render it an object worthy of great attention.

Light is too familiar to every one to require any definition, and too simple to admit of any. It is by the light of the sun, or that which proceeds from burning bodies, that we are informed of the presence of objects; the rays of light proceeding from these bodies, and entering the eye, produce the sensation of vision. We have no certain knowledge concerning the nature of
127 Opinions of the nature of light. light. Various conjectural theories, however, have been proposed, with regard to it. Two of these we shall only mention. According to Des Cartes, Huygens, and some other philosophers, all space is filled up
128 An undulating fluid. with a very subtile fluid, and this fluid is agitated or put in motion by the sun, or burning bodies. This motion consists of vibrations or undulations, which, extending themselves and reaching the eye, render the bodies which have produced these motions visible.

The other theory is that of Newton and his follow-
129 Material. ers. According to this theory, light is supposed to be a material emanation from luminous bodies; that is, a subtile fluid, consisting of peculiar particles of matter, which are constantly separating from such bodies, and, by entering the eye, excite the sensation of light, or the perception of the objects from which it proceeds, or those from which it is reflected. This theory, which has been deduced from numerous facts and observations, was established by Newton by mathematical demonstration. If then it be admitted, that light is a subtile fluid, consisting of minute particles, several consequences follow, which require explanation, with regard to the size, the velocity, and the momentum of these particles. In what follows, we shall consider light with regard to its physical properties; its chemical properties, or the effects it produces on bodies with which it enters into combination; and, lastly, the sources from which it is obtained.

Sect I. *Of the Physical Properties of Light.*

130 Velocity. 1. One of the most astonishing properties of light is its velocity. It has been observed by astronomers, that the eclipses of the satellites of the planet Jupiter appear to take place sooner, when that planet is nearest
131 discovered. to the earth, and later when Jupiter is on the opposite side of his orbit from the earth. Roemer, a Danish astronomer, in attempting to account for this apparent anomaly, proved that it was owing to the difference of time which the particles of light required, to pass through the semidiameter of Jupiter's orbit: and from this he demonstrated, that the particles of light move through one half of the diameter of the earth's orbit in about eight minutes. This discovery of Roemer has 132 Confirmed.
been fully confirmed by the theory proposed by Dr Bradley, to account for the aberration of the light of the fixed stars. From these data it has been computed, that light moves at the rate of 200,000 miles in a second;—a velocity of which the human mind can form no distinct conception. In comparing it with that of a cannon ball, it may be observed, that light passes through a space in about eight minutes, which a cannon ball with its ordinary velocity could not traverse in less than thirty-two years!

2. From the remarkable velocity of light, may be 133 Particles very minute.
inferred the extreme minuteness of its particles. The force with which moving bodies strike, is in proportion to their masses, multiplied by their velocities. If, therefore, the one or the other, or both, be increased, the striking force is proportionally augmented; and consequently, if the particles of light were not extremely small, their excessive velocity would generate a momentum highly destructive to the existing arrangements of other matter. Were they even equal in weight to the two millionth part of a grain of sand, this impulse would not be less than that of sand shot from the mouth of a cannon.

The minuteness of the rays of light may be also demonstrated from the great facility with which they pass through transparent solid bodies. In moving through such bodies, light seems not to suffer the slightest diminution of its velocity. If there is nothing to obstruct the rays of light which proceed from a candle, it will fill the whole space within two miles around, almost instantaneously, before it has lost any sensible part of its substance.

3. When a ray of light falls on a polished substance 134 Reflection.
in a perpendicular direction, it is thrown back in the same direction; but when a ray of light falls on the same body obliquely, it returns from the surface on the opposite side of a perpendicular line drawn from the point on which the ray falls, and at an equal distance from that perpendicular. The angle which the ray of light forms with the perpendicular as it falls, is equal to the angle which it forms with the same line, when it is thrown back. The first angle is called the *angle of incidence*, and the second the *angle of reflection*. Hence the optical law, that the angle of incidence is equal to the angle of reflexion. When the rays of light fall obliquely on polished surfaces, they are reflected before they actually touch these surfaces, which is supposed to be owing to a repulsion between the particles of light and the particles of the polished body. But when rays of light fall obliquely on a transparent substance, as a plate of glass, they pass through to the other side, and then return to the same surface, and are reflected.

4. When a ray of light is admitted into a dark 135 Inflection.
room, through a small hole, it forms a luminous spot on any object opposite to that from which the light proceeds; and if the blades of two knives are placed on opposite sides of the hole, having their planes parallel to the plane of the window shutter or pasteboard through which the ray passes, when the edges of the knives

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Light. knives are brought near each other, the rays of light are drawn from their former direction towards the edges of the knives, and the luminous spot appears enlarged. This is called the *inflection* of light. A similar effect is produced by nearly shutting the eyes, and looking at a candle. The rays of light appear to proceed from it in various directions: for the light, in passing through the eye-lashes, is inflected, and is divided into separate beams, diverging from the luminous object.

136 Refraction. 5. A ray of light passing from one medium to another, in a line perpendicular to the surface by which they are separated, moves on in the same direction; as, for instance, when light passes from air to water, or from water into air. But if a ray of light passes in an oblique direction from one medium to another, it is bent from its former course, and then moves on in a new direction: this is called the *refraction* of light. A straight rod, which is introduced obliquely into a vessel of water, appears bent at the place where it touches the surface of the water. This is owing to the refraction of the rays of light passing from the rarer medium of the air to the denser medium of the water.

When the light passes into a medium of greater density, as for instance from air into water, it is refracted or bent towards the perpendicular; but when it passes from a denser into a rarer medium, as from water into air, it is refracted from the perpendicular. The measure of the quantity of this refraction is nearly in proportion to the density of the medium: with this exception, however, that if the medium be a combustible substance, the refractive power is then found to be greater. It was from the observation of this law of the refraction of light, that the conjecture which was thrown out by Newton, of the combustible nature of water and the diamond, which has been verified by the discoveries of modern chemistry, occurred to the mind of that sagacious philopher.

137 Spectrum. 6. When a ray of light is admitted through a small hole, and received on a white surface, it forms a luminous spot. If a dense transparent body be interposed, the light will be refracted, in proportion to the density of the medium; but if a triangular glass prism be interposed, the light is not merely refracted, but it is divided. The ray of light no longer forms a luminous spot, but has assumed an oblong shape, terminating in semicircular arches, and exhibiting different colours, generally reckoned seven in number. This image is called the spectrum, and, from being produced by the prism, the *prismatic spectrum*. These different coloured rays appearing in different places of the spectrum,

138 Of seven colours. shew that their refractive power is different. Those which are nearest the middle are the least refracted, and those which are the most distant, the greatest. The order of the seven rays of the spectrum is the following: RED, ORANGE, YELLOW, GREEN, BLUE, INDIGO, VIOLET. The red, which is at one end of the spectrum, is the least, and the violet, which is at the other end, is the most refracted.

Sir Isaac Newton found that, if the whole spectrum was divided into 360 parts, the proportional space occupied by each of the colours would be the following.

Red,	45 parts.
Orange,	27
Yellow,	48 parts
Green,	60
Blue,	60
Indigo,	40
Violet,	80

These different coloured rays are not subject to farther division. No change is effected upon any of them by being farther refracted or reflected; and, as they differ in refrangibility, so also do they differ in the power of inflection and reflection. The violet rays are found to be the most reflexible and inflexible, and the red the least. 139 Not farther divisible.

7. Light, it is well known, seems to suffer no interruption in passing through some bodies; such are glass or water: but it is interrupted in its passage through other bodies, as a piece of wood or stone. The first set of bodies are called *transparent*, and the other *opaque*. The density of water or of glass is greater than that of a piece of wood. It cannot therefore be owing to the density of the later, or the closeness of the particles which compose it, that the transmission of light is prevented. In the explanation which has been given by Newton, it is supposed that the particles which compose transparent bodies are of equal density, and are uniformly arranged; but in opaque bodies he supposes the particles to be of unequal density, or not uniformly arranged. From the uniform arrangement and equal density which, according to this explanation, are supposed to exist in transparent bodies, the light passing through them moves in a straight line, because it is equally attracted by the particles of the body. But in the latter (the opaque bodies) the attraction between light and the particles of the body is unequal; its direction is constantly changing, till at last it is entirely interrupted. 140 Transparency. 141 Opacity.

8. Dr Herschel, who has made some interesting discoveries concerning light and heat, found that the illuminating power of the different rays was different. From the observations which he made on this subject, he says, that "with respect to the illuminating power assigned to each colour, we may conclude, that the red-making rays are very far from having it in any eminent degree. The orange possesses more of it than the red, and the yellow rays illuminate objects still more perfectly. The maximum of illumination lies in the brightest yellow or palest green. The green itself is nearly equally bright with the yellow; but from the full deep green the illuminating power decreases very sensibly; that of the blue is nearly upon a par with that of the red: the indigo has much less than the blue; and the violet is very deficient *." 142 Illuminating power.

* Philos. Trans. vol. xc. p. 26.

SECT. II. *Of the Chemical Properties of Light.*

1. From the properties of light now detailed, it appears that it is subject to the universal law of attraction, as well as other bodies; but it is also found to enter into chemical combination with many substances. These substances, it has been discovered by experiment, after being for some time exposed to the light, and carried into a dark place, appear luminous. It is found, however that this property is lost when they are kept in the dark, and they do not recover it till after they have been again exposed to the 143 Light enters bodies.

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Light.

the light. Some substances possess this property in a greater degree than others. One which was discovered by Mr Canton, who made a number of experiments on this phosphorescent light, as it has been called, is prepared by the following process. He took some oyster-shells and calcined them, after which they were reduced to powder, and the purest part of them was put through a fine sieve. Three parts of this powder were mixed together with one part of the flower of sulphur; the mixture was put into a crucible, and firmly pressed to the bottom, which was then exposed for an hour to a red heat. It was then removed from the fire, and when it cooled, the purest parts of the mixture were scraped off, and put up in a well-closed phial. This is called Canton's pyrophorus. When this is exposed to the light for a short time, it becomes so luminous that objects may be distinctly perceived in the dark, by the light which it emits. It loses the property, however, by being kept in the dark, but recovers it again when it is exposed to the light. And, after being kept in the dark for some time, the light from the pyrophorus becomes feeble, or is nearly extinct, but it may be revived or increased by plunging the phial into hot water. But, if the whole of the light has been separated previous to the application of heat, no farther application can cause it to emit light, till it has been exposed to a luminous body. Thus it appears that light enters into combination with other bodies, and that it afterwards leaves them without having undergone any perceptible change.

144 Canton's pyrophorus.

145 From which light is again emitted.

2. If a quantity of purple-coloured fluate of lime (Derbyshire spar) be reduced to coarse powder, and exposed to heat in a dark place, it emits a great quantity of coloured light; but when this light which has been in combination with the spar is once expelled, it does not recover its property of shining in the dark, as in the case of Canton's pyrophorus.

146 Supposed to be slow combustion.

It has been supposed by some, that the light emitted by these substances is the consequence of slow combustion; but many of the substances which have this property are not combustible, and none of the changes which take place during that process have been observed. In some cases it would appear that the light which is given out is different from that to which they were exposed, and which they must have absorbed. In some of the pyrophori, the blue rays were observed to have a greater effect, and the light which was emitted was of a red colour,

147 Emitted by animal matters, &c.

3. Light is well known to be given out by a number of animal and vegetable matters, when the process of putrefaction commences. In this case it seems to have constituted one of their component parts. This particularly happens to fish of different kinds, as the herring and the mackerel; and is supposed to be the cause of the phosphorescent light of the sea, which appears when the water is broken and agitated. These phenomena were observed by Mr Boyle and Dr Beale, both in the flesh of quadrupeds and fishes, and earlier by Fabricius ab Aquapendente and Bartholin in the flesh of quadrupeds. Experiments were made on the same subject by Mr Canton, whom we have already mentioned, and more lately by Dr Hulme. The latter concludes from his experiments, that this light is a constituent principle of marine fishes; that it is incorporated with their whole substance, making a part of it, in the same manner as any other constituent principle; that when this spontaneous light is extinguished by some substances, it may be again revived; that the quantity of light emitted is not in proportion to the degree of putrefaction, but the reverse.

148 A constituent principle.

For the sake of those who may wish to repeat these experiments, we shall detail the following made on the herring and mackerel, in the words of the author.

The Flesh of Herring.

149 Dr Hulme's experiments.

(1.) "A fresh herring was divided longitudinally by a knife, into two parts. Then about four drams of it, being cut across, were put into a solution, composed of two drams of Epsom salt, and two ounces of cold spring water drawn up by the pump. The liquid was contained in a wide-mouthed three-ounce phial, which was placed in the laboratory. Upon carefully examining the liquid on the second evening after the process was begun, I could plainly perceive a lucid ring (for the phial was round) floating at the top of the liquid, the part below it being dark; but, on shaking the phial, the whole at once became beautifully luminous, and continued in that state. On the third evening, the light had again risen to the top; but the lucid ring appeared less vivid, and, on shaking the phial as before, the liquid was not so luminous as on the preceding night.

(2.) The same experiment was repeated. On the second night, the liquid, being agitated, was very luminous; on the third, not so lucid; and on the fourth the light was extinguished.

(3.) With sea salt half a dram and two ounces of water. On the second night, the liquid, when agitated, was dark; on the third, lucid; on the fourth, very luminous; on the fifth, it began to lose light; on the sixth, it continued to decrease; and on the seventh, it was quite gone. Neither the liquid nor the herring had contracted any putrid smell.

(4.) With sea water two ounces. On the second night, dark; on the third, fourth, and fifth, luminous; on the sixth, nearly extinct; and on the seventh, totally. The piece of herring, when taken out and examined, was remarkably sweet.

Roe of Herring.

(5.) About four drams, with Epsom salt two drams, and water two ounces. On the second night, the liquid was pretty luminous; on the third and fourth, still luminous; and on the fifth, its light was extinct.

(6.) With Glauber's salt or vitriolated natron, two drams to two ounces of water. On the second night, when the phial was shaken, as usual in all these experiments, the liquid was pretty luminous; on the third, less so; and on the fourth the light was scarcely visible.

(7.) With sea water two ounces. On the second night dark; on the third, the liquid was moderately luminous; on the fourth and fifth, it had extracted much light; and on the seventh it was still shining. After this process, both the roe and the sea water remained perfectly sweet.

The Flesh of Mackerel.

(8.) With Epsom salt two drams, and water two ounces. On the second night, the liquid was finely illuminated;

Light. luminated; on the third, a similar appearance; on the fourth, a diminution of light; on the fifth, it continued lucid in a small degree; and on the sixth the light was extinguished.

Roe of Mackerel.

(9.) With Epsom salt two drams, and water two ounces. On the second night, the liquid, when agitated, was exceedingly bright; on the third, the same; and on the fourth and fifth, still lucid †.

* *Philos. Trans.* 1800, p 168.

Dr Hulme found that some substances have the power of extinguishing this light. It was quickly extinguished when mixed with water alone, with water impregnated with lime, carbonic acid gas, or sulphurated hydrogen gas; by fermented liquors and ardent spirits; by the acids, both concentrated and diluted; by the alkalies when dissolved in water; by many of the neutral salts, as the solutions of common salt, Epsom salt, and sal ammoniac. It was also extinguished by infusions of chamomile flowers, of long pepper, and of camphor, made with boiling hot water, but not used till quite cool.

When the substances emitting this light were placed in a freezing medium, the light was in a short time quite extinguished; but when exposed to a moderate degree of temperature, it was revived. A moderate degree of heat increased this light, but it was extinguished by a high temperature, and no luminous appearance could again be discovered.

150 Colour.

4. When all the rays of light are reflected from any body, that body is said to be white; when all the rays are absorbed, the body which absorbs them is said to be black: but experience informs us, that different bodies absorb and reflect different rays. Thus, if a body absorb all the rays excepting the yellow, that body is said to be of a yellow colour; or if a body reflect the red rays, while the others are absorbed, it is said to be red. The colour of the body is characterized by the colour of the ray which is reflected.

151 Effects of light on metallic oxides and salts.

5. One of the most singular effects which is observed in the combination of light with bodies, is its power of reducing the oxides of the metals. Some of these, as for instance, the red oxide of lead, when exposed to the light of the sun, lose part of their weight. The oxide of gold may be reduced in the same way, the white salts of silver become black, and the oxide is reduced; and when that process is going on, oxygen gas is emitted, which, it would appear, has been separated by the action of light. Some of the rays are found to have a greater effect than others. Scheele, who made a set of experiments to ascertain the difference of effect of the different coloured rays in blackening the muriate of silver, discovered that the violet ray was the most powerful in reducing the oxide of silver.

152 Peculiar rays.

It was formerly the general opinion, that the colorific rays of light were the cause of the reduction of the oxides of the metals; but the experiments and observations of Messrs Bockman and Ritter in Germany, and of Dr Wollaston in England, prove that the muriate of silver is more strongly and rapidly darkened by rays of the sun which have been more refracted than the violet rays: for it appeared that the muriate was affected in a space lying beyond the violet light. These rays, therefore, have not the property of giving light, nor do they produce any sensible degree of heat: in fact, it appears that there are three different sets of rays; namely, rays which illuminate, rays which warm without giving any light (which will be mentioned in the next chapter), and rays which produce a chemical action on bodies, but which give neither light or heat. From the consideration of these curious and interesting experiments, it has been very naturally supposed, that the chemical actions dependent on solar light are owing to the invisible rays which are refracted beyond the violet rays; and that the colorific rays have no share in these actions: for it has been observed, that the effect of the different colours increases with their refrangibility; the whole therefore is owing to the invisible rays, which increase in quantity as they approach to the violet ray, and are in greatest quantity at a certain distance beyond it.

153 Light absorbed by plants.

6. The absorption of light by plants produces another remarkable effect. It has been long known, that the green colour of the leaves of plants is produced by the light of the sun. Experiments were first made to ascertain this fact by M. Dufay and some others of the French academicians. The subject has been farther prosecuted and extended by Senebier of Geneva. When seeds are sown in a dark place, they vegetate, and the plant grows with considerable luxuriance; but it never has any green colour as long as the light is excluded; the leaves continue white; and this happens although air be freely admitted. When the plant in this state is exposed to the light, the green colour begins to appear, and the plant assumes its ordinary habit. While the plant remains white, it also contains but a small quantity of combustible matter, and has but little taste. When it reassumes the green colour after its exposure to the light, it acquires its natural taste, and the ordinary quantity of combustible matter. It is upon this principle that the art of blanching celery and other garden plants depends; by heaping up the earth about the stems, we exclude the light, and thus they are deprived of any pungent taste, and become white and tender." (K).

SECT.

(K) This is remarkably illustrated by the following observations of Professor Robison. "Having occasion, in autumn 1774, to go down and inspect a drain in a coalwork, where an embankment had been made to keep off a lateral run of water, and, crawling along, I laid my hand on a very luxuriant plant, having a copious, deep-indented, white foliage, quite unknown to me. I inquired of the colliers what it was. None of them could tell me. It being curious, I made a sod be carried up to the daylight, to learn from the workmen what sort of a plant it was. But nobody had ever seen any like it. A few days after, looking at the sod, as it lay at the mouth of the pit, I observed that the plant had languished and died, for want of water, as I imagined. But looking at it more attentively, I observed that a new vegetation was beginning, with little sproutings from the same stem, and that this new growth was of a green colour. This instantly brought to my recollection the curious

Sect. III. *Of the Sources of Light.*

154 The sun.

1. The principal source of light is the sun. It has been a question of more curiosity than utility, what is the cause of the sun constantly emitting light, and what are the means of repairing the waste? By calculations it is supposed, that there ought to issue from one square foot of the sun's surface in one second, $\frac{1}{40000}$th part of a grain of matter, to supply the consumption of light; that is, at the rate of little more than two grains a-day, or about 4,752,000 grains, or 670lb. in 6000 years, which would have shortened the sun's diameter about 19 feet, if it was formed of matter of the density of water only *.

But at the time this calculation was made, the discoveries of Herschel, of the constitution of the sun, were not known. The body of the sun, according to the observations of this philosopher, is not luminous, but opaque; the light which was supposed to come from his surface, proceeds from a luminous atmosphere which surrounds that body; and there are probably some means by which the waste that is constantly going on is repaired. The light which comes from the stars is of the same nature with that of the sun.

* Priestley's Optics, p. 389.

155 Combustion.

2. Another source of light is the burning of bodies. In all cases of burning, light is emitted. This light, therefore, must have been in combination with some of the substances which are employed in these processes.

156 Heat.

3. But when bodies, without undergoing the process of combustion, are heated to a certain temperature, they emit light: and it would appear, from experiments which have been made upon the subject, that all bodies which are not decomposed before they arrive at the proper temperature, begin to give out light, exactly at the same degree of heat. Iron heated to 635°, according to Sir Isaac Newton's experiments, becomes visible in the dark; at 752° it shines brightly; and becomes luminous in the twilight at 884°. The temperature is above 1000° when it shines in broad day light. A red heat, according to the experiments of others, commences at the temperature of 800°, and when a body reaches the proper degree of heat, it appears luminous, independent of the air. Mr T. Wedgwood, who made a number of experiments on this subject, found that a piece of iron wire became red hot when immersed in melted glass. Air, therefore, is not necessary to the shining of ignited bodies.

It was also ascertained by Mr Wedgwood, that a piece of red-hot metal continues to shine for some time after it has been removed from the fire, which proves that constant accessions of light or heat are not necessary for the shining of ignited bodies. But if the red-hot metal be strongly blown upon, it instantly ceases to shine, the temperature being now diminished †.

† Philos. Trans. vol. lxxxii. p. 279.

157 Gases not luminous.

From the experiments of Mr Wedgwood, it appears that the gases do not become luminous, even at a higher temperature. He took an earthen-ware pipe of a zig-zag form, and placed it in a crucible filled up with sand. The ends of the pipe were left uncovered. To one end was attached a pair of bellows, and to the other a globular vessel with a lateral bent pipe, to let out air, but exclude the external light, and having a neck in which was inserted a circular plate of glass. The crucible, with the sand and the part of the pipe contained in it, was heated to redness. The eye was fixed in the neck of the vessel, which was then observed to be perfectly dark within. A stream of air was then directed through the tube from the bellows, but this air which passed through the red-hot tube was not luminous. A small strip of gold was then fixed into the orifice of the tube opposite to the eye, and after two or three blasts, it became faintly red; which shows, that though the air was not luminous, it was equal in temperature to what is called red heat. Dr Darwin made an experiment of the same kind, and with a similar result. The heated air was altogether invisible; but when a bit of gold was introduced, it acquired a bright glow in a few seconds *.

* Philos. Trans. vol. lxxxii. p. 271.

158 Attrition and percussion.

4. Light is also emitted by attrition and percussion. In the experiments which were made by Mr Wedgwood, on the attrition of bodies, he found that different coloured rays were emitted; sometimes it was a pure white light, as from the diamond; sometimes of a faint red, as from blackish gun flint; and sometimes of a deep red, as from unglazed white biscuit earthen ware. But this effect, produced by attrition, may perhaps be considered as the same with that of percussion. It

curious observations of M. Dufay; and I caused the sod to be set in the ground and carefully watered. I was the more incited to this, because I thought that my fingers had contracted a sensible aromatic smell by handling the plant at this time. After about a week, this root set out several stems and leaves of common tansy. The workmen now recollected that the sods had been taken from an old cottage garden hard by, where a great deal of tansy was still growing among the grass. I now sent down for more of the same stuff, and several sods were brought up, having the same luxuriant white foliage. This, when bruised between the fingers, gave no aromatic smell whatever. All these plants withered and died down, though carefully watered, and, in each, there sprouted from the same stocks fresh stems, and a copious foliage, and produced, among others, common tansy, fully impregnated with the ordinary juices of that plant, and of a full green colour. I have repeated the same experiment with great care on lovage (*levisticum vulgare*), mint, and caraways. All these plants throve very well below, in the dark, but with a blanched foliage, which did not spread upwards, but lay flat on the ground; in all of them there was no resemblance of shape to the ordinary foliage of the plant; all of them died down when brought into daylight; and the stocks then produced the proper plants in their usual dress, and having all their distinguishing smells.

From such experiments, I thought myself entitled to say that the sun's rays not only produced the green fæcula of plants, but also the distinguishing juices, and particularly the essential oils. The improvements which have been made in chemical science since that time, have, I think, fully confirmed my conjecture." *Black's Lect.* i. 533.

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Caloric.

It is a familiar circumstance, that sparks of light are emitted, when two hard bodies, as, for instance, two quartz stones, are smartly struck against each other; it appears that light is emitted, or sparks given out, when these bodies are treated by percussion or attrition, even under water; and they seem equally luminous in atmospheric air, oxygen gas, carbonic acid, or hydrogen gases. The emission of this light is accompanied with a peculiar smell, which varies in different bodies. The smell appears to be strongest where the friction is greatest; it has no dependence on the light produced by attrition, because it is often very strong when no light is emitted. Rock crystal, quartz, and other hard bodies, also emit this smell under water*.

* Ibid. p. 42.

When flint and steel are struck smartly together, a spark is produced which will communicate fire to combustible substances. This spark has been found to be a particle of the iron which is driven off, and which catches fire as it passes through the air. It is to be considered as a case of combustion, and quite different from what happens when two stones are rubbed or struck against each other.

The matter driven off, when stones of quartz are struck against each other, consists of small, black, friable bodies, which leave a black stain when rubbed on paper, and, when examined with a magnifying glass, have the appearance of being fused. The light is produced, in these cases, by the substances struck together having been red hot. Some have supposed that they are a combination with oxygen; while others, who have probably examined them more accurately, assert that they are pieces of the quartz surrounded with a quantity of black powder; and having been raised to a very high temperature, set fire, in their passage through the air, to the combustible bodies that are floating in it.

Chap. III. Of CALORIC.

159 Term explained.

The word *heat* in common language has two different meanings. When we say that we feel heat, we mean the sensation of heat excited in the body; but when we say that the fire or a stone is hot, it means that the power of exciting the sensation of heat in us, exists in the stone or fire. The one is the cause, and the other the effect. Thus the word *heat* is generally employed to express both the sensation and the cause of that sensation. To prevent any ambiguity in the use of terms, the word *caloric* has been adopted in the new chemical nomenclature, to signify that state or condition of matter by which it excites in us the sensation of heat; and in this sense it is now to be employed.

The nature and effect of caloric are highly interesting, as curious subjects of speculation; and the knowledge of them is of the utmost importance in the study of chemical phenomena, because no change takes place, no decomposition is effected, and no new compound is formed, without the agency of caloric.

Sect. I. *Of the Nature and Properties of Caloric.*

160 Two opinions.

Two opinions have been maintained by philosophers concerning the nature of caloric. According to one, it is supposed to be a peculiar subtile fluid, of a highly elastic and penetrating nature, which is universally diffused. According to the other opinion, it depends on a peculiar tremor or vibration existing among the particles of heated bodies.

161 Bacon's.

Among the first who seem to have adopted the latter opinion, was the celebrated Bacon. In his treatise, *De forma calidi*, which he proposed as a model of scientific investigation, he enumerates all the facts which were then known concerning heat; and after a cautious consideration of these facts, concludes, that heat is motion. 162 That heat is motion. The facts on which he founded this opinion were derived from some of the most familiar methods by which heat is produced in bodies. A blacksmith can make a rod of iron red hot by striking it smartly with a hammer; the heavy parts of machinery, by friction upon each other, and the axles of the wheels of carriages, by being heavily loaded, sometimes take fire. A fire may be kindled by the friction of two pieces of dry wood; and the branches of trees strongly rubbed against each other by the violence of a storm, have set fire to thick forests. From the observation and consideration of these facts, this eminent philosopher was led to conclude, that heat is the effect of mechanical impulse. Since the time of Bacon, this theory has had many followers, and even at the present day it is maintained by some philosophers.

163 A distinct substance.

But the theory which supposes caloric to be a distinct material substance, is now more generally adopted. It was first supposed, by those who favoured this theory, that this peculiar matter was chiefly characterized by the great elasticity, or repulsive power, of the particles among each other; but, besides this property, Dr Cleghorn supposed that it possessed another, namely, 164 Is attracted. that its particles are at the same time attracted by other kinds of matter, with different degrees of force. But whatever opinion may be formed of the nature of caloric, after we have investigated its properties and effects, we shall probably find, that the phenomena which it exhibits will be easier understood, and more satisfactorily accounted for, on the supposition that it is a distinct substance.

165 Velocity.

1. The rays of light and caloric accompany each other as they proceed from the sun, or from burning bodies. It is therefore supposed that they move with the same degree of velocity. If this be the case, the velocity of the rays of caloric must be 200,000 miles in a second. An experiment made by Mr Pictet proves their great velocity. Two concave mirrors, the one of tin, and the other of gilt plaster, 18 inches in diameter, were placed at the distance of 69 feet from each other. A thermometer was placed in the focus of the latter, and a heated bullet of iron in the former. When the bullet was placed in the focus, a thick screen, which was a few inches from the face of the metallic mirror, was removed. The thermometer instantly rose, so that the time which caloric requires to move through the space of 69 feet, cannot be estimated. And indeed, if caloric, as is most probable, moves with the velocity of light, the time that it passes the distance of 69 feet, or even 69,000 feet, is by far too minute to be measured by our instruments; so that no conclusion whatever with regard to the measurement of its velocity, can be drawn from such an experiment.

166 Minute particles.

2. From the extreme velocity of caloric, and from its being equal to that of light, it is concluded that its particles are equally minute. From the accumulation of

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Caloric.

of caloric in bodies, and particularly from one striking effect which this accumulation produces, namely, expansion, it was natural to suppose that bodies having received this addition, acquired an increase of weight. Experiments have therefore been made to ascertain this effect. Boerhaave weighed a mass of iron of 5lb. weight, while red hot, and afterwards repeated the same experiment with other metals, but found no variation, either in the hot or cold bodies, but what he could account for from the errors of the balance.

167 Experiments to ascertain the weight of caloric.

Muschenbroek supposed that heat is ponderous, or produced by a ponderous substance; and Buffon thought he had proved, by his own experiments, that a body is heavier when it is hot than when it is cold; but when similar experiments were repeated, particularly by Dr Roebuck and Mr Whitehurst, with very nice and delicate balances, the bodies which were weighed appeared heavier cold than when they were hot. This seems to be owing to the rarefaction of the air surrounding that scale in which the heated body is placed; the buoyancy of which favours an ascending motion in the scale. From more recent experiments, and particularly one made by Dr Fordyce, it appeared that bodies become heavier, but in a very small degree only, not by the increase, but by the diminution of temperature. When the whole quantity of 1700 grs. of water was frozen, it was found to be, when carefully weighed, $\frac{1}{10}$ths of a grain heavier than it had been when fluid. At this time the thermometer applied to the vessel which contained the frozen water, stood at 10°; but when it was allowed to remain till the thermometer rose to 32°, it weighed only $\frac{2}{10}$ths of a grain more than when fluid, and at the same temperature.

168 unsuccessful

That the addition of caloric to bodies produces no sensible change on their weight, seems to be placed beyond a doubt by the accurate experiments of Lavoisier, which were made with a view of ascertaining whether the weight of bodies is altered by heating or cooling them; but he found no difference.

In the year 1787, Count Rumford repeated the experiment of Dr Fordyce with the greatest care; and varying it in every possible way to avoid error, the results led him to conclude, that there is no sensible difference in the weight of bodies, either by the addition or abstraction of caloric.

169 Repulsion.

3. Caloric agrees with light in another of its peculiar properties; this is, its *repulsive* power, or the tendency of its particles to separate from each other. The particles of caloric, therefore, can never be supposed to cohere.

170 Reflection.

4. It is found that the rays of caloric have, like light, the property of being reflected by polished surfaces. Scheele discovered, that the angle of reflection of the rays of caloric is equal to the angle of incidence. This has been more fully established by Dr Herschel. Some very interesting experiments were made by Professor Pictet of Geneva, which proved the same thing. These experiments were conducted in the following manner. Two concave mirrors of tin, of nine inches focus, were placed at the distance of twelve feet two inches from each other. In the focus of the one was placed the bulb of a thermometer, and in that of the other a ball of iron two inches in diameter, which was heated, but not so as to be visible in the dark. In the space of six minutes the thermometer rose 22°. A similar effect was produced by substituting a lighted candle in place of the ball of iron. Conceiving that both the light and heat acted in the last experiment, he interposed between the two mirrors a plate of glass, with the view of separating the rays of light from those of caloric. The rays of caloric were thus interrupted, but the rays of light were not perceptibly diminished. In nine minutes the thermometer sunk 14°; and in seven minutes after the glass was removed, it rose about 12°. He therefore justly concluded, that the caloric reflected by the mirror, was the cause of the rise of the thermometer. He made another experiment, substituting boiling water in a glass vessel in place of the iron ball; and when the apparatus was adjusted, and a screen of silk which had been placed between the two mirrors removed, the thermometer rose 3°; namely, from 47° to 50°.

The experiments were varied by removing the tin mirrors to the distance of 90 inches from each other. The glass vessel, with boiling water, was placed in one focus, and a sensible thermometer in the other. In the middle space between the mirrors, was a common glass mirror, suspended so that either side could be turned towards the glass vessel. When the polished side of this mirror was turned towards the glass vessel, the thermometer rose only $\frac{1}{10}$ths of a degree; but when the other side, which was darkened, was turned towards the glass vessel, the thermometer rose 3°.5. And in another experiment, performed in the same way, the thermometer rose 3° when the polished side of the mirror was turned to the glass vessel, and 9° when the other side was turned. These experiments shew clearly, that the rays of caloric are reflected from polished surfaces, as well as the rays of light.

5. Transparent bodies have the power of refracting the rays of caloric, as well as those of light. 171 Refraction.

They differ also in their refrangibility. So far as experiment goes, the most of the rays of caloric are less refrangible than the red rays of light. The experiments of Dr Herschel shew, that the rays of caloric, from hot or burning bodies, as hot iron, hot water, fires and candles, are refrangible, as well as the rays of caloric which are emitted by the sun. Whether all transparent bodies have the power of transmitting these rays, or what is the difference in the refractive power of these bodies, is not yet known.

6. The light which proceeds from the sun seems to be composed of three distinct substances. 172 Three sets of rays,

Scheele discovered, that a glass mirror held before the fire, reflected the rays of light, but not the rays of caloric: but when a metallic mirror was placed in the same situation, both heat and light were reflected. The mirror of glass became hot in a short time, but no change of temperature took place on the metallic mirror. This experiment shews that the glass mirror absorbed the rays of caloric, and reflected those of light; while the metallic mirror, suffering no change of temperature, reflected both. 173 coloured and heating.

And if a plate of glass be held before a burning body, the rays of light are not sensibly interrupted, but the rays of caloric are intercepted; for no sensible heat is observed on the opposite side of the glass; but when the glass has reached a proper degree of of temperature, the rays of caloric are transmitted with the same facility as those of light. And thus the rays of light and caloric may be separated.

174 Invisible have the greatest heating power.

But the curious experiments of Dr Herschel have clearly proved, that certain invisible rays which are emitted by the sun, are possessed of the greatest heating power. In these experiments, the different coloured rays were thrown on the bulb of a very delicate thermometer, and their heating power was observed. The heating power of the violet, green, and red rays, was found to be to each other as the following numbers:

Violet	16.
Green	22.4
Red	55.

The heating power of the most refrangible rays was least, and this power increases as the refrangibility diminishes. The red ray, therefore, has the greatest heating power, and the violet, which is the most refrangible, the least. The illuminating power, it has been already observed, is greatest in the middle of the spectrum, and diminishes towards both extremities; but the heating power, which is least at the violet end, increases from that to the red extremity: and when the thermometer was placed beyond the limit of the red ray, it rose still higher than in the red ray, which has the greatest heating power in the spectrum. The heating power of these invisible rays was greatest at the distance of ½ inch beyond the red ray, but it was sensible at the distance of 1½ inch.

Dr Herschel's experiments have been varied, and still farther confirmed; by a set of experiments by Sir H. Englefield, the results of which were the following:

Therm. in the blue ray rose	in 3′	from 55°	to 56°
in the green	in 3′	from 54°	to 58°
in the yellow	in 3′	from 56°	to 62°
in the full red	in 2½′	from 56°	to 72°
in confines of the red	in 2½′	from 58°	to 73½°
quite out of visible light	in 2½′	from 61°	to 79°

The thermometer used in these experiments had its bulb blackened with Indian ink.

In the following experiments, three thermometers were employed; one had a naked ball, another was whitened, and the third was blackened. They were exposed to the sun's rays till they became stationary, when the thermometer with the

Naked ball stood at	58½°
Whitened ball	58½°
Blackened ball	63°

In the full red ray	the blackened thermom. rose	in 3′ from 58° to 61°
	whitened - - -	in 3′ from 55° to 58°
In quite dark -	blackened thermom. -	in 3′ from 59° to 64°
	whitened - - -	in 3′ from 58° to 58½°
In confines of the red -	black thermom. - -	in 3′ from 59° to 71°
	white - - -	in 3′ from 57½° to 60½°

In other experiments, which were made afterwards, the results were,

In the full red ray	the black therm. rose	in 3′ from 66° to 82°
	white - - -	in 3′ from 66° to 69½°
In quite dark, ½ inch out of the red, the black thermom. rose -	- - - -	in 3′ from 70° to 84°

In this last experiment, when the thermometer was carried into the faint red light, it sunk quickly; and rose again as quickly, when carried into the dark focus; but when carried into the dark on the other side of the red light, it sunk very rapidly, and did not appear to receive any heat at all †.

Thus it appears that the rays of caloric, and the rays of light are different. These experiments clearly show, that there are rays which produce heat, but give no light, and rays which give light but produce no heat. It was formerly mentioned, that there is another set of rays which give neither light nor heat, but produce a remarkable effect in reducing the metallic oxides and salts. The light which is emitted from the sun then consists of three distinct sets of rays, which have been fully recognized by their different degrees of refrangibility and their different effects. The heating rays are in the smallest degree refrangible; the rays which have the greatest effect on the metallic oxides are the most refrangible, and the coloured rays are in an intermediate degree. The invisible rays beyond the red extremity of the spectrum, which are least refracted, have the greatest heating power; the invisible rays beyond the violet end, which are most refracted, have the greatest power in reducing the metallic salts or oxides, and the rays in the middle of the spectrum have the greatest illuminating power.

† *Jour. Roy. Inst.* vol. i. p. 206.

Sect. II. *Of the* Effects *of* Caloric.

175 Effects of caloric different in different bodies.

The effects of so powerful an agent as heat must be very considerable: and these effects are found to be different in different bodies, or as it is more or less accumulated in these bodies. One general effect is, that the accumulation of heat enlarges, and its abstraction proportionally diminishes, the bulk of all bodies. When this accumulation is continued in some bodies, they change their condition from the state of solid to that of liquid; and, when the accumulation is still greater, liquid bodies are reduced to the form of vapour. These effects, certainly curious and interesting of themselves, are of the utmost importance in the phenomena of nature and in the processes of art; and the knowledge of the laws which have been deduced from these remarkable changes, enables us to explain many natural appearances, and to improve many of the arts of life.

1. Of Expansion.

176 Caloric expands all bodies.

1. One of the most general effects of heat, it has been observed, is the expansion of bodies; that is, when caloric is accumulated in any body, it is enlarged in

Caloric. in bulk; and, when that quantity of caloric is abstracted, there is a corresponding contraction. Experience teaches us, that this effect of caloric is invariable by uniform in all the simpler kinds of matter. In some bodies, however, there are seeming exceptions to this general rule. In these bodies, when the temperature rises a little above, or falls a little below a certain
177 point, they are subject to irregular variations of their
Exceptions. bulk; but these irregularities are limited to a few bodies, and to certain states of temperature of these bodies; for when they are exposed to equal variations of heat, above or below the temperature at which these irregularities are observed, the general law of expansion uniformly holds. The expansion of all bodies by heat, therefore, and their corresponding contraction by the abstraction of caloric or by cold, may be considered as
178 one of the most general facts in chemical science.
Expansion proved. 2. We have many familiar instances of the expansion of bodies by means of caloric, and the law can be proved by very simple experiments. We shall mention an example of this effect on bodies in the solid, the
179 liquid, and the gaseous state.
In a solid body. (1.) If a rod of metal, as of iron, of an inch in diameter, six or eight inches long, and the same thickness through its whole length, be exactly fitted to pass through a hole in a plate of the same metal, and to be admitted lengthwise within the projecting edges of a ruler while it is cold, the same rod, when it is made red hot, will be found to have enlarged in bulk so much, that it will not fall between the projecting parts of the ruler, nor will it pass through the hole; but when it is cooled, or reduced to its former temperature, it again contracts, and returns precisely to its former dimensions.
180
In a liquid. (2.) As an example of a liquid, whose bulk is enlarged by the accumulation of caloric, fill the body of a glass vessel which has a long slender neck with spirit of wine. On the application of heat, the liquid in the body of the vessel is expanded, and rises in the neck; and when the heat is abstracted, and the liquid returns to its former temperature, it is again contracted, and returns to its original bulk. This experiment is most conveniently performed by immersing the body of the vessel in hot water.

(3.) The expansion of a body in the gaseous state by 181 In an elastic fluid.
the accumulation of caloric, is shewn by the following experiment. Let a quantity of air be confined in a bladder, but not so much as to distend it fully. If the bladder is exposed to heat, the confined air expands, and the bladder is now fully distended; but when it is again cooled, the air resumes its former bulk, and the bladder its original flaccid state.

3. Thus it appears, that all bodies expand by heat, 182 Uniform in the same bodies.
and contract by cold, and the quantity of this expansion is uniformly the same in the same bodies, when exposed to the same temperature. But this quantity is found to differ greatly in different kinds of matter, by the same increase or diminution of their heat. In solid bodies it is least, in liquids it is greater, but in elastic fluids greatest of all; and in different kinds of solids, liquids, and elastic fluids, this difference is very considerable. The ratio at which this expansion takes place in different bodies, can only be ascertained by experiment; and as the knowledge of this is a matter of great consequence in many of the arts, experiments have been made with this view by different philosophers. (L).

The expansion of gaseous bodies, we have said, is 183 But very different in solids, liquids, and elastic fluids.
greatest, that of liquids less, and that of solids least of all, by being exposed to the same degree of heat, which will appear from the following proportions.

100 cubic inches of	Atmospheric air,	from 32° to 112° increased to	137.5 cubic inches.
	Water,		104.5
	Iron,		100.1

184
Effects of expansion on brittle substances. 4. This expansive effect of heat enables us to account for the cracking or breaking of vessels which are made of brittle substances, by its sudden application or abstraction. This is particularly the case with substances which have little flexibility, as cast iron, glass, or earthen ware; and accidents of this kind most frequently happen in vessels made of these materials. If, for instance, heat be suddenly applied to a glass vessel of considerable thickness, its external surface, to which it is first applied, expands more than the internal parts; the consequence must therefore be, that they are separated or drawn asunder, and the vessel is split or broken.

185
In fitting iron hoops to carriage wheels. 5. One of the best illustrations of this expansion by heat and contraction by cold on solid bodies, is in the application of iron hoops to carriage wheels. The hoop which has been intended for the wheel is made of rather smaller dimensions than exactly to fit it. It is then made red hot, and while it is thus expanded, it is applied to the wheel. It is suddenly cooled by throwing cold water upon it, when it contracts, and returning to its former dimensions, is strongly fastened on the wheel.

The unequal contraction at the same degree of temperature, which is observed among solids, liquids, and 186 Different metals unequally affected.
aeriform substances, when respectively compared, also takes place among solids themselves. Thus, different metallic substances, at the same temperature, are found to expand and contract very unequally.

6. Advantage has been taken of this unequal contraction of metallic substances, to remedy those defects and imperfections of delicate instruments, which are occasioned by the contractions and expansions of the substances employed in their construction, when exposed to different temperatures. These inconveniences were most felt in instruments which were employed for the measurement of time, where great accuracy was required. The spring of a watch and the pendulum of a clock being subject to the same law of contraction and expansion by heat and cold, in these changes, necessarily

(L) See experiments on this subject by Mr Elliot, Phil. Trans. vol. xxxix. and by Mr Smeaton, ibid. vol. xlviii.

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Calorie.

cessarily caused variations, in proportion to the extent of the effect. But as different metals were observed to expand unequally by the same temperature, this was applied to the construction of those parts of the instrument on which the accuracy of its indications depends. The equable measurement of time, for instance, by a clock, depends on the length of the pendulum always
187 Use of this in constructing the pendulum. continuing the same. If it is subject to variations in length by expansion or contraction, there will also be variations in the rate of its motions; when the pendulum is lengthened by heat, the clock goes slower; and when it is shortened by cold, it goes faster. It becomes therefore an object of great importance, that these instruments should go at an equable rate in all temperatures; but this can only be effected by having the pendulum so constructed, that it shall neither lengthen by heat, nor contract by cold. This object is obtained by constructing a pendulum in the following manner.

"Supposing we have two metals, one of which expands three times as much as the other by the same increment of temperature. From the point of expansion A (fig. 1. Plate CXLII.) a rod of thick wire, AB, of the less expansible metal, must hang down a certain length. At the lower end it must have a stud, or cross piece, BC, strongly fastened, and projecting a little to one side. On the projecting part, C, of this cross piece, must be erected a pillar, CD, of the more expansive metal. To the top of this pillar, another cross and projecting piece, DE, must be strongly fastened; and, from this last, must again hang down another rod or wire, EF, of the first metal, having the ball of the pendulum at its extremity. And now, if the height of the pillar CD be one-third of the length of the two rods taken together, the pendulum can neither be lengthened by heat nor shortened by cold. For by the expansion of the pillar, the pendulum is shortened, or the ball is raised nearer to the point of suspension, because the upper end D of the pillar is more raised by its expansion, than the lower end C is depressed by the expansion of AB; and, on the other hand, by its contraction, the pendulum is lengthened, or the ball is lowered: but, while this happens, the two rods, by their expansion or contraction, produce a contrary effect; and the quantity of expansion or contraction is the same in the rods that it is in the pillar, the greater length in the rods compensating for the greater expansibility of the pillar. The consequence therefore must be, that the length of the pendulum, that is, the distance between the point of suspension and the ball, cannot be varied by heat or cold. Accordingly, the clocks made for the use of astronomers, have pendulums constructed upon this principle.

188 The bulk of water when frozen is increased. 7. There are, however, some remarkable instances which are seeming exceptions to this general law of expansion. This is the case with those bodies which pass from the liquid to the solid state; as for instance, water, when it assumes the solid form. Close vessels which are filled with water, are burst when it freezes. In an experiment made by Mr Boyle, a brass tube three inches in diameter, which was closed with a moveable stopper, was filled with water; when the water was frozen, it raised a weight equal to 74lb. with which the stopper was loaded. In an experiment made by the Florentine academicians, a hollow brass globe, the diameter of whose cavity was an inch, was burst by freezing the water with which it was filled. Muschenbroeck has computed the force necessary to produce this effect, by estimating it equal to a pressure of 27,720lbs. weight. But the most remarkable experiments to prove the expansive force of ice, were made by Major Williams in Canada, in the years 1784 and 1785. The iron plugs with which iron bombshells filled with water were closed up by driving them in strongly with a hammer, were thrown out to a great distance by the force of the congelation of the water; and when the plugs were so firmly secured as to resist this force, the shell itself was burst*. 189 and acts with prodigious force.

8. To the same expansive force in the congelation of water, the bursting of water pipes, the splitting of trees and of rocks, is to be ascribed, which not unfrequently happens, when the water which has been collected in their cavities or fissures is frozen. The stones of the pavement are also raised and loosened by the expansion of the water, by frost, in the earth in which they are imbedded. 190 Other effects.

9. Attempts have been made to discover the cause of this astonishing effect. According to some, it is owing to the extrication of the air which water holds in combination in a dense, nonelastic state. When the water is freezing, part of the air assumes the elastic form, and separates from it; but when the surface of the water is covered with ice, no more air can make its escape. It is then confined, and forms those numerous cavities which are observed in ice. In consequence of these cavities, a mass of ice must be of greater bulk than the water previous to congelation, and cannot therefore be contained in the same space. But another cause, which is perhaps the most probable, has been assigned for this increase of bulk, and consequent expansive force. Water, when it passes from the liquid to the solid state, has a strong tendency among its parts to arrange themselves in a determinate manner. They assume the form of prismatic crystals, which cross each other at angles of 60° and 120°. In this way the increase of bulk, and the expansive force of water, when it is consolidated, are accounted for. 191 Accounted for from the new arrangement of the particles.

10. Another, and a much more singular exception to this law, occurs in water while still fluid, between the degrees of 32° and 40° (Fahr.). Within this short range of temperature it contracts by heat and expands by cold. At 40°, or nearly so, this fluid is at its maximum density. It expands while it is lowered to 32°, as it does when it is raised to 48°. 192 More remarkable exception in fluid water under 40°.

Exper. If we fill a tall cylindrical vessel with water at 40°, and apply a temperature of 32° round the outside, by means of ice, at the middle of its height, the water thus cooled does not sink as it would if the water had been at 60°. It is found to rise. A thermometer immersed near the top, shews, by falling, that colder water now surrounds it; while another thermometer at the bottom remains stationary at 40°.

This probably arises from the particles of water now changing their arrangement, in such a way as is preparatory to their crystalline or frozen state, in which the volume is so powerfully expanded.

This singular law of water, serves the important purpose of preventing the downward progress of freezing in the water of deep lakes. While it cools, and before it is so low as 40°, the colder water at the surface, by its

* Edin. Trans. vol. ii. p. 23.

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Caloric.

its superior density, sinks, and the cooling process is thus uniformly diffused; but this motion stops when it is at 40°. The water cooled still lower is now expanded, and therefore remains on the surface; and even when the surface is frozen, and a stratum of ice-cold water lies under the ice, the lower strata remain at 40°, and are only cooled lower by a very slow transmission of the temperature, independent of the motion of the particles or by motions of an occasional or accidental kind. Hence lakes retain at the bottom a temperature adapted to the life of fishes during the hardest winters.

Some metallic substances, particularly cast iron, are observed to enlarge in bulk, when they pass from the fluid to the solid state, in the same way as water. To this increase of bulk in cast iron when it cools, are owing the sharpness and distinctnass of the lines in the ornamental figures on grates and furnaces which are

193 In cast iron.

made of this metal. The metal is introduced into the mould while in a state of fusion, and increasing in bulk as it cools, the minute cavities of the mould are more accurately filled. This increase of bulk, as in the case of water when it becomes solid, is also ascribed to a determinate arrangement of the parts of the metal, or to crystallization.

11. On the expansive property of bodies depends the construction of the thermometer, which is employed for the measurement of the relative temperatures of bodies.

194 The thermometer invented.

The invention of this instrument is generally ascribed to Santorio, an Italian physician, who lived about the beginning of the 17th century, although it is said by some, that thermometers were made by Drebel, a Dutch physician, and that they were common in Holland, and even in England, before Santorio was known in these conntries.

195 First construction.

In the thermometer of Santorio, the expansive power of air was employed to measure the temperature. His thermometer is constructed in the following manner. A tube of glass of 18 inches or two feet in length, open at one end, is blown into a ball at the other. When the ball is heated, the air within is expanded, and if the open end of the tube be now immersed in a vessel filled with any coloured fluid; as the internal air cools, and is diminished in bulk, the liquid will rise in the tube by the pressure of the external air on the surface of the liquid in the vessel. A scale of equal degrees was then applied to the whole length of the tube, and the thermometer was constructed. To ascertain the heat of any body, as for instance the hand, it was applied to the ball, and if this temperature was greater than the medium in which the apparatus was placed, the internal air was rarefied, and consequently depressed the surface of the coloured liquid in the tube. The number of degrees of this depression was observed and compared in different ex-

196 Imperfect.

periments. As, for instance, the difference of temperature of the human body at different periods, to ascertain which, it is said, it was employed by the inventor. But the inaccuracy of this instrument will be obvious, when we consider that it depended, not only on the temperature, but also on the pressure of the atmosphere.

197 Improved.

This defect in the air thermometer was avoided in the one invented by Mr Boyle, and by the Florentine academicians, nearly at the same time. The first fluid that was used was spirit of wine, which contracting and expanding more than water at the same temperature, and not being liable to be frozen by cold, was found to be much more convenient. Quicksilver was some time afterwards employed in the same way. The ball of the glass, and part of the tube, was filled with the fluid, when the open extremity of the tube was closed. When heat was applied to the ball, the fluid within expanded, and contracted by cold, without being influenced by the pressure of the atmosphere, as in Santorio's thermometer. But still this thermometer was very imperfect, for want of determinate points in the scale, by which different instruments might be compared together. This desideratum was first supplied by Sir Isaac Newton, and after various improvements, it was brought to its present state of perfection.

198 Fahrenheit's thermometer.

The method of constructing Fahrenheit's thermometer, which is now in general use in this country, is the following: A small ball is blown on the end of a glass tube, of uniform width throughout. The ball and part of the tube are then to be filled with quicksilver, which has been previously boiled to expel the air. The open end of the tube is then to be hermetically sealed (M). The next object is to construct the scale. It is found by experiment, that melting snow or freezing water is always at the same temperature. If, therefore, a thermometer be immersed in the one or the other, the quicksilver will always stand at the same point. It has been observed, too, that water, while under the same pressure of the atmosphere, boils at the same temperature. A thermometer, therefore, immersed in boiling water, will uniformly stand at the same point. Here then are two fixed points from which a scale may be constructed, by dividing the intermediate space into equal parts, and carrying the same divisions as far above and below the two fixed points as may be wanted. Thus, thermometers constructed in this way may be compared; for if they are accurately made, and placed in the same temperature, they will always point to the same degree on the scale.

The fluid that is now generally employed is quicksilver; and it is found to answer best, because its expansions are most equable. The freezing point of Fahrenheit's thermometer, is marked 32°, as this artist thought that he had produced the greatest degree of cold by a mixture of snow and salt; and the point at which the thermometer then stood in this temperature, was marked zero. The intermediate space between the boiling and freezing points being divided into 180°, the boiling point in this thermometer is 212°. This is the thermometer that is commonly used in Britain.

There are three other thermometrical scales employed in different countries of Europe, which differ from each other in the number of degrees between the freezing and boiling points.

Reaumur's

(M) This is done by heating the end of the tube with the flame of a lamp, and by closing it while the glass is softened.

2

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Caloric.

199 Reaumur's. Reaumur's thermometer was generally used in France before the revolution, and is still employed in different countries on the continent. The freezing point in this thermometer is marked zero, and the boiling point 80°. To convert the degrees of Reaumur's thermometer to those of Fahrenheit, the following is the formula. Reaum. $\frac{9}{4}+32=$Fahr. that is, multiply the degrees of Reaumur by 9, divide by 4, and add 32. This gives the corresponding degrees on Fahrenheit's scale.

200 Celsius. The thermometer of Celsius has the space between the freezing and boiling points divided into 100°. The boiling point is 100°, and the freezing point zero. This thermometer is used in Sweden, and in France, where it is distinguished by the term *centigrade*. To convert the degrees of this thermometer into those of Fahrenheit; Cel. $\frac{9}{5}+32=$Fahr.

201 Delisle's. In Delisle's thermometer, which is used in Russia, the space between the boiling and freezing points is divided into 150°; but the degrees are reckoned downwards. The boiling point is marked zero, and the freezing point 150°. To reduce the degrees of this thermometer under the boiling point to those of Fahrenheit, Del. $\frac{6}{5}-212=$Fahr. and above the boiling point, Del. $\frac{6}{5}+212=$Fahr.

Such are the principles and mode of construction of the thermometer; an instrument which has been of the utmost importance in enabling us to discover many of the properties and effects of caloric, as by it only we can ascertain with accuracy the relative temperatures (N).

12. It has been an object of considerable interest and importance to ascertain the quantity and rate of expansion in bodies. Among solid bodies the quantity of expansion is very small, so that a nice apparatus is necessary to ascertain it. But it appears that the ratio of this expansion is equable, or nearly so. The results of experiments made by Mr Smeaton and some other philosophers upon this subject, are exhibited in the following table. 202 Quantity of expansion.

203 Of different metals.

Temperature.	Platina.	Antimony.	Steel.	Iron.	Cast Iron.	Bismuth	Copper.	Cast Brass.	Brass Wire.
32°	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
212	120,104	120,130	120,147	120,151		120,167	120,204	120,080	120,232
White heat.			123,428	121,500	122,571				

Temperature.	Tin.	Lead.	Zinc.	Hammered Zinc.	Zinc 8. Tin 1.	Lead 2. Tin 1.	Brass 2. Zinc 1.	Pewter.	Copper 3. Tin 1.
32°	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000
212	120,298	120,344	120,355	120,373	120,123	120,301	120,247	120,274	120,218

204 Of glass. The rate of the expansion of glass, which is a matter of considerable importance, has been ascertained by M. de Luc, and is exhibited in the following table:

Temperature.	
32°	100,000
50	100,006
70	100,014
100	100,023
120	100,033
150	100,044
167	100,056
190	100,069
212	100,083

205 Of liquids. 13. The expansion of liquid bodies is greater than that of solids, but it is not equable with equal additions of temperature. It has been observed, that those liquids which are most readily brought to the state of vapour, or whose boiling point is lowest, expand most. With the same given temperature, the expansion of water is greater than that of mercury, and the expansion of alcohol is greater than that of water. The boiling point of water is lower than that of mercury, and the boiling point of alcohol is lower than that of water; from which it would appear, that the expansion of liquids is nearly in the inverse ratio of their boiling temperatures, and this expansion seems to increase with the temperature; that is, the nearer a liquid is to that point of temperature at which it boils, the greater is the degree of expansion by the addition of caloric; and the farther it is from the boiling temperature, the smaller is the increase of bulk by the addition of caloric. The following table exhibits the ratio of expansion of several liquids, as they have been ascertained by different philosophers.

Table

(N) For measuring high degrees of temperature, the pyrometer of Wedgwood is employed, which will be described under the earth *alumina*.

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Table of the Rate of Expansion of different Liquids from 32° to 212°.

Temp.	Mercury.	Linseed Oil.	Sulphuric Acid.	Nitric Acid.	Water.	Oil of Turpent.	Alcohol.
32°	100000	100000	—	—	—	—	100000
40	100081	—	99752	99514	—	—	100539
50	100183	—	100000	100000	100023	100000	101105
60	100304	—	100279	100486	100091	100460	101688
70	100406	—	100558	100990	100197	100993	102281
80	100508	—	100806	101530	100332	101471	102890
90	100610	—	101054	102088	100694	101931	103517
100	100712	102760	101317	102620	100908	102446	104162
110	100813	—	101540	103196	—	102943	—
120	100915	—	101834	103776	101404	103421	—
130	101017	—	102097	104352	—	103954	—
140	101119	—	102320	105132	—	104573	—
150	101220	—	102614	—	102017	—	—
160	101322	—	102893	—	—	—	—
170	101424	—	103116	—	—	—	—
180	101526	—	103339	—	—	—	—
190	101628	—	103587	—	103617	—	—
200	101730	—	103911	—	—	—	—
212	101835	107250	—	—	104577	—	—

206 All gases expand equably.

14. It has been proved by experiment that all gaseous bodies undergo the same expansion, with the same addition of heat. This has been ascertained by the ingenious experiments of Mr Dalton and M. Gay Lussac. The increase of bulk of some elastic fluids from 32° to 212°, as determined by the latter, will be seen in the following table:

Atmospheric air 100 parts, increased	37.50	
Hydrogen gas	37.52	difference +0.2
Oxygen gas	37.40	——— —0.02
Azotic gas	37.49	——— —0.01*

* Ann. de Chim. vol. xliii. p. 167.

In other experiments he found, that the expansion of the vapour of water and of ether corresponded with the expansion of other gases; and he remarks, that this property of the equable dilatation of the vapour of ether and water, and the gases, with the same degrees of temperature, depends not on the peculiar nature of the vapour and gases, but solely on their elastic state.

Mr Dalton's experiments shew that the expansion of air is very nearly equable. It appears, however, that the rate of expansion diminished as the temperature increased. The expansion from 55° to 132½°, which includes 77½°, was 167 parts; but the expansion from 132½° to 212°, the next 77½°, was only 158 parts, which was nine parts less than the first. The same philosopher observes, that the results of several experiments which he made upon hydrogen gas, oxygen gas, carbonic acid gas, and nitrous gas, correspond with those on atmospherical air, not only in the total expansion, but in the gradual diminution of it in ascending. Small differences were observed, but they never exceeded six or eight parts in the whole amount 325; and differences to this amount, he adds, will take place in common air, when not freed from aqueous vapour, which, he says, was the situation of his factitious gases.

2. Of Fluidity.

1. When still greater additions are made to most bodies, they are followed not merely by a change of bulk, but by a total change of their state and properties. 207 Change of state.

All matter exists, either in the state of solid, of liquid, or of vapour. Most bodies, by the addition or the abstraction of caloric, are convertible from one of these states into another. Ice is water in the solid state. When a mass of ice has received a certain quantity of caloric, it assumes the liquid state; and, when this liquid has received another portion of caloric, it is changed into the state of vapour. On the other hand, if the vapour is deprived of a certain portion of caloric, it returns to the state of liquid or that of water; and when this water is deprived of another portion of caloric, it becomes solid, or is converted into ice.

This seems to be a general law of bodies, to which there are but few exceptions. Some may be converted into all the three states, as water; others, as spirit of wine, are known only in the fluid or the gaseous state, and there are some solid bodies which are not convertible into the state of liquid; but these exceptions are so few, that it has been supposed the same effect would follow, were these bodies exposed to the requisite degree of temperature.

2. The temperatures at which these changes are effected are invariably the same in the same body. Thus, a mass of ice is converted into the state of liquid or of water, when it is exposed to a temperature above 32°; and water, when it is raised to the temperature of 212° under the usual pressure of the atmosphere, assumes the state of vapour or of steam. But although this temperature is constant in the same bodies, 208 Bodies become fluid at the same degree of temperature.

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Caloric. dies, it varies greatly in different bodies. Thus, spirit of wine and ether are converted into vapour at a very low temperature, while mercury and the fixed oils, to undergo this change, require a temperature far above that which is necessary for water.

209 In some instantaneously. 3. Some bodies are instantaneously converted from the solid to the liquid state. Thus ice, when the temperature is raised, passes immediately from the solid to the fluid state.
210 In others gradually. Other bodies undergo a gradual change. They first become soft, as in the instance of melting wax, and pass through different degrees of softness, till at last they become perfectly fluid.

4. It may perhaps now seem surprising, that these phenomena should have so long been familiarly known, while no conception was entertained of the true explanation. The want of instruments to measure accurately the relative degrees of temperature at which these changes took place, might be one cause of the unsuccessful investigations of philosophers on this subject. But even after the invention and improvement of the thermometer, it was long before the simple cause of these wonderful effects was fully ascertained. The discovery of this law, of such universal application to the phenomena of nature, was reserved for the sagacity of Dr Black; and the era may be regarded as one of
211 Great discovery of Dr Black. the most important in the history of chemical science. Dr Black was distinguished for caution and precision in all his views; and the progressive steps by which this celebrated philosopher was led to ascertain the true cause of fluidity, afford us a fine example of simple and elegant investigation.

5. After stating that the cause of fluidity which had been formerly given was unsatisfactory, and inconsistent with the phenomena, he observes that "these phenomena, when attentively considered, shew that fluidity is produced by heat, in a very different manner from that which was commonly imagined; a manner, however, which, when understood, enables us to explain many particulars relating to heat or cold, which appeared, in the former view of the subject, quite perplexing and unaccountable.

212 Fluidity, supposed to be owing to a small addition of caloric. "Fluidity had been universally considered as produced by a small addition to the quantity of heat which a body contains, when it is once heated up to its melting point; and the returning of such body to a solid state, as depending on a very small diminution of the quantity of its heat, after it is cooled to the same degree; that a solid body, when it is changed to a fluid, receives no greater addition to the heat within it than what is measured by the elevation of temperature indicated after fusion by the thermometer; and that, when the melted body is again made to congeal, by a diminution of its heat, it suffers no greater loss of heat than what is indicated also by the simple application to it of the same instrument.

213 Inconsistent with facts. "This," says the author, "was the universal opinion on this subject, so far as I know, when I began to read my lectures in the university of Glasgow, in the year 1757. But I soon found reason to object to it, as inconsistent with many remarkable facts, when attentively considered; and I endeavoured to shew, that these facts are convincing proofs that fluidity is produced by heat in a very different manner.

"I shall now describe the manner in which fluidity appeared to me to be produced by heat, and we shall then compare the former and my view of the subject with the phenomena.

"The opinion I formed from attentive observation of the facts and phenomena, is as follows: When ice, for example, or any other solid substance, is changing into a fluid by heat, I am of opinion that it receives a much greater quantity of heat than what is perceptible in it immediately after by the thermometer. 214 Caloric is absorbed by solids becoming fluid. A great quantity of heat enters into it, on this occasion, without making it apparently warmer, when tried by that instrument. This heat, however, must be thrown into it, in order to give it the form of a fluid; and I affirm, that this great addition of heat is the principal and most immediate cause of the fluidity induced.

"And, on the other hand, when we deprive such a body of its fluidity again, by a diminution of its heat, a very great quantity of heat comes out of it, while it is assuming a solid form, the loss of which heat is not to be perceived by the common manner of using the thermometer. 215 Fluids becoming solid give out caloric. The apparent heat of the body, as measured by that instrument, is not diminished, or not in proportion to the loss of heat which the body actually gives out on this occasion; and it appears from a number of facts, that the state of solidity cannot be induced without the abstraction of this great quantity of heat. And this confirms the opinion, that this quantity of heat, absorbed, and as it were, concealed in the composition of fluids, is the necessary and immediate cause of their fluidity.

"To perceive the foundation of this opinion, and the inconsistency of the former with many obvious facts, we must consider, in the first place, the appearances observable in the melting of ice, and the freezing of water.

"If we attend to the manner in which ice and snow melt, when exposed to the air of a warm room, or when a thaw succeeds to frost, we can easily perceive, that however cold they might be at the first, they are soon heated up to their melting point, or begin soon at their surface to be changed into water. 216 Proved by the melting of ice and freezing of water. And if the common opinion had been well founded, if the complete change of them into water required only the further addition of a very small quantity of heat, the mass, though of a considerable size, ought all to be melted in a very few minutes or seconds more, the heat continuing incessantly to be communicated from the air around. Were this really the case, the consequences of it would be dreadful in many cases; for, even as things are at present, the melting of great quantities of snow and ice occasions violent torrents, and great inundations in the cold countries, or in the rivers that come from them. But, were the ice and snow to melt as suddenly as they must necessarily do, were the former opinion of the action of heat in melting them well founded, the torrents and inundations would be incomparably more irresistible and dreadful. They would tear away and sweep up every thing, and that so suddenly, that mankind should have great difficulty to escape from their ravages. 217 Melting of ice a very slow process. This sudden liquefaction does not actually happen; the masses of ice or snow melt with a very slow progress, and require a long time, especially if they be of a large size, such as are the collections of ice, and wreaths of snow, formed in some places during the winter. These, after they begin to melt, often require many weeks of warm weather,

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Caloric.

weather, before they are totally dissolved into water. This remarkable slowness with which ice is melted, enables us to preserve it easily during the summer, in the structures called ice-houses. It begins to melt in these, as soon as it is put into them: but, as the building exposes only a small surface to the air, and has a very thick covering of thatch, and the access of the external air to the inside of it is prevented as much as possible, the heat penetrates the ice-house with a slow progress, and this, added to the slowness with which the ice itself is disposed to melt, protracts the total liquefaction of it so long, that some of it remains to the end of summer. In the same manner does snow continue on many mountains during the whole summer, in a melting state, but melting so slowly, that the whole of that season is not a sufficient time for its complete liquefaction.

"This remarkable slowness with which ice and snow melt, struck me as quite inconsistent with the common opinion of the modification of heat, in the liquefaction of bodies.

218 Foundation of the discovery.

"And this very phenomenon is partly the foundation of the opinion I have proposed; for if we examine what happens, we may perceive that a great quantity of heat enters the melting ice, to form the water into which it is changed, and that the length of time necessary for the collection of so much heat from the surrounding bodies, is the reason of the slowness with which the ice is liquefied. If any person entertain doubts of the entrance and absorption of heat in the melting ice, he needs only to touch it; he will instantly feel that it rapidly draws heat from his warm hand. He may also examine the bodies that surround it, or are in contact with it, all of which he will find deprived by it of a great part of their heat; or if he suspend it by a thread, in the air of a warm room, he may perceive with his hand, or by a thermometer, a stream of cold air descending constantly from the ice; for the air in contact is deprived of a part of its heat, and thereby condensed and made heavier than the warmer air of the rest of the room; it therefore falls downwards, and its place round the ice is immediately supplied by some of the warmer air; but this, in its turn, is soon deprived of some heat, and prepared to descend in like manner; and thus there is a constant flow of warm air from around, to the sides of the ice, and a descent of the same in a cold state, from the lower part of the mass, during which operation the ice must necessarily receive a great quantity of heat.

"It is, therefore, evident, that the melting ice receives heat very fast, but the only effect of this heat is to change it into water, which is not in the least sensibly warmer than the ice was before. A thermometer, applied to drops or small streams of water, immediately as it comes from the melting ice, will point to the same degree as when it is applied to the ice itself, or, if there is any difference, it is too small to deserve notice. A great quantity, therefore, of the heat, or of the matter of heat, which enters into the melting ice, produces no other effect but to give it fluidity, without augmenting its sensible heat; it appears to be absorbed and concealed within the water, so as not to be discoverable by the application of a thermometer.

219 Thermometer does not indicate the caloric absorbed.

"In order to understand this absorption of heat into the melting ice, and concealment of it in the water, more distinctly, I made the following experiments.

220 Proved by experiments.

"The plan of the first was to take a mass of ice, and an equal quantity of water, in separate vessels, of the same size and shape, and as nearly as possible of the same heat, to suspend them in the air of a warm room, and, by observing with a thermometer the celerity with which the water is heated, or receives heat, to learn the celerity with which it enters the ice; and the time necessary for melting the ice being also attended to, to form an estimate, from these two data, of the quantity of heat which enters the ice during its liquefaction.

221 First experiment.

"In order to prepare for this experiment, I chose two thin globular glasses, four inches diameter, and very nearly of the same weight: I poured into one of them five ounces of pure water, and then set it in a mixture of snow and salt, that the water might be frozen into a small mass of ice. As soon as frozen, it was carried into a large empty hall, in which the air was not disturbed or varied in its temperature during the progress of the experiment; and in this room the glass was supported, as it were, in mid air, by being set on a ring of strong wire, which had a tail issuing from the side of it five inches long, and the end of this tail was fixed in the most projecting part of a reading desk or pulpit: And in this situation the glass remained until the ice was completely melted.

"When the ice was thus placed, I set up the other globular glass precisely in the same situation, and at the distance of 18 inches to one side, and into this poured five ounces of water, previously cooled, as near to the coldness of melting ice as possible, viz. to 33°, and suspended in it a very delicate thermometer, the bulb of which being in the centre of the water, and the tube being so placed, that, without touching the thermometer, I could see the degree to which it pointed. I then began to observe the ascent of this thermometer, at proper intervals, in order to learn with what celerity the water received heat, stirring the water gently with the end of a feather about a minute before each observation. The heat of the air, examined at a little distance from the glasses, was 47° of Fahrenheit's scale.

"The thermometer assumed the temperature of the water in less than half a minute, after which, the rise of it was observed every five or ten minutes, during half an hour. At the end of that time, the water was grown warmer than at first, by 7 degrees; and the temperature of it had risen to the 40th degree of Fahrenheit's scale.

"The glass with the ice was, when first taken out of the freezing mixture, four or five degrees colder than melting snow, which I learned by applying the bulb of the thermometer to the bottom of it; but after some minutes, it had gained from the air those four or five degrees, and was just beginning to melt, which point of time was then noted, and the glass left undisturbed ten hours and a half. At the end of this time, I found only a very small and spongy mass of the ice remaining unmelted, in the centre of the upper surface of the water, but this also was totally melted in a few minutes more; and, introducing the bulb of the thermometer into the water, near the sides of

Caloric.

of the glass, I found the water there was warmed to the 40th degree of Fahrenheit. From this it appears, that when a considerable part of the ice was melted, and the quantity of water around it was increasing, the heat was not transmitted through this water to the remaining ice altogether so fast as it was received by the water; which is easily understood, if we consider that the distance between the remaining ice and the external surface of the vessel through which the heat entered, was gradually increasing, and that heat always requires time to pass through bodies or to be communicated from one part of them to another.

"It appears, therefore, from this experiment, that it was necessary that the glass with the ice receive heat from the air of the room during 21 half-hours, in order to melt the ice into water, and to heat that water to the 40th degree of Fahrenheit. During all this time, it was receiving the heat, or matter of heat, with the same celerity (very nearly) with which the water-glass received it during the single half-hour in the first part of the experiment. For, as the water received it with a celerity which was diminishing gradually during that half hour, in consequence of the diminution of difference between its degrees of heat and that of air; so the glass with the ice also received heat with a diminishing celerity, which corresponded exactly with that of the water-glass, only that the progression of this diminution was much more slow, and corresponded to the whole time which the water surrounding the ice required to become warmed to the 40th degree of Fahrenheit. The whole quantity of heat, therefore, received by the ice-glass during the 21 half-hours, was 21 times the quantity received by the water-glass during the single half-hour. It was, therefore, a quantity of heat, which, had it been added to liquid water, would have made it warmer by $\overline{40-33}\times 21$, or 7×21, or 147 degrees. No part of this heat, however, appeared in the ice-water, except 8 degrees; the remaining 139 or 140 degrees had been absorbed by the melting ice, and were concealed in the water into which it was changed.

"The communication of heat to the melting ice was easily perceived, during the whole time of its exposition, by feeling the stream of cold air which descended from the glass.

"This experiment was an analysis of the manner in which ice is melted by the heat of the air in ordinary circumstances.

"But another obvious method of melting ice occurred to me, in which it would be still more easy to perceive the absorption and concealment of heat, and this was the action of warm water.

222 Second experiment.

"When hot and cold water are mixed together, the excess of heat contained in the hot water is equally distributed in an instant through the whole mixture, and raises the temperature of it according to the greatness of the excess of temperature, and the proportion which the hot water bore to the cold. If the quantities of hot and cold water are equal, the temperature is the middle degree between that of the hot and that of the cold. No part of the heat disappears on this occasion, so far as we can perceive, but the intensity of it only is diminished, by its being diffused through a larger quantity of matter. It was, therefore, obvious, that if a quantity of heat is absorbed, and disappears in the melting of ice, this would easily be perceived when the ice is melted with warm water.

"To make this experiment, I first froze a quantity of water in the neck of a broken retort, in order to have a mass of ice of an oblong form.

"At the same time I heated a quantity of water, nearly equal in weight to the ice, in a very thin globular glass, the mouth of which was sufficiently wide to take in the piece of ice. The water was heated by a small spirit of wine lamp applied to the bottom of the glass; it was also stirred with the end of a feather, and a thermometer hung in it.

"While the water was heating, the mass of ice was taken out of the mould in which it had been formed, and was exposed to the air of a temperate room, until it was perceived to be beginning to melt over the whole of its surface.

"I then put a woollen glove on my left hand, and taking hold of the ice, I wiped it quite dry with a linen towel, laid it in the scale of a balance on a piece of flannel, and hastily counterpoised it with sand in the opposite scale, that I might examine the weight of it afterwards; and I immediately plunged it into the hot water, and extinguished the lamp at the same time. The lamp being small, the heat of the water had been increasing very slowly, and had almost ceased to increase; and being examined immediately before I put the ice into it, the temperature was found to be just 190 degrees. The ice was all melted in a few seconds, and produced a mixture, the temperature of which was 53 degrees.

"The weight of the ice, when put into the hot water, was seven ounces three drams and a half. The weight of the glass, with the whole mixture in it, was 16 ounces, seven drams, and seven grains. The weight of the glass alone was nearly one ounce.

"In considering this experiment, we may overlook quantities less than half a dram, or 30 grains, and reckon the quantities of the different articles by the number of half-drams in each.

"Thus the weight of the ice was 119 half-drams.

——— Hot water	135
——— Mixture	254
——— Glass alone	16

"The melting of the ice was affected, not only by the heat of the hot water, but also by that of the glass. And, by other experiments, I learned that 16 parts of hot glass have more power in heating cold bodies, than eight parts of equally hot water; we may therefore substitute, in place of the 16 half-drams of warm glass, eight half-drams of warm water, which, added to the above quantity of warm water, make up 143 half-drams.

"The heat of this warm water was 190 degrees, that is 158 hotter than the ice; and if this heat had abated in the mixture only in consequence of the quantity and coldness of the ice, and if nothing had happened when the ice was put in, but merely a communication of this heat, and an equal distribution of it through the mixture, the temperature of the mixture should have been 158, viz. the excess of heat in the warm water, multiplied

multiplied by 143, the quantity of the warm matter, and divided by 262, the quantity of the whole, which gives 86.

223 Caloric is absorbed.

"The mixture should have been 86 degrees warmer than melting ice; but it was found only 21 degrees warmer. Therefore a quantity of heat has disappeared, which, if it had remained in a sensible state, would have made the whole mixture and glass warmer by 65 degrees than they were actually found to be. But this quantity of heat would be sufficient for increasing, by 143 degrees, the heat of a quantity of water, equal in weight to the ice alone. It was, however, absorbed by the ice, without in the least increasing its sensible heat (o).

"The result of this experiment coincides sufficiently with that of the former; the difference is not greater than what may be expected in similar experiments, and might arise from the accident of the central parts of the mass of ice being colder than the surface, by one or two degrees.

"I have, in the same manner, put a lump of ice into an equal quantity of water, heated to the temperature 176, and the result was, that the fluid was no hotter than water just ready to freeze. Nay, if a little sea salt be added to the water, and it be heated only to 166 or 170, we shall produce a fluid sensibly colder than the ice was in the beginning, which has appeared a curious and puzzling thing to those unacquainted with the general fact.

"It is, therefore, proved that the phenomena which attend the melting of ice in different circumstances, are inconsistent with the common opinion which was established upon this subject, and that they support the one which I have proposed *."

* *Black's Lect.* vol. i. p. 125.

6. These experiments shew clearly and incontrovertibly, that the conversion of ice into water is owing to the absorption of a certain portion of caloric: and that the quantity of caloric absorbed is equal to what would have given to the temperature of a body which remained unchanged, as, for instance water, a rise of 140 degrees. These 140°, therefore, have disappeared (for no increase of temperature is indicated by the thermometer), have been absorbed by the ice, and are necessary to reduce it to the liquid state. This portion of caloric, which had thus disappeared, Dr Black called *latent heat*, because in this state of combination its presence was not indicated by the thermometer. By others this has been called *the caloric of fluidity*.

224 Called *latent heat*.

225 Experiments on other bodies prove the same thing.

7. In the progress of these investigations, experiments were made on other substances, which clearly shewed that their fluidity is owing to the same cause. These experiments were made on wax, tallow, spermaceti, sulphur, alum, nitre, and some of the metals. The late ingenious Dr Irvine, the pupil of Dr Black, and who materially assisted him in many of his experiments, ascertained the quantity of caloric which was necessary for the fluidity of the following substances; which, when compared with that of ice, will shew that the quantity of the caloric of fluidity increases with the temperature at which the body is converted into the liquid state.

Spermaceti,	148°
Bees wax,	175
Tin,	500 *

* *Black's Lect.* vol. i. p. 137.

226 Softness and malleability owing to the same cause.

8. Dr Black farther observes on the operation of this cause, that there is reason to think, that not only the fluidity of bodies, but even the softness of such as are rendered plastic by heat, depends on a quantity of heat combined with them, in the form of latent heat; and that the malleability and ductility of metals depend upon the same cause. For, while they are extended under the hammer, they become warm, and in some cases very hot; at the same time they become rigid, and are no longer malleable. They have lost their toughness and softness. To restore this, they must be annealed, or made hot in the fire and allowed to cool. They thus recover their malleability, of which they may be again deprived by a second hammering.

227 Temperature at which bodies become fluid constant.

9. The temperature at which solid bodies begin to be converted into the liquid state, is consant; and till they are raised to this temperature, no change takes place. Water in the solid state, or ice, always remains unchanged till it is placed in a temperature above 32°. This point, which is called the *melting* point, is constant in the same body, but is very different in different bodies. The following table exhibits the melting point of a number of solid bodies.

Lead,	594°
Bismuth,	576
Tin,	442
Sulphur,	212
Wax,	142
Spermaceti,	133
Phosphorus,	100
Tallow,	92
Oil of anise,	50
Olive oil,	36
Ice,	32
Milk,	30
Vinegar,	28
Blood,	25
Oil of bergamot,	23
Wines,	20
Oil of turpentine,	14
Sulphuric acid,	36
Mercury,	39
Liquid ammonia,	46
Ether,	46
Nitric acid,	66

3. Of Vapour.

228 Water changed into vapour.

1. If, after a mass of ice is converted into water or the liquid state, the application of heat to that water be continued, it undergoes other changes, and exhibits very different phenomena. If the temperature be raised sufficiently high, the water becomes agitated with an intestine

(o) "These two experiments, and the reasoning which accompanies them, were read by me in the Philosophical Club, or Society of Professor and others in the University of Glasgow, in the year 1762."

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Caloric. testine motion, and if it is supplied with a sufficient quantity of caloric, the whole of the water is dissipated. This agitation of the water, it is well known, is called, in common language, *boiling*.

2. As solid bodies which are capable of being converted into the liquid state by an increase of caloric, have a certain determinate temperature, so many of those bodies which are capable of assuming the form of an elastic fluid undergo this change only when they are raised to a certain temperature. Some liquids, indeed, assume the form of vapour at all temperatures, which is the case with water, with volatile oils, spirits of wine and ether. This change is called *spontaneous evaporation*; but there are others which remain unchanged till the temperature is raised to that point at

229 Boiling, what. which they boil. Boiling is nothing else but the rapid conversion of the liquid into vapour. The heat being

230 Boiling point constant; applied to the bottom of the vessel which contains the liquid, the particles at the bottom first assume the elastic form; and as they rise through the liquid, cause it to be violently agitated. This boiling point, under the same pressure, is always the same in the same liquid; and however strong the heat that may be applied, or however long it may be continued, the temperature of the liquid, in open vessels, never rises above this point. The boiling point of water, for instance, is 212°, and it never becomes hotter: the application of a higher heat around it only hastens the progress of evaporation; and if the heat be continued, the whole is dissipated, and converted into vapour.

Table shewing the boiling points of several liquids.

Ether,	98°
Ammonia,	140
Alcohol,	176
Water,	212
Muriate of lime,	230
Nitric acid,	248
Phosphorus,	554
Oil of turpentine,	560
Sulphur,	570
Sulphuric acid,	590
Linseed oil,	600
Mercury,	660

231 but varies with pressure. 3. But this boiling point is found to vary considerably, and this variation depends on the pressure on the surface of the liquid. When the pressure is diminished, liquids boil at a lower temperature; but when this pressure is increased, they require a higher temperature to produce boiling. Water boils at a low temperature on the top of a high mountain, or in the vacuum of an air pump, where the pressure is greatly diminished; but when it is confined in close vssels, as in Papin's digester, the temperature may be raised to 300° or 400° without boiling.

232 Law of latent heat extended. 4. The general law which was discoverd by Dr Black, of the conversion of solids into liquids, was also applied by him to account for the change of liquids into elastic fluids. This was proved by the following experiments.

"*Experiment* 1.—I procured, (says Dr Black), some cylindrical tin-plate vessels, about four or five inches diameter, and flat-bottomed. Putting a small quantity of water into them, of the temperature 50°, I set them upon a red-hot kitchen table, that is, a cast-iron plate, having a furnace of burning fuel below it, taking care, that the fire should be pretty regular. After four minutes, the water began sensibly to boil, and in 20 minutes more, it was all boiled off. This experiment was made 4th October 1762.

"*Experiment* 2.—Two flat-bottomed vessels, like the former, were set on the iron plate, with eight ounces of water in each, of the temperature 50°. They both began to boil at the end of three minutes and a half, and in eighteen minutes more, all the water was boiled off.

"*Experiment* 3.—The same vessels were again supplied with 12 ounces of water in each, also of the temperature 50°. Both began to boil at the end of six minutes and a quarter, and the water was all boiled off from the one in 28 minutes, and from the other in something more than 29.

"I reasoned from these experiments in the following manner: The vessels in the first experiment received 162 degrees of heat in four minutes, or $40\frac{1}{2}$ degrees each minute. If we, therefore, suppose that the heat enters equally fast during the whole ebullition, we must suppose that 810 degrees of heat have been absorbed by the water, and are contained in its vapour. Since this vapour is no hotter than boiling water, the heat is contained in it in a latent state, if we consider it only as the cause of warmth. Its presence is sufficiently indicated, however, by the vaporous or expansive form which the water has now acquired.

"In experiment second, the heat absorbed, and rendered latent, seems to be about 830. 233 Quantity of caloric in vapour.

"In the third experiment, the heat absorbed seems to be somewhat less, viz. about 750. The time of rising to the boiling heat, in experiment third, has nearly the same proportion to that in experiment first, that the quantities of water have. The deficiency, therefore, in the heat absorbed, has been probably only apparent, and arising from irregularity in the fire. Upon the whole, the conformity of their results with my conjecture was sufficient to confirm me in my opinion of its justice. In the course of further experiments made both by myself and by some friends, and in which the utmost care was taken to procure a perfect uniformity in the heat applied, the absorption was found extremely regular, and amounted at an average to about 810 degrees.

"There are other cases where this absorption appears in a much more singular manner. I put into a very strong phial, about as much water as half filled it, and I corked it close. The phial was placed in a sand-pot, which was gradually heated, until the sand and phial were several degrees above the common vaporific pint of water. I wrs curious to know what would be the effect of suddenly removing the pressure of the air, which is well known to prevent water from boiling. The water boiled a very short while, but the ebullition gradually decreased, till it was almost insensible. Here the formation of more vapour was opposed by a very strong pressure, proceeding from the quantity of vapour already accumulated, and confined in the upper part of the phial, and from the increased elasticity of this vapour, by the increase of its heat. When matters were in this state, I drew out the cork. Now, according to the common opinion of the formation of vapour by 234 Other proofs of caloric absorbed in vapour.

 heat,

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Caloric.

heat, it was to be expected that the whole of the water would suddenly assume the vaporous form, because it was all heated above the vaporific point. But I was beginning by this time to expect a different event, because I could not see whence the heat was to be supplied, which the water must contain when in the form of vapour. Accordingly, it happened as I expected; a portion only of the water was converted into vapour, which rushed out of the phial with a considerable explosion, carrying along with it some drops of water. But, what was most interesting to me in this experiment was, that the heat of what remained was reduced in an instant to the ordinary boiling point. Here, therefore, it was evident, that all that excess of heat which the water had contained above the boiling point, was spent in converting only a portion of it into vapour. This is plainly inconsistent with the common opinion, that nothing more is necessary for water's existing in a vaporous form under the pressure of the atmosphere, than its being raised to a certain temperature. The experiment makes it more probable, that if the influx of heat could at that instant have been prevented, it would have remained in the form of water, although raised, in a very sensible degree, above the boiling temperature.

"I was anxious to learn whether the heat which disappeared in this experiment was in an accurate proportion to the quantity of vapour produced, or the quantity of water that had disappeared. But the drops of water that were hurried along by the explosion, without being converted into vapour, made it impossible for me to ascertain this with any tolerable accuracy, although I repeated the experiment several times.

235 The caloric absorbed in proportion to the quantity of vapour.

"This experiment was afterwards made by my friend Mr Watt, in a very satisfactory manner. His studies for the improvement of his steam-engine, gave him a great interest in every thing relating to the production of steam. He put three inches of water into a small copper digester, and, screwing on the lid, he left the safety-valve open. He then set it on a clear fire of coals, and after it began to boil and produce steam, he allowed it to remain on the fire half an hour, with the valve open. Then, taking it off the fire, he found that an inch of water had boiled away. In the next place, he restored that inch of water, screwed on the lid, and set it on the fire; and as soon as it began to boil, he shut the safety-valve, and allowed it to remain on the fire half an hour as before. The temperature of the whole was many degrees above the boiling point. He took it off the fire, and set it upon ashes, and opened the valve a very small matter. The steam rushed out with great violence, making a shrieking noise for about two minutes. When this had ceased, he shut the valve, and allowed all to cool. When he opened it, he found that an inch of water was consumed.

"It is reasonable to conclude from this experiment, that nearly as much heat was expended during the blowing of the steam pipe, as had been formerly expending in boiling off the inch of water. For, before opening the valve, the temperature was many degrees above the boiling point, and all this disappeared with the vapour. The same inference may be drawn from the time that the digester continued upon the fire with the valve shut, because we may conclude that the heat was entering nearly at the same rate during the whole time. It is plain, however, that the experiment is not of such a kind as to admit of nice calculation; but it is abundantly sufficient to shew that a prodigious quantity of heat had escaped along with the particles of vapour produced from an inch of water. The water that remained could not be hotter than the boiling point, nor could the vessel be hotter, otherwise it would have heated the water, and converted it into vapour. The heat, therefore, did not escape along with the vapour, but *in* it, probably united to every particle, as one of the ingredients of its vaporous constitution. And as ice, united with a certain quantity of heat, is water; so water, united with another quantity of heat, is steam or vapour *."

* *Black's Lect.* vol. i. p. 161.

236 Confirmed by Dr Irvine.

The following experiment made by the late Dr Irvine of Glasgow, at the desire of Dr Black, and recorded by the latter, is a still farther confirmation of the general fact, that the conversion of liquids into elastic fluids is produced by their combining with caloric.

"Five measures (each containing 4lb. 5 oz. and 6 dr. avoirdupois) of water, of the temperature 52°, were poured into a small still in the laboratory. The fire had been kindled about 40 minutes before, and was come to a clear and uniform state. The still was set into the furnace, and, in an hour and 20 minutes, the first drop came from the worm; and in three hours and 45 minutes more, three measures of water were distilled, and the experiment ended. The refrigeratory contained 38 measures of water, of which the temperature, at the beginning of the experiment, was 52°. When one measure had come over, the water in the refrigeratory was at 76°. When two had come over, it was at 100°; and when three had come over, it was at 123°.

"In this experiment, the heat, which emerged from three measures of water, had raised the temperature of the water in the refrigeratory from 52° to 123°, or 71°. Now 3 is to 38 as 71 to $899\frac{1}{3}$, and the heat would have raised the three measures $899\frac{1}{3}$ degrees in its temperature, if this had been possible without converting it into vapour. The heat of the vapour from which this emerged was 212°, or 160° more than that of the water. Taking this from 899°, there remains 739°, the heat contained in the vapour in a latent state.

"But this must be sensibly less than the truth. During the experiment, the vessels were very warm—the head of the still as hot as boiling water, and the refrigeratory gradually rising from 52°, which was within a degree or two of the temperature of the air of the laboratory, to 123°. A very considerable portion of the latent heat of the steam must have been carried off by the air in contact with a considerable surface, some of which was exceedingly hot. A great deal must also have been carried off in the steam which arose very sensibly from the water in the refrigeratory, towards the end of the experiment. Mr Irvine also observed, that, during the distillation, the temperature of the water which ran from the worm was about 11° hotter than the water in the refrigeratory. The steam, therefore, at a medium, was not 160° hotter than the water which ran from the worm, but 125°, its mean temperature being

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being about 87°. This consideration alone will make the latent heat of the steam not less than 774 degrees, without any allowance for waste.

"Some comparison may also be made between the heat expended in the production of the steam, and that which emerges during its condensation. The time which elapsed during the raising of the temperature of the five measures of water from 52° to 212°, that is 160°, was one hour and 20 minutes, or 80',—and 225' elapsed during the boiling off of three measures. Therefore, since 80 is to 225 as 160 to 450, as much heat was expended as would have raised the five measures 450° in temperature. This would have raised three measures 750° above the boiling heat already produced. This gives 750 for the latent heat of the steam, besides what was unavoidably lost by communication to the ambient air, and what was expended in heating the vessels*."

* Lect. vol. i. p. 173.

237 Caloric of steam estimated by Watt.

In some experiments made by Mr Watt, who also assisted Dr Black in conducting these invaluable experiments, it appears that the latent heat of steam is from 900° to 950°. This he discovered by observing the quantity of caloric which was absorbed by the water in its conversion into steam or vapour, and the quantity given out, when that vapour returned to the state of water.

238 By Lavoisier.

The latent heat of steam, estimated by the experiments of M. Lavoisier, amounts to more than 1000°.

5. Thus is this general law established, that all liquids are converted into elastic fluids, by combining with a certain portion of caloric. This portion of caloric is not indicated by the thermometer, and is therefore said to be latent heat, as we have already mentioned; but when the elastic fluid returns to the liquid state, it again becomes sensible, and precisely the same quantity is extricated which has been absorbed.

239 Elasticity of all vapour the same as that of water with the same increase of temperature.

6. It is an object of some importance to ascertain the elastic force of vapour, and the ratio of the increase of this elasticity by increase of temperature. The elasticity of vapour which is formed by a liquid boiling in the open air, is equal to the pressure of the atmosphere; and it has been ascertained by the experiments of Mr Dalton and of M. Gay-Lussac, that the elasticity of all elastic fluids is the same with that of the vapour of water, with the same increase or diminution of temperature from the boiling point. If, then, the boiling point of any liquid be known, the elasticity of its vapour may be discovered, by comparing it with the elasticity of the steam of water, the same number of degrees above or below the boiling point. In the following table, constructed by Mr Dalton from his experiments and calculations, the elasticity of the vapour of water is given for every temperature from 40° to 325°. To find the elasticity of the vapour of ether at 40° below its boiling point, which is 98°, take 40° from 98°, there remains 58, and the same number from 212° the boiling point of water, there remains 172°, opposite to which number in the table is 12.73, which is the elasticity of the steam of water at 172°, and also the elasticity of the vapour of ether at 58°.

Table of the Force of Vapour from Water in every temperature, from that of Congelation of Mercury, or 40° below Zero of Fahrenheit, to 325°†.

† Manch. Mem. vol. v. p. 559.

Temp.	Force of Vap. in inches of Mercury.	Temp.	Force of Vap. in inches of Mercury.	Temp.	Force of Vap. in inches of Mercury.
-40°	.013	48°	.351	102°	1.98
-30	.020	49	.363	103	2.04
-20	.030	50	.375	104	2.11
-10	.040	51	.388	105	2.18
		52	.401	106	2.25
0	.064	53	.415	107	2.32
1	.066	54	.429	108	2.39
2	.068	55	.443	109	2.46
3	.071	56	.458	110	2.53
4	.074	57	.474	111	2.60
5	.076	58	.490	112	2.68
6	.079	59	.507	113	2.76
7	.082	60	.524	114	2.84
8	.085	61	.542	115	2.92
9	.087	62	.560	116	3.00
10	.090	63	.578	117	3.06
11	.093	64	.597	118	3.16
12	.096	65	.616	119	3.25
13	.100	66	.635	120	3.33
14	.104	67	.655	121	3.42
15	.108	68	.676	122	3.50
16	.112	69	.698	123	3.59
17	.116	70	.721	124	3.69
18	.120	71	.745	125	3.79
19	.124	72	.770	126	3.89
20	.129	73	.796	127	4.00
21	.134	74	.823	128	4.11
22	.139	75	.851	129	4.22
23	.144	76	.880	130	4.34
24	.150	77	.910	131	4.47
25	.156	78	.940	132	4.60
26	.162	79	.971	133	4.73
27	.168	80	1.00	134	4.86
28	.174	81	1.04	135	5.00
29	.180	82	1.07	136	5.14
30	.186	83	1.10	137	5.29
31	.193	84	1.14	138	5.44
		85	1.17	139	5.59
32	.200	86	1.21	140	5.74
33	.207	87	1.24	141	5.90
34	.214	88	1.28	142	6.05
35	.221	89	1.32	143	6.21
36	.229	90	1.36	144	6.37
37	.237	91	1.40	145	6.53
38	.245	92	1.44	146	6.70
39	.254	93	1.48	147	6.87
40	.263	94	1.53	148	7.05
41	.273	95	1.58	149	7.23
42	.283	96	1.63	150	7.42
43	.294	97	1.68	151	7.61
44	.305	98	1.74	152	7.81
45	.316	99	1.80	153	8.01
46	.328	100	1.86	154	8.20
47	.339	101	1.92	155	8.40

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Table Continued.

Temp.	Force of Vap. in inches of Mercury.	Temp.	Force of Vap. in inches of Mercury.	Temp.	Force of Vap. in inches of Mercury.
156°	8.60			269°	76.82
157	8.81	213°	20.60	270	77.85
158	9.02	214	31.21	271	78.89
159	9.24	215	31.83	272	79.94
160	9.46	216	32.46	273	80.98
161	9.68	217	33.09	274	82.01
162	9.91	218	33.72	275	83.13
163	10.15	219	34.35	276	84.35
164	10.41	220	34.99	277	85.47
165	10.68	221	35.63	278	86.50
166	10.96	222	36.25	279	87.63
167	11.25	223	36.88	280	88.75
168	11.54	224	37.53	281	89.87
169	11.83	225	38.20	282	90.99
170	12.13	226	38.89	283	92.11
171	12.43	227	39.59	284	93.23
172	12.73	228	40.30	285	94.35
173	13.02	229	41.02	286	95.48
174	13.32	230	41.75	287	96.64
175	13.62	231	42.49	288	97.80
176	13.92	232	43.24	289	98.96
177	14.22	233	44.00	290	100.12
178	14.52	234	44.78	291	101.28
179	14.83	235	45.58	292	102.45
180	15.15	236	46.39	293	103.63
181	15.50	237	47.20	294	104.80
182	15.86	238	48.02	295	105.97
183	16.23	239	48.84	296	107.14
184	16.61	240	49.67	297	108.31
185	17.00	241	50.50	298	109.48
186	17.40	242	51.34	299	110.64
187	17.80	243	52.18	300	111.81
188	18.20	244	53.03	301	112.98
189	18.60	245	53.88	302	114.15
190	19.00	246	54.68	303	115.32
191	19.42	247	55.54	304	116.50
192	19.86	248	56.42	305	117.68
193	20.32	249	57.31	306	118.86
194	20.77	250	58.21	307	120.03
195	21.22	251	59.12	308	121.20
196	21.68	252	60.05	309	122.37
197	22.13	253	61.00	310	123.53
198	22.69	254	61.92	311	124.69
199	23.16	255	62.85	312	125.85
200	23.64	256	63.76	313	127.00
201	24.12	257	64.82	314	128.25
202	24.61	258	65.78	315	129.29
203	25.10	259	66.75	316	130.43
204	25.61	260	67.73	317	131.57
205	26.13	261	68.72	318	132.72
206	26.66	262	69.72	319	133.86
207	27.20	263	70.73	320	135.00
208	27.74	264	71.74	321	136.14
209	28.29	265	72.76	322	137.28
210	28.84	266	73.77	323	138.42
211	29.41	267	74.79	324	139.66
212	30.00	268	75.80	325	140.70

Sect. III. *Of the Motion of Caloric.*

1. It appears that the motion of caloric, when it is not interrupted, is equal in velocity to that of light. When therefore it is emitted by one body, it moves on with this velocity till it is received by another. This has been called the *transmission* or *radiation* of heat. This radiation or separation of heat from any body, arises from the force with which it is connected with that body being diminished; that is when a greater quantity of caloric is accumulated in that body than it can contain. The experiments of Dr Herschel shew, that heat is radiated, refracted, and reflected in the same manner as light. The reflection of caloric has also been proved by the experiments of Mr Pictet formerly mentioned. But caloric is communicated from one body to another by direct contact of these bodies. 240 Velocity of caloric equal to that of light. 241 Radiated. 242 Refracted, 243 and reflected.

2. It is well known that a cold body brought into contact with a warm body, becomes in a certain time hot, but this does not take place instantaneously; and the time necessary for one body to receive caloric from another, or for the different parts of the same body to acquire the same temperature, varies according to the nature and state of these bodies. This is called the *conducting* power of bodies. 244 Is communicated by contact.

3. But as different bodies have different degrees of affinity for caloric, or contain different proportions of it, it must be separated or absorbed with greater or less facility. The motion of caloric therefore, in these different circumstances, will be considerably varied in its celerity. This may be proved by direct experiment. If one extremity of two substances of different properties, as, for instance, a rod of iron and another of wood, be put into the fire, and the hand brought into contact with the other extremity, the rod of iron will soon be heated too much for the hand to bear, while the rod of wood will not have its temperature increased. This shews, that the caloric is carried a shorter distance through the wood; or, in other words, the iron is a better conductor than the wood. 245 More rapidly in some bodies.

4. All solid bodies are conductors of caloric, but they possess this power in very different degrees. Those which conduct caloric with facility are called *good* conductors; those through which it passes with difficulty, or very slowly, are said to be *bad* conductors. The motion of caloric from one body to another, or through the same body, is not altogether in proportion to their densities, as might be supposed from the instance of the communication of caloric through wood and iron, just mentioned. Caloric is conducted very slowly through a more porous substance, such as a mass of cork, or a quantity of wool, feathers, or furs. It is on account of the slowness with which heat is conducted in these substances, that some of them are employed in cold weather, and in cold countries, as materials for clothing. The heat being slowly conducted through such substances, they prevent the heat of the body from being dissipated; they retard the communication between the warm body and the cold air. We find a wise provision of nature, in furnishing all animals which are inhabitants of the colder regions of the earth, with a thick covering of fur or feathers. The conducting power of fur, feathers, silk, and wool, was found in the experiments of Rumford, to diminish in proportion to the fineness of their texture. 246 Good conductors. 247 Bad conductors. 248 Their use.

Metallic

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Caloric.

249 Metals the best conductors. Metallic substances are the best conductors of caloric; but among the metals there is considerable variety of conducting power, and this is not in proportion to their density, as appears from the experiments of Dr Ingenhousz on the following metals, which are set down in the order of their conducting power *.

* Journ. de Phys. 1789.

Silver,
Gold,
Copper,
Tin,
Platina,
Iron,
Steel,
Lead.

250 Conducting power of woods. A set of experiments was made on the conducting power of different woods, by Professor Mayor of Erlangen, of which the following are the results, compared with the conducting power of water †.

† Annal. de Chim. vol. xxx. p. 43.

Water,	10.0
Ebony,	21.7
Crab apple,	27.4
Ash,	38.0
Beech,	32.1
Hornbeam,	32.3
Plum tree,	32.5
Female oak,	32.6
Pear tree,	33.2
Birch,	34.1
Oak,	36.3
Pitch pine,	37.5
Alder,	38.4
Pine,	38.6
Fir,	38.9
Lime tree,	39.0

The experiments of Guyton shew, that the conducting power of charcoal is to that of fine sand nearly in the proportion of 2 to 3 ‡.

‡ Ibid. vol. xxvi. p. 227.

251 Fluids are conductors. 5. Fluid bodies, as well as solids, are conductors of caloric; but they are found to conduct it so slowly, that it was at one time supposed that they did not possess this power at all, that is, that the caloric was not conducted from particle to particle in fluids, as it is in solid bodies. This opinion seemed to be supported by the nature and constitution of fluids, in which the particles have free motion among each other, so that when one set of particles acquires an additional quantity of caloric, their specific gravity is necessarily diminished; and if lower, they naturally change place with those other particles of the fluid which have been less heated, and are consequently heavier. These different appearances which were observed in the heating of fluids led Count Rumford, who made many ingenious experiments on this subject, to conclude, that fluids are heated, or conduct caloric, in a different manner from solids. In a spirit of wine thermometer, which was placed in a window to cool, he observed the fluid in the tube in rapid motion. There were two currents going in different directions, the one ascending, and the other descending. The descending current occupied the sides of the tube, and the ascending current the middle. The currents were owing to the change in the specific gravity of the particles, which being heated became lighter, and rose to the top; the heavier particles at the same time descended. The particles which ascended having reached the sides or top of the tube, gave out their caloric, became specifically heavier, and again fell to the bottom. The motion of the currents was considerably increased by the application of a cold body to the sides of the tube. The count also repeated the experiment with linseed oil, and with water, in the latter of which he dissolved potash, to bring its specific gravity to that of amber, small pieces of which he introduced, to observe the currents more distinctly. These experiments were followed with the same result. When the temperature was increased or diminished, the currents were set in motion, and only ceased when the temperature became equal to that of the surrounding bodies.

In prosecuting this subject, the count made other experiments, to ascertain how far the heating or cooling of fluids is affected by a difference of fluidity. The thermometer which he employed in these experiments, had a copper bulb and a glass tube, and was filled with linseed oil. This was placed in the centre of a brass cylinder, and the space between the sides of the cylinder and the thermometer, was 0.25175. The thermometer being secured, the cylinder was filled with 2276 grs. of pure water, and held in melting snow, till the thermometer fell to 32°. It was then immersed in boiling water, and the thermometer rose from 32° to 200° in 597″. The caloric which raised the thermometer must have been communicated to it through the water in the cylinder. The experiment was then varied, by boiling 192 grs. of starch in the water in the cylinder. The thermometer now required 1109″ to rise from 32° to 200°. The same experiment was repeated by mixing 192 grs. eider down with the same quantity of water, and also with a quantity of stewed apples. The result of these experiments will be seen in the following tables §.

§ Rumford, Essay 7.

Time the Caloric took in passing into the Thermometer.

Temperature.	Through the Water and Starch.	Through the Water and Eider down.	Through stewed Apples.	Through pure Water.
	Seconds.	Seconds.	Seconds.	Seconds.
Therm. rose from 32° to 200°, in	1109	949	1096½	597
Therm. rose 80°, viz from 80° to 160°, in	341	269	335	172

Time the Caloric took in passing out of the Thermometer.

Temperature.	Through the Water and Starch.	Through the Water and Eider down	Through stewed Apples.	Through pure Water.
	Seconds.	Seconds.	Seconds.	Seconds.
Therm. fell from 200° to 40°, in	1548	1541	1749½	1032
Therm. fell 80°, viz. from 160° to 80°, in	468	460	520	277

The

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Caloric.

The substances which were added to the water in these experiments, had, by diminishing its fluidity, the effect of retarding the internal motions or currents by which the caloric is conducted through fluids. Thus, when starch was mixed with water, it required nearly double the time to raise the thermometer to the same degree, as with pure water. From these and from some other experiments, Count Rumford concluded, that fluid bodies are heated in a different manner from solids; that caloric is not communicated through fluids from particle to particle, but that all the particles individually come in contact with the heating body, and this is supposed to be the cause of the currents which are observed during the heating of the fluids.

6. Fluids no doubt acquire great part of their temperature in this manner; but it has been clearly proved, by the experiments of others, that they are also conductors of caloric exactly the same way as solid bodies, only in an inferior degree. This has been established in the most satisfactory manner by the experiments of Dr Thomson * and Dr Murray †, which were published in Nicholson's Journal; and also by another set of experiments by Mr Dalton, which were published in the Manchester Memoirs ‡. By these experiments it is demonstrated, that fluids conduct caloric from the surface downwards; which could not be the case, were it only communicated through them by the ascending currents of particles, in the way Count Rumford supposed; but they are worse conductors of caloric than solids; that is, it passes through them much more slowly.

252 but worse than solids.

* Vol. iv. p. 529.
† Ibid. octavo, vol. i. p. 165.
‡ Vol. v. p. 373.

Sect. IV. *Of the Distribution of Caloric.*

253 All bodies acquire the same temperature in the same medium.

If a number of bodies be exposed to different temperatures, and then be all placed in the same temperature, or brought into contact with each other, they acquire in a certain time the same temperature. Thus, if one body be raised to the temperature of 200°, another to that of 100°, and a third to the temperature of 60°; and if these three bodies be placed in the temperature of 80°, they all indicate, in a short time, the same temperature. The bodies which were at the temperature of 200° and 100° are reduced to 80°, and the temperature of the body at 60° rises to the same. This is called the *distribution*, or the tendency to *equilibrium* of caloric. To whatever degree bodies are heated or cooled, they all acquire in time the temperature of the surrounding medium, as indicated by the thermometer. It may therefore be received as a general law, *that all bodies which communicate freely with each other, and are subject to no inequality of external action, acquire the same temperature.*

254 Radiation not the sole cause of cooling.

1. Bodies are deprived of caloric, not only by radiation from their surfaces, but it is also conducted by the surrounding bodies with which the heated body comes in contact, and this depends greatly on the nature of the cold body. The experiments of Professor Pictet and Count Rumford, however, shew, that radiation is not the only cause. By those of the former it appeared, that hot bodies suspended in the vacuum of an air pump, cooled more slowly than in the open air; and by those of the latter, the cooling was still slower in the Torricellian vacuum.

2. The time requisite for the heating or cooling of bodies depends much on their conducting power. A substance which is a good conductor of caloric cools much more rapidly than a bad conductor. Mercury and water heated to the same temperature cool in very different times: the mercury cools more than twice as fast as the water in the same circumstances. The time of the cooling of fluids has been considered as nearly in the inverse ratio of their conducting power. It depends, however, in part on other qualities, as their moveableness and their capacity for heat, a subject to be afterwards explained, and which has the principal influence in the difference between water and mercury.

255 Good conductors cool most rapidly.

256 Distribution of caloric explained by Boerhaave, &c.

3. This equal distribution of caloric was attempted to be explained by Boerhaave, Muschenbroeck, and others, by supposing that there is an equal quantity of caloric in every equal measure of space, however that space might be filled up with different bodies, and that these bodies floated, as it were, in this caloric. From this equal distribution of caloric in space, they concluded that there was an equal quantity of caloric in all bodies, because, whatever was the density or different circumstances of bodies, they always indicated the same temperature to the thermometer. A cubic foot of gold, and a cubic foot of air, according to this theory, contained the same quantity of caloric.

257 By Pictet.

Professor Pictet gave another explanation of this phenomenon. He supposed that the accumulation of caloric in a body increased the repulsive force between its particles, by the diminution of the distance between them. By the action of this repulsive force, the particles are driven off in all directions. This repulsion continues to act till it is opposed by a new force, which is the force of repulsion between the particles of caloric separated from another body; and, till these two forces acquire the same intensity, the particles of caloric continue to separate from the hotter body. When the two forces are balanced, the bodies are of the same temperature. Thus, if two bodies of different temperatures are brought into contact with each other, the repulsive force of the particles of caloric in the hotter body is the greatest, and therefore the particles tend to separate from each other; but the repulsion between the particles of the colder body being less, they come nearer each other. The caloric from the hotter body continues to separate, and to enter the colder body, till the two forces exactly balance each other, and then the temperature is the same *. But this theory, with all its simplicity and ingenuity, being unsatisfactory in accounting for the equilibrium of temperature, has been given up, even by its author.

* Essai sur le Feu, chap. i.

258 His theory unsatisfactory.

259 Prevost's theory.

4. Another theory has been proposed by M. Prevost, professor of philosophy at Geneva. "Accustomed," says he, "for a long time, to consider this subject in a different view from what had been formerly taken of it, I endeavoured to draw the attention of naturalists to this investigation, in a memoir on the equilibrium of caloric †, and in my *researches on heat* ‡. In these works, I believe it was first proposed to substitute a moveable equilibrium in place of the immoveable equilibrium, the existence of which had been generally admitted.

† Journ. de Phys. April 1791.
‡ Geneva 1792.

"On this hypothesis, it is equally easy and satisfactory to account for the reflection of cold, as for that of heat. I consider it indeed a characteristic of its truth; for these two facts being of the same kind, the theory that

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Caloric. that will account for the one is applicable to the other. Before I proceed to state in a few words the principle of this theory, I may premise, that I had the satisfaction of seeing it adopted by M. Pictet and others, who are well qualified to judge of it.

"Caloric is a discrete, agitated fluid: each particle of free caloric moves with immense velocity; one particle moves in one direction, and another particle moves in another, so that a heated body gives out calorific rays in all directions; and these particles are so far separated from each other, that two or more currents may cross each other, as is the case with light, without mutual disturbance in their course. Conceiving this to be the constitution of caloric, if we suppose two contiguous spaces in which it abounds, there will be continual changes between these spaces. If in the two spaces caloric abounds equally, the exchanges will be equal; there will be an equilibrium. If one of the spaces contain more caloric than the other, the exchanges will be unequal. The coolest will receive more particles of caloric than it gives out, and after a sufficient time, the continual repetition of these changes will restore the equilibrium *.

"From these principles may be deduced all the laws of the increase and diminution of temperature. Let us suppose a body placed in a medium hotter than itself, and that this medium has a constant temperature. We may consider the caloric of the medium as composed of two parts, the one equal to that of the body, and the other equal to the difference of the two. With regard to the first, the exchanges are equal; between the body and the medium there is an equilibrium. The excess of the heat of the medium may then only be considered; and relatively to this excess the body is absolutely cold. Let us suppose that in one second the body receives $\frac{1}{10}$ of this caloric; at the end of the first second the excess will be no more than $\frac{1}{10}$: the $\frac{1}{10}$ of this new excess will pass into the body during the next second; and the excess will be reduced to $\frac{9}{10}$ of $\frac{9}{10}$; and in pursuing this, at the end of the third second, the excess will be $(\frac{9}{10})$, and so on; so that, conformably to the observed law, the times increase in arithmetical progression, and the differences decrease in geometrical progression. In the same way may be easily deduced the law of the cooling of a body placed in a medium colder than itself. And thus the true theory of heat, founded on facts totally different from those by which Richmann established this law, necessarily leads us to it †.

* Phil. Trans. 1802.

† Phil. Trans. 1802. p. 444.

Sect. V. *Of the Quantity of Caloric in Bodies.*

We are next to consider the *quantity* of caloric which different bodies contain. This subject has occupied the attention and speculations of many philosophers. In these speculations, two objects were kept in view, the one to ascertain the whole quantity of caloric which a body contains, and the other the quantity of caloric necessary to raise different bodies to the same temperature. This last is most easily investigated, and is usually called *specific caloric*.

1. Of Specific Caloric.

260 explained. 1. If one lb. of water at the temperature of 100° be mixed with another lb. of water at the temperature of 50°, they will very soon acquire the same temperature, which will be the mean of the two temperatures. The pound of water at 100° will give out 25°, and the pound of water at 50° will receive 25°, which brings both to the temperature of 75°.

2. But if we take one pound of water at 100°, and one pound of mercury at 50°, the temperature, after mixing the water and the mercury, will not be 75°, the medium temperature in the former case. On the contrary, when the mixture is made, the temperature will be found to be 88°. The water therefore has lost only 12°, and the mercury has gained 38°. If this experiment be reversed, and one pound of water at 50° be mixed with a pound of mercury at 100°, the temperature of the mixture will be found to be only 62°; so that in this case the mercury has given out 38°, and the water has received only 12°. In this experiment, therefore, it appears clearly, that different quantities of caloric are necessary to increase or diminish the temperature of different bodies; for, the quantity of caloric which raises water 12°, raises mercury no less than 38°. This quantity of caloric which bodies require to raise them to the same temperature, is called *specific caloric*.

3. "It was formerly a common supposition," says Dr Black, "that the quantities of caloric required to increase the heat of different bodies by the same number of degrees, were directly in proportion to the quantity of matter in each; and therefore, when the bodies were of equal size, the quantities of caloric were in proportion to their density. But very soon after I began to think of this subject, in the year 1760, I perceived that this opinion was a mistake, and that the quantities of heat which different kinds of matter must receive, to reduce them to an equilibrium with one another, or to raise their temperature by an equal number of degrees, are not in proportion to the quantity of matter in each, but in proportions widely different to this, and for which no general principle or reason can yet be assigned ‡." This difference was first pointed out by Dr Black, which he states in the above observations, and he distinguished it by the term *capacity of bodies for heat*. Dr Black's method, which is given by Professor Robison, is the following.

‡ Black's Lect. vol. i. p. 79.

261 Dr Black's method.

"Dr Black estimated the capacities, by mixing the two bodies in equal masses, but of different temperatures; and then stated their *capacities as inversely proportional to the changes of temperature of each by the mixture*. Thus, a pound of gold, of the temperature 150°, being suddenly mixed with a pound of water, of the temperature 50°, raises it to 55° nearly: Therefore the capacity of gold is to that of an equal weight of water as 5 to 95, or as 1 to 19; for the gold loses 95°, and the water gains 5°.

"It will be most convenient to compare all bodies with water, and to express the capacity of water by unity, or to call it 1. Let the quantity of the water be W, and its temperature w. Let the quantity of the other body be B, and its temperature b. Let the temperature of the mixture be m. The capacity of B is $\frac{W \times \overline{m-w}}{B \times \overline{b-m}}$, or when the water has been the hotter of the two, the capacity of B is $\frac{W \times \overline{w-m}}{B \times \overline{m-b}}$. In other words,

Caloric.

words, *multiply the weight of the water by its change of temperature. Do the same for the other substance. Divide the first product by the second. The quotient is the capacity of the other substance, that of water being accounted* 1 * (P)."

* Lect. v. i. p. 506.

4. This subject was still farther prosecuted by other philosophers, particularly by Dr Irvine of Glasgow, Dr Crawford of London, and Professor Wilcke of Stockholm.

262 Dr Crawford's.

The method which was employed by Dr Crawford was similar to that of Dr Black. Two substances, which were of different temperatures, were uniformly mixed; the change of temperature produced on each was observed, and this was considered as inversely proportional to its specific caloric.

263 Mr Wilcke's.

Mr Wilcke has ascertained the specific caloric of many metals, by a set of very ingenious experiments, which were conducted in the following manner. The metal, which was the subject of the experiment, was first accurately weighed. The quantity employed was generally a pound. It was then suspended by a thread, plunged into a vessel of tin-plate filled with boiling water, and allowed to remain till it reached a certain temperature indicated by the thermometer. A quantity of water at the temperature of 32°, exactly equal in weight to the metal, was put into another vessel of tin plate. The metal was then immersed in this vessel, and suspended in it so as to be kept clear of the sides and bottom. The temperature, at the moment when the metal and water were reduced to the same, was observed. The specific caloric of the metal was then deduced by calculation from the change of temperature. He first calculated what the temperature would have been, if a quantity of water of equal weight with the metal, and of the same temperature, had been added to the ice-cold water. The following is the process.

Let M be a quantity of water at the temperature C, m another quantity at the temperature c, and let their common temperature after mixture be x; according to a rule demonstrated long ago by Richman, $x=\frac{MC+mc}{M+m}$. In the present case the quantities of water are equal, therefore M and m are each $=1$; C, the temperature of the ice-cold water, $=32$: therefore $\frac{MC+mc}{M+m}=\frac{32+c}{2}$. Now c is the temperature of the metal. Therefore if 32 be added to the temperature of the metal, and the whole be divided by 2, the quotient will express the temperature of the mixture, if an equal weight of water with the metal, and of the same temperature with it, had been added to the ice-cold water instead of the metal.

He then calculated what the temperature of the mixture would have been, if, instead of the metal, a quantity of water of the same temperature with it, and equal to the metal in bulk, had been added to the ice-cold water. As the weights of the ice-cold water and the metal are equal, their volumes are inversely as their specific gravities. Therefore the volume of ice-cold water is to a quantity of hot water equal in volume to the metal, as the specific gravity of the metal to that of the water. Let M = volume of cold water, m = volume of hot water, g = specific gravity of the metal, 1 = specific gravity of water; then $m:M::1:g$; hence $m=\frac{M}{g}=$ (M being made $=1$) $\frac{1}{g}$. Substituting this value of m in the formula, $\frac{MC+mc}{M+m}=x$, in which $M=1$ and $C=32$, x will be $=\frac{32g+c}{g+1}$. Therefore, if the specific gravity of the metal be multiplied by 32, and the temperature of the metal be added, and the sum be divided by the specific gravity of the metal $+1$, the quotient will express the temperature to which the ice-cold water would be raised, by adding to it a volume of water equal to that of the metal, and of the same temperature with it.

He then calculated how much water at the temperature of the metal it would take to raise the ice-cold water the same number of degrees which the metal had raised it. Let the temperature to which the metal had raised the ice-cold water be $=$N, if in the formula $\frac{MC+mc}{M+m}=x$, x be made $=$N, $M=1$, $C=32$, m will be $=\frac{N-32}{c-N}$. Therefore, if from the temperature to which the ice-cold water was raised by the metal 32 be subtracted, and if from the temperature of the metal be subtracted the temperature to which it raised the water, and the first remainder be divided by the last, the quotient will express the quantity of water of the

(P) "These experiments require the most scrupulous attention to many circumstances which may affect the result. 1. The mixture must be made in a very extended surface, that it may quickly attain the medium temperature. 2. The stuff which is poured into the other should have the temperature of the room, that no change may happen in the pouring it out of its containing vessel. 3. The effect of the vessel in which the mixture is made must be considered. 4. Less chance of error will be incurred when the substances are of equal bulk. 5. The change of temperature of the mixture, during a few successive moments, must be observed, in order to obtain the real temperature at the beginning. 6. No substances should be mixed which produce any change of temperature by their chemical action, or which change their temperature, if mixed, when of the same temperature. 7. Each substance must be compared in a variety of temperatures, lest the ratio of the capacities should be different in different temperatures.

"When all these circumstances have been duly attended to, we obtain the measure of the *capacities* of different substances for heat." *Black's Lect.* vol. i. p. 506.

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Caloric.

the temperature of the metal which would have raised the ice-cold water the same number of degrees that the metal did.

Now, $\frac{N-32}{c-N}$ expresses the specific caloric of the metal, that of water being =1. For (neglecting the small difference occasioned by the difference of temperature) the weight and volume of the ice-cold water are to the weight and volume of the hot water as 1 to $\frac{N-32}{c-N}$, and the number of particles of water in each are in the same proportion. But the metal is equal in weight to the ice-cold water, it must therefore contain as many particles of matter; therefore the quantity of matter in the metal must be to that in the hot water as 1 to $\frac{N-32}{c-N}$. But they gave out the same quantity of caloric; which, being divided equally among their particles, gives to each particle a quantity of caloric inversely as the bulks of the metal and water; that is, the specific caloric of the water is to that of the metal as 1 to $\frac{N-32}{c-N}$ (R).

It will now be proper to give a specimen or two of his experiments, and the calculations founded on them, as above described.

GOLD. *Specific Gravity* 19.040.

Number of experiments.	Temperature of the metal.	Temper. to which the metal raised the water at 32°.	Temper. to which it would have been raised by a quantity of water equal in weight and heat to the metal.	Temper. to which it would have been raised by water equal in bulk and temperature to the metal.	Denominator of the fraction $\frac{N-32}{c-N} = \frac{1}{\frac{c-N}{N-32}}$, the numerator being 1.
1	163.4°	38.3°	97.7°	38.555°	19.857
2	144.5	37.4	88.25	37.58	19.833
3	127.4	36.5	79.7	36.68	20.500
4	118.4	36.05	75.2	36.15	20.333
5	103.1	35.6	65.75	35.42	18.750
6	95	34.45	63.5	35.06	19.000

Mean 19.712

LEAD.

(R) All these formulas have been altered to make them correspond with Fahrenheit's thermometer. They are a good deal simpler when the experiments are made with Celsius's thermometer, as Mr Wilcke did. In it the freezing point is zero; and consequently instead of 32 in the formula, 0 is always substituted.

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LEAD. *Specific Gravity* 11.456.

Number of experiments.	Temperature of the metal.	Temper. to which the metal raised the water at 32 deg.	Temper. to which the water would have been raised by a quantity of water equal in weight and heat to the metal.	Temper. to which the water would have been raised by water equal in bulk and temperature to the metal.	Denominator of the fraction, $\frac{1}{\frac{c-N}{N-32}}$
1	186.8	38.3	109.4	44.425	23.571
2	181.40	37.85	106.7	43.473	24.538
3	165.2	37.4	98.6	42.692	23.666
4	163.4	37.4	97.7	42.548	23.333
5	136.4	36.5	84.2	40.344	22.200
6	131	36.05	81.5	39.947	24.700
7	126.5	36.05	79.25	39.585	22.333
8	107.6	35.15	69.8	38.339	23.000
9	94.1	34.7	63.05	36.985	22.000

Mean 23.515

It is needless to add, that the last column marks the denominator of the specific caloric of the metal; the numerator being always 1, and the specific caloric of water being 1. Thus the specific caloric of gold is $\frac{1}{19.712}$. In exactly the same manner, and by taking a mean of a number of experiments at different temperatures, did Mr Wilcke ascertain the specific caloric of a number of other bodies *.

† *Thomson's Chemistry*, vol. i. 314.

5. With the same view, to ascertain the specific caloric of bodies, a simple and ingenious apparatus was contrived by Lavoisier and La Place. This instrument is called a *calorimeter*, or measurer of heat. Its principles and construction are the following :

264 Lavoisier's method.

" If, after having cooled (says Lavoisier) any body to the freezing point, it be exposed in an atmosphere of 88.25°, the body will gradually become heated, from the surface inwards, till at last it acquire the same temperature with the surrounding air. But, if a piece of ice be placed in the same situation, the circumstances are quite different: it does not approach in the smallest degree towards the temperature of the circumambient air, but remains constantly at 32°, or the temperature of melting ice, till the last portion of ice be completely melted.

" This phenomenon is readily explained; as, to melt ice, or reduce it to water, it requires to be combined with a certain portion of caloric, the whole caloric attracted from the surrounding bodies is arrested or fixed at the surface or external layer of ice which it is employed to dissolve, and combines with it to form water; the next quantity of caloric combines with the second layer to dissolve it into water, and so on successively till the whole ice be dissolved, or converted into water, by combination with caloric; the very last atom still remaining at its former temperature, because the caloric could never penetrate so far, while any intermediate ice remained to melt, or to combine with.

" Upon these principles, if we conceive a hollow sphere of ice at the temperature of 32° placed in an atmosphere of 54.5°, and containing a substance at any degree of temperature above freezing; it follows, That the heat of the external atmosphere cannot penetrate into the internal hollow of the sphere of ice; and, That the heat of the body which is placed in the hollow of the sphere, cannot penetrate outwards beyond it, but will be stopped at the internal surface, being continually employed to melt successive layers of ice, until the temperature of the body be reduced to 32° by having all its superabundant caloric above that temperature carried off to melt the ice. If the whole water, formed within the sphere of ice during the reduction of the temperature of the included body to 32°, be carefully collected, the weight of the water will be exactly proportioned to the quantity of caloric lost by the body, in passing from its original temperature to that of melting ice; for it is evident that a double quantity of caloric would have melted twice the quantity of ice. Hence the quantity of ice melted is a very exact measure of the proportional quantity of caloric employed to produce that effect, and consequently of the quantity lost by the only substance that could possibly have supplied it.

" I have made this supposition, of what would take place in a hollow sphere of ice, for the purpose of more readily explaining the method used in this species of experiment, which was first conceived by M. de la Place.

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Place. It would be difficult to procure such spheres of ice, and inconvenient to make use of them when got; but, by means of the following apparatus, we have remedied that defect.

"The calorimeter is represented in Plate CXLII. fig. 2. The capacity or cavity is divided into three
265 Apparatus described. parts, which, for better distinction, I shall name the interior, middle, and external cavities. The interior cavity *ffff*, into which the substances submitted to experiment are put, is composed of a grating or cage of iron wire, supported by several iron bars; its opening or mouth LM, is covered by the lid HG, fig. 3. which is composed of the same materials. The middle cavity *bbbb*, fig. 2. contains the ice which surrounds the interior cavity, and which is intended to be melted by the caloric of the substances employed in the experiment. The ice is supported by the grate *mm* at the bottom of the cavity, under which is placed the sieve *nn*.

"In proportion as the ice contained in the middle cavity is melted by the caloric disengaged from the body placed in the interior cavity, the water runs through the grate and sieve, and falls through the conical funnel *ccd*, fig. 2. and the tube *xy*, into a receiver. This water may be retained or let out at pleasure, by means of the stop-cock *u*. The external cavity *aaaa*, fig. 2. is filled with ice, to prevent any effect upon the ice in the middle cavity from the heat of the surrounding air, and the water produced from it is carried off through the pipe ST, which shuts by means of the stop-cock *r*. The whole machine is covered by a lid made of tin, and painted with oil colour, to prevent rust.

"When this machine is employed, the middle cavity *bbbb*, fig. 2. and the lid GH, fig. 3. of the interior cavity, the external cavity *aaaa*, fig. 2. and the lid which covers the whole, are all filled with pounded ice, well rammed, so that no void spaces remain, and the ice of the middle cavity is allowed to drain. The machine is then opened, and the substance submitted to experiment being placed in the interior cavity, it is instantly closed. After waiting till the included body is completely cooled to the freezing point, and the whole melted ice has drained from the middle cavity, the water collected in the receiver is accurately weighed. The weight of the water produced during the experiment is an exact measure of the caloric disengaged during the cooling of the included body, as this substance is evidently in a similar situation with the one formerly mentioned as included in a hollow sphere of ice. The whole caloric disengaged from the included body is stopped by the ice in the middle cavity, and that ice is preserved from being affected by any other heat by means of the ice contained in the cover and in the external cavity. Experiments of this kind generally last from 15 to 20 hours, but they are sometimes accelerated by covering up the substance in the interior cavity with well drained ice, which hastens its cooling.

"It is absolutely requisite that there be no communication between the external and middle cavities of the calorimeter, otherwise the ice melted by the influence of the surrounding air, in the external cavity, would mix with the water produced from the ice of the middle cavity, which would no longer be a measure of the caloric lost by the substance submitted to experiment.

"When the temperature of the atmosphere is only a few degrees above the freezing point, its heat can hardly reach the middle cavity, being arrested by the ice of the cover, and of the external cavity; but, if the temperature of the air be under the degree of freezing, it might cool the ice contained in the middle cavity, by causing the ice in the external cavity to fall, in the first place, below 32°. It is therefore essential that this experiment be carried on in a temperature somewhat above freezing: Hence, in time of frost, the calorimeter must be kept in an apartment carefully heated. It Elem. Chim.
is likewise necessary that the ice employed be not under 32°, for which purpose it must be pounded, and spread out thin for some time, in a place where the temperature is higher.

6. Tables of the specific caloric of bodies have been given by Dr Crawford, Mr Kirwan, Bergman, Gadolin, and Meyer. The following are the results of their investigations.

Table of the Specific Caloric of various Bodies, that of Water being = 1.0000.

Bodies.	Specific Gravity.	Specific Caloric.
I. Gases.		
Hydrogen gas	0.000094	21.4000
Oxygen gas	0.0034	4.7490
Common air	0.00122	1.7900
Carbonic acid gas	0.00183	1.0459
Steam		1.5500
Azotic gas	0.00120	0.7036
II. Liquids.		
Water	1.0000	1.0000
Carbonate of ammonia		1.851
Arterial blood		1.030
Cows milk	1.0324	0.9999
Sulphuret of ammonia	0.818	0.9940
Venous blood		0.8928
Solution of brown sugar		0.8600
Nitric acid		0.844
Sulphate of magnesia 1 } Water 8 }		0.844
Common salt 1 } Water 8 }		0.832
Nitre 1 } Water 8 }		0.8167
Muriate of ammonia 1 } Water }		0.779
Tartar 1 } Water 237.3 }		0.765
Solution of potash	1.346	0.759
Sulphate of iron 1 } Water 2.5 }		0.734
Sulphate of soda 1 } Water 2.9 }		0.728
Oil of olives	0.9153	0.710
Ammonia	0.997	0.7080

Table

TABLE continued.

Bodies.	Specific Gravity.	Specific Caloric.
Muriatic acid	1.122	0.6800
Sulphuric acid 4 } Water 5 }		0.6631
Alum 1 } Water 4.45 }		0.649
Nitric acid 9⅓ } Lime 1 }		0.6181
Nitre 1 } Water 3 }		0.646
Alcohol	0.8371	0.6021
Sulphuric acid	1.840	0.5968
Nitrous acid	1.355	0.576
Linseed oil	0.9403	0.528
Spermaceti oil		0.5000
Oil of turpentine	0.9910	0.472
Vinegar		0.3870
Lime 9 } Water 16 }		0.3346
Mercury	13.568	0.3100
Distilled vinegar		0.1030
III. SOLIDS.		
Ice		0.9000
Ox-hide with the hair		0.787
Lungs of a sheep		0.769
Lean of ox-beef		0.7400
Pine	0.408	0.65
Fir	0.447	0.60
Lime	0.408	0.62
Pitch-pine	0.495	0.58
Apple tree	0.639	0.57
Alder	0.484	0.53
Oak	0.531	0.51
Ash	0.631	0.51
Crab-apple	0.603	0.50
Rice		0.5050
Horse beans		0.5020
Dust of the pine tree		0.5000
Pease		0.4920
Beech	0.692	0.49
Hornbeam	0.690	0.48
Birch	0.608	0.48
Wheat		0.4770
Elm	0.646	0.47
Female oak	0.668	0.45
Plum tree	0.687	0.44
Ebony	1.054	0.43
Barley		0.4210
Oats		0.4160
Pitcoal		0.2777
Charcoal		0.2631
Chalk		0.2564
Rust of iron		0.2500
White oxide of antimony washed		0.2270
Oxide of copper nearly freed from air		0.2272
Quicklime		0.2199

TABLE continued.

Bodies.	Specific Gravity.	Specific Caloric.
Stoneware		0.195
Agate	2.648	0.195
Crystal	3.189 ?	0.1929
Cinders		0.1923
Swedish glass	2.386	0.187
Ashes of cinders		0.1885
Sulphur	1.99	0.183
Flint glass	3.3293	0.174
Rust of iron nearly freed from air		0.1666
White oxide of antimony ditto		0.1666
Ashes of the elm		0.1402
Oxide of zinc nearly free from air		0.1369
Iron	7.876	0.1264
Brass	8.358	0.1141
Copper	8.784	0.1121
Sheet iron		0.1099
Oxide of lead and tin		0.102
Gun-metal		0.1100
White oxide of tin nearly free from air		0.0990
Zinc	8.154	0.0981
Ashes of charcoal		0.0909
Silver	10.001	0.082
Yellow oxide of lead nearly freed from air		0.0680
Tin	7.380	0.0661
Antimony	6.107	0.0637
Gold	19.040	0.050
Lead	11.456	0.0424
Bismuth	9.861	0.043

2. Of the ABSOLUTE QUANTITY of CALORIC.

1. Such are the different methods which have been proposed to ascertain the relative quantities of caloric which are necessary to reduce bodies to the same temperature. Attempts have also been made to discover the temperature of absolute privation, and thus to ascertain the whole quantity of caloric which a body contains.

266 Dr Irvine's method

The first attempt made with this view was by the late Dr Irvine of Glasgow. The theorem which he invented to ascertain the real zero, or the absolute quantity of caloric which a body contains, is founded on the uniformity of the specific caloric of bodies at all temperatures. And taking it for granted that the specific caloric of bodies is always the same, whatever be the temperature, the whole quantity, or the absolute quantity, will be proportional to the specific caloric. Having discovered the ratio between the absolute calorics of bodies, and the difference between two absolute calorics, the whole quantity in any body might be found by calculation. But either the data on which the theorem proceeds are wrong, or the experiments which have been made with the view of applying it to the

267 founded on the uniformity of specific caloric.

Caloric. the estimation of the absolute quantity of caloric have been very inaccurately conducted, the results varying so much from each other. According to Dr Irvine's own experiments and calculation, the real zero with regard to ice would be 1228° below 0°; but according to Dr Crawford's it is 1500°. Mr Kirwan makes it 1318° below 0°, from a comparison of the specific caloric of water and ice. Lavoisier and La Place fix it at 3426° below 0°, from the result of experiments on a mixture of water and quicklime. But in other experiments by the same philosophers, there is a great variation in the result. Four parts of sulphuric acid, and three parts of water, mixed together, give a result for the real zero equal to 7260° below 0°; and four parts of sulphuric acid, and five of water, give it only equal to 2598° below 0°. Professor Robison, speaking of the specific and absolute quantities of heat in bodies being supposed to be proportional, observes that "this opinion is just, only on the supposition that the measures obtained by experiments and calculation are constantly the same, whatever the temperatures may be in which the experiments are made. Dr Irvine's ingenious method of discovering the temperature of absolute privation, evidently presupposes this constancy of specific heat; or, if they are not constant, it supposes that we know the whole law of variation. Now, both of these assumptions are improbable. In none of the progressions of natural operations that we are acquainted with do we find this constancy. It is much more analogous to other phenomena, to suppose that, in the temperatures near to that of absolute privation, the quantities of heat necessary for producing equal elevation gradually diminish, and this, perhaps, without end, like the distance of the hyperbola from its assymptote. It is equally probable that the law of diminution may be different in different substances. This will cause the measures of specific heats to change their proportions continually; and therefore the specific capacities observed in temperatures, all of which are far removed from that of the entire absence of heat, give us no means of obtaining the proportions of the accumulated sum of all the heats which have been received into the substances. It follows from this, that even although it should be granted to Dr Irvine, that the heat which emerges, in mixing vitriolic acid and water, or in the freezing of water, is the difference between the absolute heats of the mixture or the ice, and the absolute heats of the substances before mixture, or of the water before freezing, still we cannot ascertain those absolute heats, or the temperature of no heat.

268 Results very different.

Accordingly it appears, that it has been only in a very few cases that Dr Irvine found a tolerable coincidence of his determination of this extreme cold, and the determination by means of mixtures differed enormously from those obtained by means of congelation; and still more from those obtained by means of the condensation of vapour *.

* Black's Lect. vol. i. p. 508.

269 Mr Dalton's method.

2. Mr Dalton has proposed another hypothesis for determining the real zero, or the absolute quantity of caloric in bodies. He observes that the remarkable fact of the quantity of expansion of elastic fluids being the same in the same circumstances, shews, that it depends solely upon heat: "whereas the expansion in solid and liquid bodies seems to depend upon an adjustment of the two opposite forces of heat and chemical affinity, the one a *constant* force in the same temperature, the other a *variable* one, according to the nature of the body; hence the unequal expansion of such bodies. It seems therefore that general laws respecting the absolute quantity and the nature of heat, are more likely to be derived from elastic fluids than from other substances.

"In order to explain the manner in which elastic fluids expand by heat, let us assume an hypothesis that the repulsive force of each particle is exactly proportional to the whole quantity of heat combined with it, or in other words to its temperature reckoned from the point of total privation: then since the diameter of each particle's sphere of influence is as the cube root of the space occupied by the mass, we shall have $\sqrt[3]{1000} : \sqrt[3]{1325}$ (10 : 11, nearly) :: the absolute quantity of heat in air of 55° : the absolute quantity in air of 212°. This gives the point of total privation of heat, or absolute cold, at 1547° below the point at which water freezes. Dr Crawford deduces the said point, by a method wholly different, to be 1532°. So near a coincidence is certainly more than fortuitous.

"The only objection I see to this hypothesis is, that it necessarily requires the augmentation of elastic fluids for a given quantity of heat to be greater in the higher temperatures than in the lower, because the cubes of a series of numbers in arithmetical progression differ more the larger the numbers or roots: but it has just been shewn that in fact an augmentation of a contrary kind is observed. This refers us to the consideration whether the mercurial thermometer is an accurate measure of the increments of heat: if it be, the hypothesis fails; but if equal increments of heat cause a greater expansion in mercury, in the higher than in the lower temperatures, and that in a small degree, the fact noticed above, instead of being an objection, will corroborate the hypothesis. Dr Crawford determines the expansions of mercury to be very nearly in proportion to the increments of heat: M. de Luc makes them to be less for a given quantity of heat in the lower than in the higher part of the scale; and in a ratio that agrees with this hypothesis. Now as every other liquid we are acquainted with is found to expand more in the higher than in the lower temperatures, analogy is in favour of the conclusions of De Luc, that mercury does the same."

Manch. Mem. v. 602.

The different methods which have been proposed by philosophers to determine the real zero, or the absolute quantity of caloric in bodies, and the want of coincidence between the results of the experiments and calculations founded on these methods, shew us, at least, that the subject is attended with great difficulty and uncertainty. Perhaps the present state of our knowledge does not furnish us with the means of removing the difficulty.

270 Cold.

3. Having thus considered the relative and absolute quantities of caloric in bodies, and the methods which have been proposed for ascertaining these quantities, it may be necessary to state in what sense, or with what limitations, the term *cold* is to be employed. When we leave a room at the temperature of 60°, and go into the air in a frosty day at the temperature of 32°, we say that it is cold; or when the hand is held in water at the temperature of 100° for a few minutes, and

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Caloric.

and then suddenly plunged into water at the temperature of 40°, the latter is said to be cold. This, however, is merely an expression of the sensation excited in the body, which depends solely on the abstraction of its heat. This may be proved by the following experiment. If three quantities of water are taken, the first at the temperature of 32°, the second at the temperature of 50, and the third at the temperature of 100°. Immerse the right hand into the water at the temperature of 100°, and the left into the water at the temperature of 32°. Let them remain for a minute, and then suddenly plunge both hands into the water at the intermediate temperature of 50°; the right hand will feel cold, and the left hand warm; and thus different sensations are produced by the same body at the same time and at the same temperature. This depends entirely on the previous state of the hands, and on the absorption or abstraction of caloric; and this seeming paradox is easily explained by what has been said on the equal distribution of caloric. The right hand which was placed in the water at the temperature of 100° absorbed caloric, because the temperature of the water is above that of the body. This excites the sensation of heat; but when the same hand is placed in the water at the temperature of 50° it is deprived of caloric, because the surrounding medium is far below its temperature; and thus the sensation of cold is produced. But from the left hand, placed in the water at 32° caloric is abstracted, which gives the sensation of cold, and the same hand placed in the water at 50° receives caloric, and this entering the body, excites the sensation of heat.

Thus, then, the term *cold* is merely expressive of the relative temperature of two bodies. In common language the word *cold* is sufficiently intelligible, but in the present view of the doctrine of caloric, it can have no other precise meaning, than to express the absence of a quantity of heat.

The remarkable effects which were produced on fluids by the abstraction of caloric, were once ascribed rather

271 Frigorific particles.

to the addition of a new body, than to the abstraction of one formerly in combination. The hypothesis of Le Mairan and Muschenbroeck, supposed the existence of frigorific particles; and this prevailed till the effects of caloric were developed by the discoveries of modern chemistry. They were led to this hypothesis from observing the increase of bulk which takes place when water is converted from the fluid into the solid state. These frigorific particles were imagined to have some resemblance to nitre. This opinion probably arose from the circumstance of a great degree of cold, or diminution of temperature, being produced by dissolving nitre in water. The frigorific particles were supposed to be constantly floating in the air, and by mixing with liquid bodies, as water, converted them into solids, by acting the part of wedges, which prevented the free motion of the particles among each other.

272 Cold seems to be reflected.

The experiments of Professor Pictet, in which cold seemed to be reflected, still gave some support to this opinion. Two concave mirrors of tin were placed at the distance of $10\frac{1}{2}$ feet from each other; a glass vessel full of snow was placed in the focus of the one, and an air thermometer in that of the other. The thermometer sunk several degrees, but when the snow was removed, it rose again; and when a greater degree of cold was produced on the snow, by pouring an acid upon it which dissolved it rapidly, the thermometer fell several degrees lower. At first sight it appears, that cold has been given out by the snow, and this cold reflected by the mirrors occasioned the fall of the thermometer. The explanation of this fact has been reckoned difficult; but, on closer attention, all difficulty vanishes. The thermometer itself is a radiant body and; its loss of heat, by radiation, is rendered apparent when placed in a situation in which a stream of caloric is invited by the cold body, the snow; and the direction of this current made to pass through the bulb of the thermometer, as through a focus, by the adaptation of the metallic reflecting surfaces. See the article COLD in our SUPPLEMENT: in which it is to be observed, however, that the doctrine of Professor Leslie is adopted, by which the phenomena of radiation are ascribed to certain rapid vibrations or pulses taking place in the surrounding air, in straight lines, between a hot and a cold body, whether the air is in other respects stagnant or subjected to motions in any other direction. This doctrine, we may observe in the passing, receives great countenance from the fact already mentioned, of the great interruption to radiation, when a heated body is placed in an exhausted receiver, or the Torricellian vacuum.

273 Accounted for.

374 To produce great cold.

4. Great degrees of cold are produced, by mixing together substances which dissolve rapidly. The reason of this will appear by recollecting what has been said of the absorption of caloric when a solid body is converted into a fluid. Mixtures to produce artificial cold, are generally made of the neutral salts dissolved in water; of diluted acids and some of the neutral salts; and of snow or pounded ice with some of these salts. A great number of experiments were made upon this subject by Mr Walker *; also by Professor Lowitz of Petersburgh †; by Fourcroy and Vauquelin ‡; and by Guyton §. The following table exhibits the results of these experiments.

* Phil. Trans. 1795. p. 270. 1801, p. 120.
† Ann. de Chim. vol. xxvi. p. 297.
‡ Ibid. vol. xxix. p. 281.
§ Ibid. 290.

Table of Freezing Mixtures.

	Mixtures.	Parts.	Thermometer sinks.
1.	Muriate of ammonia	5	From 50° to 10°
	Nitre	5	
	Water	16	
2.	Muriate of ammonia	5	From 50° to 4°
	Nitre	5	
	Sulphate of soda	8	
	Water	16	
3.	Nitrate of ammonia	1	From 50° to 4°
	Water	1	
4.	Nitrate of ammonia	1	From 50° to 7°
	Carbonate of soda	1	
	Water	1	
5.	Sulphate of soda	3	From 50° to 3°
	Diluted nitric acid	2	
6.	Sulphate of soda	6	From 50° to 10°
	Muriate of ammonia	4	
	Nitre	2	
	Diluted nitric acid	4	

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Caloric.

Table of Freezing Mixtures continued.

	Mixtures.	Parts	Thermometer sinks.
7.	Sulphate of soda	6	From 50° to 14°
	Nitrate of ammonia	5	
	Diluted nitric acid	4	
8.	Phosphate of soda	9	From 50° to 12°
	Diluted nitric acid	4	
9.	Phosphate of soda	9	From 50° to 21°
	Nitrate of ammonia	6	
	Diluted nitric acid	4	
10.	Sulphate of soda	8	From 50° to 0°
	Muriatic acid -	5	
11.	Sulphate of soda	4	From 50° to 3°
	Diluted sulphuric acid	4	
12.	Snow - -	1	From 52° to 0°
	Common salt -	1	
13.	Snow or pounded ice	2	From 0° to — 5°
	Common salt -	1	
14.	Snow or pounded ice	1	From — 5° to — 18°
	Common salt -	5	
	Muriate of ammonia and nitre -	5	
15.	Snow or pounded ice	12	From — 18° to — 25°
	Common salt -	5	
	Nitrate of ammonia	5	
16.	Snow and diluted nitric acid -		From 0° to — 46°
17.	Potash - -	4	From 32° to — 51°
	Snow - -	3	
18.	Snow - -	2	From — 10° to — 56°
	Diluted sulphuric acid	1	
	Diluted nitric acid	1	
19.	Snow - -	1	From 20° to — 60°
	Diluted sulphuric acid	1	
20.	Muriate of lime	3	From 32° to — 50°
	Snow - -	2	
21.	Muriate of lime	2	From 0° to — 66°
	Snow - -	1	
22.	Muriate of lime	3	From — 40° to — 73°
	Snow - -	1	
23.	Diluted sulphur. acid	10	From — 68° to — 91°
	Snow - -	8	

275 How to use the freezing mixtures.

When any of these substances are to be employed as freezing mixtures, the salts should be used fresh crystallized, and reduced to fine powder; and it will be found most convenient to observe the proportions which are set down in the table. Suppose it is wanted to produce a degree of artificial cold equal to —50°, which is that produced from 32° by the 20th freezing mixture. The substances employed, namely, the muriate of lime and the snow, must be previously cooled down to the temperature of 32°, or any degree below it. This may be done by placing them separately in the 11th freezing mixture, the sulphate of soda and diluted sulphuric acid, which reduces the temperature from 50° to 3°; or in the 12th freezing mixture of snow and common salt, which reduces it from 32° to 0. The materials, thus cooled down, are then to be mixed together as quickly as possible, when, if the experiment succeed, the temperature will fall from 32° to —50°, as in the 20th freezing mixture. The vessels which are employed for these processes should be very thin, and made of the best conductors of caloric. Vessels of tin plate answer the purpose, and when acids are to be used, they may be lined with wax, which will secure them sufficiently against their action. They should be of no larger dimensions than just to contain the materials.

276 Vessels.

Sect. VI. *Of the Sources of Caloric.*

We are now to consider the means by which caloric may be evolved, or rendered sensible. This is a subject of great importance, both as a curious investigation, and as a useful and necessary application in chemistry and the arts of life. The different sources from which caloric is derived, or the means which are employed for its evolution, may be reckoned five in number; namely, percussion, friction, mixture, the sun, combustion: and in this order we shall now consider them.

First Source of Caloric,

Percussion.

277 Flint and steel.

The production of heat by striking together flint and steel, is a well-known fact. The same thing also takes place when many other hard bodies are struck against each other. Fires are frequently kindled by making a piece of iron red-hot by striking it smartly and repeatedly with a hammer. In most of the cases in which caloric is evolved by percussion, this evolution is ascribed to the condensation of the particles of the body struck. A condensation has been observed to take place, both in elastic fluids and liquids.

278 Heat produced, owing to condensation

279 in airs;

1. The sudden condensation of air alone has been found to produce a change of several degrees in the thermometer. In some experiments by Dr Darwin, the condensed air from an air-gun, thrown on the bulb of a thermometer, uniformly sunk it about 2°. This shews that the air had given out some of its caloric; for during the operation of condensing it, the apparatus became sensibly hot *.

Mr Dalton's experiments on the condensation and rarefaction of air, shew that an increase of temperature of 50° is produced, by admitting air into an exhausted receiver; and when the equilibrium is restored to condensed air, 50° of cold are produced. The suddenness of the fall and rise of the thermometer is very remarkable

* Phil. Trans. 1789, p. 44.

markable in these cases; and from this circumstance, Mr Dalton conjectures, that the real change of temperature of the air or medium was much greater than the thermometer indicated, but that the inequality existed only for a few seconds *. From these experiments, therefore, it appears that caloric is evolved during the condensation, and absorbed during the rarefaction of air.

* Manch. Mem. vol. v. p. 515.

A considerable rise in temperature takes place, when different gases unite together, and are condensed. Muriatic acid gas and ammoniacal gas, when combined together, form a solid salt; and during this combination a great quantity of caloric is evolved.

280
in hard bodies.

2. To the same cause is ascribed the caloric which is evolved by the percussion of hard bodies. This is particularly the case with metallic substances. Before hammering, the specific gravity of iron is 7.788; after it is hammered it increases to 7.840. In some other metals the increase of density is still more remarkable. Before hammering, platinum is only 19.5; and after hammering, its specific gravity is increased to 23.0. As a proof that the heat is evolved by condensation, iron, which has been once heated by hammering, cannot be subjected to a repetition of the same process till it has been again exposed to heat. It has become so brittle that it flies to pieces under the hammer.

281
Difficult to account for incombustibles giving out heat when struck.

3. It is perhaps more difficult to account for the caloric and light which are emitted by incombustible substances; as, for instance, in the case of two quartz stones struck against each other, which has been already alluded to in treating of light. The particles of these bodies which were struck off by percussion, are found, on examination, to be in a state of fusion; and it would appear that this is a case in which light and caloric are emitted without oxygen having any share in the action, as is supposed to happen in all cases of combustion.

In some observations on the appearances produced by the collision of steel with hard bodies, made by Sir H. Davy, he mentions that Mr Hawksbee shewed †, that no sparks could be produced *in vacuo*; a faint light was only perceived. Sir H. Davy thinks, that the vivid sparks obtained from steel in the atmosphere, are owing to the combination of the small abraded and heated metallic particles with oxygen; but it has been doubted, he observes, whether the faint luminous appearance, when the experiment is made *in vacuo*, be owing to the light produced by the fracture and abrasion of the particles of the flint, or only partly to this cause, and partly to the ignition of the minute filaments separated from the steel. When a fine and thin flint, which is easily broken, is used for the collision *in vacuo*, the light is more vivid than when a thick one is employed. From this he concludes, that the particles of steel are rendered luminous in consequence of combustion. This conclusion was proved by the following experiment.

† Philos. Trans. vol. xxxiv. p. 2165.

A thin piece of iron pyrites was inserted in a gunlock in place of the flint. By collision in the atmosphere it gave vivid sparks, chiefly white, but sometimes mixed with a few red sparks. The same experiment was repeated when the apparatus was introduced into the exhausted receiver of an air-pump; but no light whatever appeared.

282
Supposed to be electric.

Sir H. Davy further observes, that bodies which become luminous by being struck or rubbed together *in vacuo*, under water, or in gases that do not contain oxygen; such bodies, for instance, as fluate and carbonate of lime, siliceous stones, glass, sugar, and many of the compound salts, are both electrics *per se* and phosphorescent substances; so that the flashes they produce are probably occasioned, partly by electricity and partly by phosphorescence. In some cases, however, by the collision of very hard stony bodies, which are bad conductors of heat, there may be an actual ignition of the particles. This seems to be countenanced by various facts. Mr T. Wedgwood found, that a piece of window-glass, when brought into contact with a revolving wheel of grit, became red-hot at its point of friction, and gave off luminous particles, which were capable of inflaming gunpowder and hydrogen gas †; and we are informed, Sir H. Davy adds, by a late voyager (s), that the natives of Oonalashka light their fires by striking together two pieces of quartz over dry grass, their surfaces being previously rubbed with sulphur *.

† Ibid. 1795, p. 45.

* Journ. Roy. Inst. vol. i. p. 264.

Second source of Caloric,

Friction.

283
Combustible bodies inflamed.

1. A great quantity of caloric is also given out by friction. The intensity of the heat produced by friction depends on many circumstances, and varies chiefly in the ratio of the time employed and the nature and surface of the bodies which are rubbed together. When the bodies rubbed are combustible, as two pieces of dry wood, they may be inflamed; but even when they possess combustibility in a low degree, or are altogether incombustible, the temperature may be raised so high as to communicate a degree of heat sufficient to set fire to combustible bodies. Greater difficulty still attends the explanation of the phenomena of the evolution of caloric by friction, than by the percussion of hard, incombustible bodies. In many instances there can be no increase of density by the friction, for caloric is evolved by rubbing together two pieces of wood, or rubbing the hand on a piece of soft cloth where increase of density can scarcely be supposed. Nor can the increase of temperature by friction be accounted for by the diminution of the specific caloric of the

(s) Sauer's account of this fact is the following: "I observed in all the huts a basket containing two large pieces of quartz, a large piece of native sulphur, and some dry grass or moss. This serves them in kindling fires; for which purpose they rub the native sulphur on the stones over the dry grass, strewed lightly with a few feathers in the top, where the sulphur falls; then they strike the two stones one against the other; the fine particles of sulphur immediately blaze like a flash of lightning, and communicating with the straw, set the whole in a flame. *Sauer's Account of Billings's Expedition to the northern parts of Russia*, p. 159.

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Caloric.

the bodies which are rubbed together; for Count Rumford, who made some interesting experiments on this subject, could not discover any change in this respect, and supposing that this change had taken place, it could not have been sufficiently great to account for all the heat produced. In one of these experiments he took a brass six-pounder, cast solid, and rough as it came from the foundery; fixed it horizontally on the boring machine, and caused its extremity to be cut off; and by turning round the metal in that part, a solid cylinder was formed $7\frac{3}{4}$ inches in diameter, and $9\frac{8}{10}$ inches long. This when finished remained joined to the rest of the metal by a small cylindrical neck $2\frac{1}{5}$ inches in diameter, and $2\frac{8}{10}$ inches long. This short cylinder was bored with a horizontal borer used in boring cannon. Its bore, which was $3\frac{7}{10}$ inches in diameter, instead of being continued through its whole length $9\frac{8}{10}$ inches, was only $7\frac{2}{10}$ inches in length. A solid bottom of $2\frac{6}{10}$ inches in length was thus left. A blunt steel borer was pressed against the bottom of the bore of the cylinder with a force equal to 10,000 lb. avoirdupois; and the cylinder was turned round by horses at the rate of about 32 times in a minute. To prevent the dissipation of the heat, the cylinder was covered up with thick flannel. At the beginning of the experiment the temperature of the air and of the cylinder was 60°. At the end of 30′, when it had made 960 revolutions, a mercurial thermometer was introduced into the hole made to receive it in the side of the cylinder, and the mercury rose to 130°. When the borer was removed, and the metallic dust taken out of the bottom of the cylinder, it was found to amount to 837 grs. As the weight of this dust amounts to no more than $\frac{1}{948}$th part of that of the cylinder, it must have given off 948° to raise the temperature of the cylinder 1°, and consequently it must have given out 66,360° of heat in the course of the experiment.

284 Heat by friction not owing to diminished specific caloric,

285 proved by Count Rumford.

286 Nor to the air.

2. But to determine whether the air of the atmosphere had any part or not in the generation of this heat, he contrived the following decisive experiment. The apparatus was inclosed in a wooden box, which was made water-tight, and filled with water, so as to exclude completely the external air. The quantity of water employed was 18.77 lb. avoirdupois, or $2\frac{1}{4}$ wine gallons, and the temperature at the commencement of the experiment was 60°. The machine was put in motion, and moved at the same rate as in the former experiment. At the end of an hour the temperature was 107°; in half an hour more, it rose to 178°, and at the end of two hours and 30′ from the beginning of the experiment the water actually boiled. By Count Rumford's calculation the caloric generated by friction in this experiment, and accumulated in two hours and 30′, would have heated ice-cold water 180°, or caused it to boil. From the results of his computation it appears, that the quantity of caloric thus generated equably, was greater than that produced equably in the combustion of nine wax-candles, each $\frac{3}{4}$ of an inch in diameter, burning clearly for the same length of time.

Reflecting on these experiments, Count Rumford recurs to the question, What is heat? Is there any such thing as an igneous fluid? And after stating that the quantity of caloric thus generated could neither be furnished by the particles of the metal detached from the solid masses, nor by the air, nor by the water, because it must have received its heat from the apparatus, he concludes, that caloric is not a material substance, but only a peculiar kind of motion produced among the particles of matter †.

287 Count Rumford concludes that heat is motion.

† *Phil. Trans.* 1798, p. 80.

3. The experiments of Professor Pictet also prove, that the caloric generated by friction is not owing to the combination of oxygen with any of the bodies. He contrived an apparatus which could be introduced into the receiver of an air-pump. By means of this apparatus, a piece of adamantine spar was rubbed against a steel cup in the open air. A thermometer, which was fixed in the inside of the cup, did not rise when the apparatus was set in motion, although abundance of sparks were produced. When the apparatus was placed in an exhausted receiver, and the experiment repeated, a phosphoric light, but no sparks, appeared, nor was the thermometer any way affected; but when a smaller brass cup was employed, and a piece of brass rubbed against it in the open air, the thermometer was not affected till the motion ceased, and then it rose 0.3°. The caloric, it would appear, was carried off as it was generated, by the motion of the air. When the same experiment was repeated *in vacuo*, the thermometer rose 1.2°, and it began to rise as soon as the friction commenced. When a piece of wood was made to rub on a wooden cup, the thermometer rose 2.1°, and *in vacuo* 2.4° †.

288 Heat generated by friction not owing to combination with oxygen.

† *Essai sur le Feu*, chap. ix.

These experiments, therefore, are sufficiently conclusive to prove that the caloric evolved by friction is not derived from the atmosphere; but still the question recurs, What is its origin? No satisfactory answer can be given to this question, if it cannot be resolved, as some have supposed, by having recourse to the agency of electricity; and considering the similarity of the effect of caloric and electricity in heating and cooling bodies, in producing the expansion and fusion of metallic substances, in effecting the actual combustion of inflammable matters, and that in other respects the one can be substituted for the other, it is not at all improbable that electric matter, which is generated in great abundance by friction, may be the chief agent in the evolution of caloric by the friction of bodies on each other.

289 Probably owing to electricity.

4. In some observations on spontaneous inflammations by Bartholdi, he mentions the experiments which were repeated by Dr Paleani, for obtaining fire by the friction of two pieces of wood, in which he gave to one of the rubbing pieces the form of a tablet, and to the other that of a spindle or cylinder; and as the results of some of these experiments are of importance to shew what attention ought to be paid to the choice of wood, in the construction of machines and instruments where there is considerable friction, we shall state the following.

290 Choice of wood in machines important on account of the friction.

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Caloric.

Cylinders.	Tablet.	Duration	Effect.
Boxwood,	Box,	5′	Sensible heat.
do.	Poplar,	5	do.
do.	Oak,	5	do.
do.	Mulberry,	3	Considerable heat and smoke.
do.	Laurel,	3	do.
Laurel,	Poplar,	2	do.
do.	Ivy,	2	do.
Ivy,	Box,	3	do.
do.	Walnut,	3	do.
Olive,	Olive,	3	do.
Mulberry,	Laurel.	2	Considerable heat smoke and blackness.
Ash,	Oak,	5	Sensible heat.
do.	Fir,	5	do.
Peartree,	Oak,	5	do.
Cherry,	Elm,	5	do.
Plumtree,	Apple tree,	5	do.
Oak,	Fir,	5	do.

When the experiment was changed, and a cylinder of one of the kinds of wood was rubbed between two tablets of the other; as, for example, a cylinder of poplar between two tablets of mulberry wood, the increase of the rubbed surfaces which were in contact with the air, produced a temperature much more considerable; and almost the whole of the kinds of wood enumerated above took fire.

The effect of friction also varies according as the woods employed of the same kind are rubbed in the direction of the fibres, or when the fibres cross each other. In the first case the friction and heat generated are much more considerable than in the second †.

† *Annal. de Chim.* vol. xlviii. p. 252.

Third Source of Caloric,

Mixture.

291. Change of temperature by combination.

1. It is one of the characteristics of chemical action to produce a change of temperature. This happens in consequence of the increase or diminution of bulk of the bodies which have been the subject of combination, or a total change of their state and properties. Thus it has been established as a general law in chemical science, that all bodies which pass from the solid to the fluid state, absorb a quantity of caloric; and all bodies which pass from the fluid to the solid state, give out caloric. This law, therefore, will enable us to account for those changes which take place by the mixture of different bodies. In the course of the details of chemical science, we shall have frequent opportunities of pointing out the effects of this law. At present we shall only mention a few instances in which caloric is evolved by mixture attended with chemical action.

292. Gaseous bodies forming solids or liquids.

2. When two substances in the state of gas enter into union, and form a solid or liquid body, caloric is evolved.

a. Ammoniacal gas and muriatic acid gas, which, when mixed together, instantly combine, and form a solid salt, give out, at the same time, a quantity of caloric.

b. When oxygen gas and nitric oxide gas are mixed together, they combine and form a liquid, and at the moment of union give out caloric.

3. When two liquids are mixed together, provided the density of the mixture be greater than the mean of the two liquids, caloric is evolved during the combination.

a. When alcohol and water are mixed, the density is greater than the mean of the two liquids; caloric, therefore, is given out during the mixture.

b. A much greater degree of heat is produced by mixing sulphuric acid and water. If four parts of sulphuric acid be combined with one part of water, the density of the mixture is much greater than the medium density of the two liquids, and accordingly the quantity of caloric evolved is sufficient to boil water.

4. A great quantity of caloric is also given out when a fluid body combines with a solid. We have an instance of this in the slacking of lime.

a. When water is thrown upon quicklime, it instantly disappears; for part of it combines with the lime, and becomes solid; and thus passing from the liquid to the solid state, it gives out caloric.

b. If a quantity of sulphuric acid be poured upon quicklime, the caloric evolved is sufficient to raise part of the sulphuric acid into vapour.

5. Were we to reverse these experiments, and state instances of caloric being absorbed during the mixture of bodies, we should observe the operation of the same law, in the case of solid bodies becoming fluid, producing a great degree of cold. But it appears that the production of cold by the solution of salts in water is owing to the water which is in a previous state of combination with one of the salts, and thus water passing from the solid to the liquid state, must absorb caloric, and therefore produce cold. The salts which are best adapted for this purpose, contain a great proportion of water in the composition; for if the same salts are deprived of water by exposing them to heat, the same effect by no means follows. On the contrary, when they are dissolved in water in this state, heat is produced, because they combine with a portion of the water for which they have a strong affinity, and this water passing from the liquid to the solid state, gives out its caloric. 293 Cold produced by water becoming suddenly fluid.

6. A considerable quantity of caloric is also generated in other mixtures, in which the fermentation and putrefaction of animal and vegetable substances takes place. During these processes the substances which are held in solution enter into new combinations, and their chemical properties are totally changed. While this change is going on, there is a gradual and constant evolution of caloric. 294 Heat evolved in fermentation, &c.

It is an artificial heat of this kind which is generated by animal and vegetable matters, and on account of its uniformity and constancy is employed for promoting vegetation; as when horse dung and tanner's bark are used in making hot beds; or for the hatching of eggs, a practice which has been long in use in Egypt.

Fourth Source of Caloric,

The Sun.

1. But the great source of light and heat in the planetary system is the sun. When treating of light we mentioned

3

mentioned a speculation of philosophers about the great and constant waste of light, which the sun, although a body of immense magnitude, must sustain. But since the nature and constitution of the sun were discovered by Dr Herschel, these speculations fall to the ground.

295 The sun an opaque body.

According to these discoveries, the sun is not, as was formerly supposed, an immense globe of fire, in which the materials composing it are continually wasting by combustion; but a solid opaque body, similar to the other planets, and surrounded by a very dense atmosphere, in which are observed two kinds of clouds. The lower region of clouds is similar to those in the atmosphere of the earth. The uppermost region of clouds is luminous, and from this proceed the light and heat which were supposed to come from the body of the sun. This luminous region, it appears from Dr Herschel's observations, in consequence of changes which seem to be constantly going on in it, exhibits different degrees of splendour, diminishing greatly the quantity of light and heat which are emitted at other times. To these variations he ascribes much of the difference of temperature in different seasons, and the consequent abundance or deficiency of crops.

296 Dark colours absorb heat.

2. It is a familiar as well as a correct observation, that dark-coloured clothes, as black for instance, are much warmer than those which are of a lighter colour. The rays of light, and also probably those of caloric, are reflected in greater proportion by white bodies than by those of a deeper colour. The sun's rays enter the opaque body, and combine with it, and thus increase the temperature. These rays are permitted to pass through transparent bodies, which are very little affected by them; but combining with opaque bodies they heat them, and the deeper the colour of the body the greater is the increase of temperature.

297 Hooke and Franklin's experiments.

3. But this has not been left to the uncertainty of common observation. Experiments were made by Dr Franklin, and before him by Dr Hooke, to ascertain this curious point. Pieces of cloth of different colours were placed upon snow, and exposed to the light of the sun. The colours were white, red, blue, black; and it was found that the darkest coloured pieces had admitted most heat, because they sunk deepest in the snow, and this was in proportion to the darkness of the colours.

298 Sir H. Davy's.

Sir H. Davy made a similar experiment, to determine the correspondence between the increase of repulsive motion in bodies from the action of light and dark colours.

"Six similar pieces of copper, of equal weight, size, and density, each an inch square, and two lines thick, were coloured, one white, one yellow, one red, one green, one blue, and one black. A portion of a mixture of oil and wax, which became fluid at about 76°, was placed on the centre of each on the inferior side. They were then attached to a board painted white, and so placed with regard to the sun, that their upper surfaces were equally exposed to the light. Their inferior surfaces, to which the cerate was attached, were equally deprived of light and heat. The cerate on the black plate began to melt perceptibly before the rest, the blue next in order, then the green and the red, and lastly the yellow. The white was scarcely at all affected; the black was in a complete state of fusion *." It appears, therefore, from these experiments, that caloric enters bodies in different proportions; and in the greatest proportion in the darkest coloured bodies.

* *Beddoes' Contributions*, p 44.

299 Bodies which absorb most light become warmest.

It appears too, that those bodies which absorb most light, acquire the greatest degree of temperature when exposed to the sun's rays. This has been demonstrated by the experiments of Wedgwood, Cavallo, and Pictet.

The former took two pieces of phosphorescent marble, one of which was blackened, and placed them on a hot iron. No light appeared from the blackened marble, but the other exhibited its usual phosphorescence. Upon a second exposure, the piece which was not blackened gave a faint light; the blackened one, as before, gave none at all. When the black was wiped off, and both pieces were again placed upon the heater, no light appeared either from the one or the other. This experiment shows, that the phosphorescent property was nearly destroyed without any visible light having appeared. But both pieces of marble before being heated, must have contained the same quantity of light and heat, and therefore the light from the blackened piece must have been absorbed by the black colour *.

* *Philos. Trans.* 1792, p. 278.

In Cavallo's experiments (U), the bulb of a thermometer was painted black, and exposed along with other thermometers to the sun's rays. The blackened thermometer indicated a temperature 10° higher than the other; but this difference was not constant; for it varied according to the brightness of the sun, and the density and temperature of the atmosphere. Considerable variations were also observed, from the difference of colours which were employed, and from the difference of polish of the surface of the plate.

The same thing was observed when the thermometers were exposed to strong day light. The thermometer whose bulb was blackened indicated the highest temperature †.

† *Ib.* 1780, p. 587.

In an experiment made by Professor Pictet, two thermometers, one of which had its bulb blackened, when they were kept in a dark place, indicated the same temperature. These experiments prove the close connection between light and caloric; for the greater the proportion of light absorbed by any body, the higher is the temperature of that body. And when the light is totally excluded, as in the last mentioned experiment of Pictet, the temperature is the same ‡.

‡ *Essai sur le feu*, chap. iv.

300 Different heating power of the rays.

4. But it has been shewn that there is a very great difference in the heating power of the different rays of light. It appears, from the experiments of Dr Herschel, that this heating power increases from the middle of the spectrum to the red ray, and is greatest beyond it, where the rays are invisible. Hence it is inferred, that

(U) The hint of these experiments, he says, was taken from the account of an experiment in a volume of the Philosophical Transactions, made with a thermometer whose bulb was painted black, and exposed to the rays of the sun. The experiment alluded to was made by Dr Watson, bishop of Llandaff. *Philosophical Transactions*, 1763, p. 40.

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Caloric.

that the rays of light and caloric nearly accompany each other, and that the latter are in different proportions in the different coloured rays.

It has also been shewn, that the different rays of light produce different chemical effects on metallic salts and oxides. These effects increase on the opposite direction of the spectrum, from the heating power of the rays. From the middle of the spectrum towards the violet end, they become more powerful; and produce the greatest effect beyond the visible rays.

301 Solar rays of three kinds.

5. From these discoveries it appears, that the solar rays are of three kinds. 1. Rays which produce heat. 2. Rays which produce colour; and, 3. Rays which deprive metallic substances of their oxygen. The first set of rays is in greatest abundance, or most powerful, towards the red end of the spectrum, and they are least refracted. The second set, or those which illuminate objects, are most powerful in the middle of the spectrum; and the third set produce the greatest effect towards the violet end, where the rays are most refracted.

302 Transparent bodies not heated by the solar rays.

6. The solar rays pass through transparent bodies without increasing their temperature. The atmosphere, for instance, receives little or no increase of temperature by transmitting the sun's rays till these rays are reflected from other bodies, or communicated to it by bodies which have absorbed them. This is also proved by the sun's rays being transmitted through convex lenses, producing a high degree of temperature when they are concentrated, but giving no increase of temperature to the glass itself. By this method, the heat which proceeds from the sun can be greatly increased. Indeed, the intensity of temperature produced in this way is equal to that of the hottest furnace. This is done either by reflecting the sun's rays from a concave polished mirror, or by concentrating or collecting them, by the refracting power of convex lenses, and directing the rays thus concentrated on the combustible body. See *Burning Glass*.

Fifth Source of Caloric,

Combustion.

303 Effects of combustion striking.

It was impossible for men whose attention was directed to the phenomena of nature, long to pass unobserved the singular appearances which are exhibited in the combustion of bodies.

304 Important,

As combustion is one of the principal sources of heat, it has long occupied the attention of men in general, both as to the means of its improvement and application in the arts of life, and in the discovery of a theory or explanation which will account for the phenomena.

305 but of difficult explanation.

But the want of success in this branch of philosophical investigation, even at the present day, shews that the subject is attended with great difficulty.

306 Difference between increase of temperature and burning.

When a piece of iron is exposed to a high temperature, it becomes red hot, and when it is removed from the heated body, it continues for some time to give out light and heat. But when it is suffered to cool, it returns to the same state in which it was before it was heated. When a piece of wood is burnt, it also gives out light and heat; but during this process it is totally changed. Great part is dissipated, and nothing remains but a small quantity of ashes.

When a piece of sulphur is exposed to a temperature between 300° and 400°, it takes fire and burns, gives out heat and light; and during this process the sulphur has acquired new properties, or has entered into new combinations.

307 Bodies totally changed by combustion.

When a metallic substance, zinc for instance, is exposed to a certain temperature, it also undergoes a very great change, during which heat and light are given out. The zinc is changed to a light flocculent substance; most other metals are reduced to the form of powder. To these substances was formerly given the name of *calces*; they are now denominated *oxides*.

308 Oxygenous gas necessary in this process.

Now, none of these changes can be effected without the presence of atmospherical air, or rather without the presence of oxygenous gas, which is one of its constituent parts, and that part of it which is necessary for the process of combustion. In all cases where combustion takes place, oxygen disappears or changes its state; light and heat are emitted, and the combustible body has changed its properties. Such are the phenomena of combustion, so far as observation and experiment have gone; but still the difficulty remains, to discover what share the different agents which are necessarily concerned in this process have in the changes which are effected. It is now universally agreed, that oxygen is fixed in the combustible body during the process of combustion, and that the caloric which was necessary to retain the oxygen in the state of an elastic fluid being emitted during the change, is the source of the heat which is given out by burning bodies.

309 Source of the light not ascertained.

But what is the source of the light? Is it emitted by the oxygenous gas along with the caloric in its change from the fluid to the solid state? Or has it been a constituent part of the combustible body which is separated during combustion? On this point, different opinions have been entertained by philosophers, and the question in a great measure still remains undecided. Let us now consider the different theories which have been proposed to account for these phenomena.

310 Theories.

1. In the early dawn of chemistry, when the scattered facts were first collected, and it began to assume a scientific form, attempts to explain this process were soon made. Beccher was the first who gave any consistent form to a theory of combustion. Before his time, sulphur was considered as the universal inflammable principle; but he rejected this opinion, considering sulphur as an inflammable substance, containing the principle of inflammability, but not that principle itself. This theory was improved and extended by Stahl, who gave this principle the name of *phlogiston* (x), from which the theory is called the phlogistic, and from his own name the *Stahlian* theory.

311 Stahlian.

This principle was supposed to exist in all inflammable bodies, and to be the same in all. The diversity which is observed among them, in external appearance and other properties, is owing to the other principles or elements of which they are composed, and with which the common

(x) This principle was also called *terra secunda*, or *terra inflammabilis*.

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Caloric.

common principle of inflammability, or phlogiston, is combined. Combustion, with the several phenomena that attend it, is supposed to depend on a gradual separation and dissipation of this principle; and this being once separated, what remains of the body is no longer combustible, but is similar to other kinds of matter. This principle is represented as a dry substance, of an earthy nature, composed of particles which more than all others are disposed to be affected with a swift whirling motion. When the particles of a body are agitated with this motion, the body becomes hot, is ignited, or undergoes combustion according to its violence. The heat and the light which are emitted during combustion, depend upon a peculiar motion of the particles of matter; phlogiston, which is supposed to be contained in all combusible substances, being most disposed to assume this motion *.

* *Black's Lect.* vol. i. p. 231, 232.

312 Hooke's

2. Before this time a different theory had been proposed by Dr Hooke, who published an account of it in 1665, in a work entitled *Micrographia*; and, in the year 1676, in another work called *Lampas*. According to this theory, the air of the atmosphere is the universal solvent of all combustibles. This solution takes place when the temperature of the combustible body is sufficiently raised, and during the violence of its action the heat is emitted. This dissolution of inflammable bodies is a substance inherent in the air, similar to that which is fixed in saltpetre, if not the very same. During this dissolution of bodies, part unites with the air and escapes; and part, after being mixed with it, forms a coagulum or precipitation, some of which being light, is carried away, while another part which is heavier remains behind.

313 and Mayow's.

Some time after, an account of the same theory was published by Dr Mayow, with some additional experiments, in a work entitled *De Sal-nitro et Spiritu Nitro-aëreo*. The nitro-aërial particles, or the spiritus nitro-aëreus of Mayow, was the same as the universal solvent of Hooke. According to Mayow, this spiritus nitro-aëreus consists of minute particles, from the motion of which it is produced, and when the motion is more rapid, not only heat but light also is extricated. The following abstract of the theory of Dr Hooke, with Professor Robison's observations, will not, we hope, be unacceptable to our readers.

314 Abstract of Hooke's theory.

"This theory, so opposite, as Dr Black observes, to the theory of Stahl, is not so recent as is generally imagined. It was seen in all its extent and importance by Dr Robert Hooke, one of the greatest geniuses, and most ardent inquirers into the operations of nature, who figured during the latter half of the 17th century, a period full of great discoveries.

"Dr Hooke proposed this theory in considerable detail in his *Micrographia*, published in 1665; and in his *Lampas*, published in 1676; and he makes it an important doctrine in his treatise on Comets, and in many passages of his Cutlerian Lectures. He promises to take it into serious consideration, and to publish a full exhibition of it. The allusions made to it in his lectures, make it evident that he had continued to make some desultory additions to his first conceptions. His *Lampas* contains a most accurate explanation of flame, which cannot be surpassed by any performance of the present day.

"In the Micrographia he states the theory in the following words:

"1. The air in which we live, and breathe, and move, and which encompasses and cherishes all bodies, is the universal solvent of all sulphurous (synonymous at that time with inflammable) bodies.

"2. This action it performs, not till the body be sufficiently heated, as we observe in other solutions.

"3. *This action of dissolution produces the great heat which we call fire.*

"4. It acts with such violence as to agitate the particles of the diaphanous body, air, and to produce that elastic pulse called light.

"5. This action, or dissolution of inflammable bodies, is performed by *a substance inherent in, and mixed with the air, that is like, if not the very same with that which is fixed in saltpetre.*

"6. In this dissolution of bodies by the air, a part of the body uniting with the air is dissolved or turned into air, and escapes and flies about.

"7. As one part is thus turned into air, so another is mixed with it, but forms a coagulum, or precipitation, some of which is so light as to be carried away with the air, while other grosser and heavier matters remain behind, &c. &c. This latter article is frequently employed in other parts of his writings, and is sometimes called a grosser *compound*, mixed with matters terrene, and originally insoluble in air, and incombustible.

"Can any thing more be wanting to prove that this is the same with the modern theory of combustion? Nothing but to shew that this coagulum contained the air which had formed it, by shewing an increase of its weight, or by separating it again. But the eager mind of Hooke, attracted by every appearance of novelty, was satisfied with the general notion of a great subject, and immediately quitted it in chase of some other interesting object. Had he not been thus led off by a new pursuit, this wonderful man would not only have anticipated, but completed many of the great discoveries of the last century. It was a bold conception, and only a vigorous mind could entertain it for a moment, that the vast heat of combustion was contained in a few grains of air. Yet this was his opinion, as appears by the explanation which he gives, in various meetings of the Royal Society, and in his lectures on comets, of the deflagration of combustible bodies with saltpetre, and of fiery motion.

"In the treatise called *Lampas*, he observes that this his treatise, published eleven years before, had been very favourably received, and that he had not seen any valid objection offered to it. It was in this interval that Dr Mayow at Oxford published his book *De Sal-Nitro et Spiritu Nitro-aëreo*, in which he holds precisely the same doctrine; but his exhibition of it is obscure, complicated, and wavering, mixed with much mechanical nonsense, of wedges, and darts, and motions, &c. according to the fashion of the times. Hooke's conception of the subject, on the contrary, is clear, simple, and steady. The only addition made by Mayow are some observations on the increase of weight observed in the preparation of diaphoretic antimony, &c. Hooke, explaining at a meeting of the Royal Society, some tricks of the plumbers

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Caloric.

bers workmen, who called the litharge which formed on the surface of the melted lead dross, and took it with them as their perquisite, says expressly that they can make dross of the whole, and that it is more than the lead by all the air which was its menstruum. But Mayow wrote on the subject expressly, and it appears in the title of his book. He is remembered, while Hooke is forgotten, because no one would think of looking into the Micrographia for chemical information. The theory comes in by chance, to explain the indestructibility of charcoal in close vessels by heat. Mayow also made many very ingenious experiments on the air which had contributed to inflammation, and has anticipated both the manipulations and the discoveries of modern pneumatic chemistry."

315 Phlogiston supposed to be light.

3. But in the progress of chemical science, the existence of the principle of phlogiston began to be called in question. It had been observed, and was proved by experiment, that substances became inflammable merely by being exposed to the light of the sun, and in this way having acquired the principle of inflammability, it was supposed to be the same as light. This opinion of phlogiston being light fixed in bodies, which was the first improvement or modification of the theory of Stahl, was adopted by Macquer and other chemists.

316 Farther modified.

4. In the progress of discovery, this theory was still farther modified. The introduction of pneumatic chemistry, and the accuracy and precision which it gave to the experiments and researches of chemists, enabled them to ascertain, with greater certainty, the changes which take place on bodies after being subjected to combustion, as well as on the air in which they are burnt. Some of these changes were observed by Dr Priestley, whose indefatigable labours contributed essentially to the extension of chemical science. He found, by experiment, that the air in which combustibles had been burnt was afterwards unfit for the support of flame, and equally so for the breathing of animals. He ascribed this change which the air had suffered, to its combination with the phlogiston which had separated from the burning body during the process of combustion. He considered air as necessary to combustion, because, having a strong affinity for phlogiston, it attracted it during the process, and combined with it; and by this combination the air was contaminated and rendered unfit for farther combustion, or for animal respiration. But still the difficulty remained to account for the heat and light which are extricated during this process.

317 Changes observed on the air by Priestley.

318 supposed that it combined with phlogiston.

319 Caloric and light exist in the air.

According to Dr Crawford, the caloric and light which appear during combustion, exist in the air in which the body is burnt; and during the process the phlogiston combines with the air, from which at the same time the light and caloric are separated.

320 Phlogiston the same with hydrogen.

5. Soon after Mr Kirwan proposed another opinion, which was pretty generally adopted by chemical philosophers. According to this opinion, hydrogen and phlogiston are the same; that it exists as a constituent part in all combustibles, separating from them during combustion, and combining with the oxygen of the air.

321 Scheele's hypothesis.

6. In the year 1777, Scheele published a work, which was entitled *Chemical experiments on Air and Fire*. Heat, according to him, consists of a certain quantity of oxygen united with phlogiston. Radiant heat, which moves in straight lines, is composed of oxygen combined with a greater proportion of phlogiston; and light, of oxygen combined with a still greater quantity.

322 Discovery of Lavoisier.

7. But the labours and discoveries of the French chemists gave a new turn to chemical science. The unfortunate Lavoisier, who had devoted his time and his fortune to chemical pursuits, had long directed his attention to the phenomena of combustion, and after an extensive series of experiments, distinguished for their accuracy and precision, he established the general law, that oxygen combines with the burning body in all cases of combustion; and thus he was enabled satisfactorily to account for the phenomena of combustion without phlogiston, the existence of which had never been proved.

323 His theory.

8. The principles of this theory are the following. No combustion can take place without the presence of oxygen, for it consists in the combination of the combustible body with oxygen. The oxygen of the atmosphere, which is in the state of an elastic fluid, exists in combination with caloric and light; and during the combustion, that is, the combination of the oxygen with the combustible body, the caloric and light are separated.

324 Difficulties attending it.

This theory is applicable to the explanation of the phenomena of combustion, in the more limited meaning of that term, i. e. as taking place in oxygenous gas. But when it is considered, that the process of combustion goes on between two solids, one of which contains oxygen in its combination, as, for instance, sulphur and nitre, difficulties arise in accounting for the heat and light, when the oxygen which combines with the combustible body is in the solid state. When it is considered also that oxygen unites slowly with metals, being condensed from the state of gas, without any extrication of heat or light, difficulties of another kind present themselves.

To remove these difficulties, and to explain the appearances, the theory of Lavoisier has been greatly modified, or new theories proposed.

325 Theory of Brugnatelli.

10. With this view a theory has been proposed by Brugnatelli. This theory supposes that oxygen exists in combination with bodies, in two states. In the one it is entirely deprived of its caloric and light, and in the other, it retains great part of the caloric and light, even in its combined, concrete state. It is simply called *oxygen* in the first case, when it is deprived of its caloric and light; in the latter it is denominated *thermoxygen*, when the caloric and light are combined with it in the concrete state. Thermoxygen, then, is a compound of oxygen and caloric in the concrete state. This caloric is different from that which holds the thermoxygen in the state of gas, and it is in the same relation to thermoxygen gas, as water is to crystallized salts. This thermoxygen only enters into the composition of acids, when it is deprived of its concrete caloric. But it combines with the metals in the state of thermoxygen; that is, united with the concrete part of caloric. Metallic substances, therefore, are denominated *thermoxides*.

In its union with metals, thermoxygen is either previously formed, or is in its nascent state, during the combination.

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Caloric. combination. In the latter case, the caloric which is disengaged by the chemical action, or that which is ppliaed to assist the combination, furnishes the necessary portion for the formation of the thermoxide; that is, the combination of oxygen containing caloric in its concrete state, with a metal. Thus it is, that some metals require the application of heat for their solution in concreted acids.

The base of pure air is in the state of thermoxygen, in its combination with water. The metals, therefore, which have a stronger affinity for it than for hydrogen, the other component part of water, readily combine with it, without the aid of external heat, in acids diluted with this fluid. Gaseous thermoxygen always gives out caloric, when it passes from the elastic to the concrete state; but as thermoxygen requires little caloric for its expansion, little is separated when it is condensed. We shall only add the author's explanation of the difference between atmospherical air and those substances which have the same constituent parts in different proportion. The difference between atmospherical air and nitric oxide gas, he supposes, is ascribed to the proportion of the constituent principles, and consequently, according to this hypothesis, the atmospherical air might be converted into that gas, by augmenting the proportion of oxygen gas, or by diminishing that of the azotic. But the difference between these two gases, according to the theory of Brugnatelli, consists in this, that in atmospherical air the azotic gas is combined with thermoxygen gas; but in nitrous gas, the azotic gas is combined with simple oxygen *.

* *Annal. de Chim.* vol. xxix. p. 182.

326 Theory which supposes the light to be given out by the combustible.

11. This theory, notwithstanding its ingenuity, is regarded by some merely as a plausible hypothesis, receiving little support from facts. We shall therefore leave it to the consideration of our readers, and proceed to state the principles of another, which is proposed to be substituted in place of the Lavoisierian theory, in explaining the phenomena of combustion. In this theory, it is supposed that the oxygen gas which is absorbed during combustion, furnishes the caloric, while the combustible body gives out the light which previously existed in it as a component part. In proof of this theory it is stated, that some bodies give out, during combustion, a greater quantity of light than others, even where the quantity of oxygen absorbed is less; that the colour of this light varies according to the nature of the combustible; and that vegetables which grow in the dark contain no combustible matter, being deprived of the light which is essentially necessary for its formation. This theory, which Gren calls *the theory of fire and combustion*, is distinctly detailed by him in the following words:

327 Light furnished by the combustible.

"I take here the word *fire* in the usual sense of common language, and understand by it that light which is combined with free caloric. *Combustion* is the extrication of fire with and by the decomposition of oxygen gas. Take the example of phosphorus. On its combustion two new products, the phosphoric acid and fire, arise from phosphorus and oxygen gas.

328 A theory must explain all the phenomena.

"In order that the theory of combustion be admissible, it must explain every circumstance by which this phenomenon is accompanied, and be in contradiction with none of them. It, besides, must not be inconsistent with any other fixed invariable law of nature.

"According to the *antiphlogistic system*, a combustible body is such as is possessed of the power of attracting, in a certain temperature, the oxygen of vital air more strongly than it is attracted by the caloric. Besides, in that system, oxygen gas does not merely consist of oxygen and caloric, but it likewise contains light, in a fixed state, as a constituent part.

"If, therefore, phosphorus, at the temperature requisite to its inflammation, be brought into oxygen gas, it robs the latter of its oxygen, and makes with it phosphoric acid; whilst the caloric and the basis, or matter of light, previously *latent* in the gas, are restored to liberty; and, combining together, produce the fire which flies off. Thus the oxygen gas is decomposed.

329 New body generated by combustion.

"A new body, the phosphoric acid, is now generated; and, because in many cases an acid is produced by the combustion of inflammable matters, this circumstance has induced modern chemists to denote the basis of vital air by the words *acidifying principle*, or *oxygen*; not on the ground that it is supposed to be sour of itself, but because it forms an acid only when combined with an *acidifiable basis*, as in our experiment with phosphorus. And it is on this account that, in this system, combustion has likewise received the name of *oxygenation*. But in the case (very often occurring) where the combustible matter imbibes oxygen, yet without becoming thereby an acid, the product is called *oxide* (also denominated *half-acid*), and the process is termed *oxydation*.

330 Acquires an increase of weight.

"Since the combustible substance takes up the ponderable basis of oxygen gas, and since, according to this system, both the caloric and light are imponderable, it is thereby accounted for, why the residue of burnt matters, the phosphoric acid, for instance, acquires an increase of weight equal to that portion of vital air which was decomposed.—If the inflammable substance be saturated with oxygen, it is rendered incapable of decomposing more oxygen gas, and the combustion is ended.

"When the combustion is performed in atmospheric air, it is then the azotic, either mingled or mixed with the oxygen gas, that prevents those phenomena from going on with the same vivacity as in pure oxygen gas; and likewise, as the azotic gas is not affected or acted on by the inflammable body, it is left as the residue of the atmospheric air.

331 Combustion a case of simple affinity in the old theory.

"Hence, by that system, the combustion of phosphorus in oxygen gas is effected by a simple affinity, and the principle of fire is not in the combustible body, but in the oxygen gas.

332 Explained by double affinity.

"However, from what I have stated of the composition of light, I cannot help thinking, that in combustion a double affinity takes place; and to explain this theory I shall select the example of phosphorus. That substance consists of the basis of light, called by me *phlogiston*, and making a constituent part of all combustible bodies united to a peculiar body, the *phosphoric-radical*.—*Oxygen gas* is a compound of *oxygen* and *caloric*.

"Now, when phosphorus is heated in this gas, and by this means the force of attraction between the phlogiston and the phosphoric-radical is sufficiently weakened, so that the attractive power between the radical of phosphorus and the oxygen may prevail, then

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Caloric. then the act of combustion ensues. The phosphoric basis attracts the oxygen, while the phlogiston of the phosphorus is attracted by the caloric of the oxygen gas. Thus, by virtue of this double affinity, two new compounds, the phosphoric acid and fire, arise from the two former combinations, phosphorus and oxygen gas.

"When the radical of phosphorus, and in general of any combustible body, has absorbed so much oxygen, that it is saturated with it, the combustion is arrived at its highest degree; and in the same manner it is ended, at the moment when all the quantity of oxygen gas, capable of being decomposed, is exhausted. By this it is explained, why, in a given volume of oxygen gas, only a certain quantity of phosphorus, and in general of every other combustible matter, can be consumed by fire.

"The increase of weight in the residue of the burnt substance is, in this phlogistic, or rather *eclectic system*, likewise explained by the access of oxygen; and the caloric and basis of light are likewise supposed to be both imponderable. The remaining azotic gas, not being acted upon by the combustible matter, is merely the residue of the atmospheric air.

333 Light given out without oxygen.

"Those that wish to be impartial, must allow that the light, in the *antiphlogistic system*, acts a part quite superfluous; that it may be thoroughly set aside without impairing the system; that by this system those phenomena cannot be explained, where light issues from combustible bodies without any access of vital air, (some instances of which will hereafter be given (z)); that the influence of light upon the growth and thriving of plants, upon the changes of their mixture during vegetation, and upon the alteration in the mixture of many other bodies, is by far too great, to allow oxygen gas to be considered as its only reservoir. Finally, it must be granted (an important point) that the antiphlogistic system does in no way explain the incidents preliminary to the process of combustion; and that it affords no argument to show why a certain degree of heat is necessary, in order that the combustible body be inflamed *."

* *Green's Chemistry*, vol. i. p. 135.

334 Three modifications.

11. Such then are the general facts with regard to combustion, and such are the theories which have been proposed, to account for the phenomena exhibited in this process. Three states or modifications have been distinguished in the act of combustion, namely, ignition, inflammation, and detonation.

335 Ignition.

a. Ignition, properly speaking, is rather a preliminary step, than a part of the process of combustion itself. A metallic substance, for instance, may become red hot when exposed to a certain temperature; but when it is cooled, it returns without change to its former state. In this case caloric and light are given out, but the body undergoes no farther change. There is no absorption of oxygen, which is one of the ordinary phenomena of combustion. But, with an increase of temperature, this also is effected, and the whole phenomena of combustion are exhibited; namely, the union of oxygen with the combustible body, and the emission of light and heat.

b. The second state or modification of combustion is called *inflammation*. This depends on the nature of the combustible body, owing partly to its strong affinity for oxygen, and partly to the slight affinity which exists between the particles of the combustible body. We have examples of this in the burning of sulphur or phosphorus, or a candle in the open air, or in oxygen gas.

336 Inflammation.

337 Detonation.

c. Detonation is another modification of combustion. It is a rapid and instantaneous inflammation, accompanied with explosion. This arises from the sudden formation of a vacuum, by the change of elastic fluids into the liquid state, or by the sudden evolution of elastic fluids from the solid state. Of the first we have an instance in the composition of water by the inflammation of oxygen and hydrogen gases, which is attended with a violent explosion, great condensation and the extrication of light and heat. Of the evolution of elastic fluids from solid bodies, we have a good instance in common gunpowder, from which an immense volume of elastic vapour is instantaneously extricated, which, by its expansive force being suddenly exerted, produces the explosion, and the irresistible effects of this powerful agent.

338 Combustible substances converted into acids,

339 or water,

340 or oxides.

12. All inflammable substances, Dr Black observes, are changed, during combustion, into one or more principles. From the combustion of some substances, as sulphur and phosphorus, an acid is obtained. From the combustion of others, as hydrogen with oxygen, water is the product; and in the case of metals, they are reduced to the state of oxide, or *calx*, as it was formerly called. After the combustible substance has been subjected to the process of combustion, it is totally changed in its properties, and no longer capable of exhibiting the phenomena of combustion.

Such, then, are the general properties and effects of light and heat, two of the most powerful agents, and of the most extensive influence, in all the changes and combinations which take place among bodies, by chemical actions. In many properties they resemble each other, but are totally different from all other kinds of matter. These bodies, possessed of a repulsive power among the particles of each other, are attracted by other bodies, and combine with them; and these combinations produce the most astonishing effects, giving new forms to matter, and inducing innumerable changes, which may be considered as constituting the principle and essence of some of the most sublime operations of nature, and many of the most important processes of art.

Connected with light and heat in many of their obvious properties, and also in many of the changes which they produce upon bodies, are electricity and galvanism; and with electricity at least, if not also with galvanism, the magnetic power possesses some common properties; and especially if some of these are to be considered, as some have supposed, only as modifications of the same substances which we have treated of, the discussion of these subjects would be properly introduced here; but according to the nature and arrangement of this work, each is to be fully detailed under its proper head. See ELECTRICITY, GALVANISM, and MAGNETISM.

CHAP.

(z) As in the case of the combination of sulphur and iron or copper.

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Chap. IV. Of OXYGEN.

341 Of great importance.

1. Oxygen is one of the most important agents in the chemical phenomena of nature, or in the processes of art. There is scarcely a single process in which it has not some share. Its nature and properties, therefore, ought to be early known.

342 A discovery of modern chemistry.

Oxygenous gas is one of the discoveries of modern chemistry. It was discovered by Dr Priestley in the year 1774, and received from him the name of *dephlogisticated air*. It was afterwards denominated *highly respirable air*. From Scheele, who discovered it in 1775, it received the name of *empyreal air*. It was called *vital air* by Condorcet; and Lavoisier gave it the name of *oxygen gas*, or *oxygenous gas*, by which it has since been generally distinguished.

343 Processes for obtaining it.

2. Oxygen gas is most easily obtained by the following process: *a*. Take a quantity of the native *oxide of manganese*; introduce it into the iron bottle A, fig. 3. to the neck of which apply the bent tube B, which is made to fit it exactly, and lute them together at the joining CD (A.). The bottle, thus prepared, is to be exposed to the heat of a furnace, or to that of an open fire. As soon as the heat is applied, the atmospheric air within the bottle is driven off; and, as the bottle becomes red hot, the quantity of air which passes over is greatly increased. Let the end of the tube connected with the bottle be introduced under the shelf in the pneumatic trough, and the bubbles of air will pass through the water, and may be received in jars filled with water, inverted over the opening in the shelf with their mouths immersed.

b. Oxygen gas may also be obtained by treating what is called in chemistry *the red oxide of mercury* in a similar manner.

c. This gas may be also readily procured, by introducing into a glass retort a quantity of the same substance (oxide of manganese) reduced to powder, adding an equal weight of sulphuric acid, and applying a moderate heat.

d. Or it may be obtained from the substance called *nitre* or saltpetre, exposed to a red heat, in an earthen or coated glass retort.

344 Nature of the process explained.

3. In all these methods of obtaining this gas, it is unnecessary to mention, that it must be received in the pneumatic apparatus, in the same way as has been directed for procuring it from the oxide of manganese, exposed to heat in the iron vessel; and, in whatever way it is obtained, the chemical change which takes place in these processes, is thus explained. Oxygen gas consists of two ingredients, the one, which is called its base, and the other *caloric*, or the matter of heat. In the oxide of manganese, this base is combined with the metallic substance; and when this compound is exposed to a sufficient temperature, the oxygen, having a greater attraction for caloric than for the metal, combines with it, and passes off in the state of gas. The same changes take place, when the process for obtaining the gas, by means of the red oxide of mercury, is employed. When the sulphuric acid, which is in the state of liquid, is added to the oxide of manganese, it combines with it at a lower state of oxidation, and becomes solid. But no liquid substance can become solid, without being deprived of the caloric necessary to retain it in the state of fluidity. The caloric which retained the sulphuric acid in the liquid state, combines with the oxygen of the manganese, assumes the fluid or gaseous form, and makes its escape. This is an example of double affinity. The sulphuric acid unites with a lower oxide of manganese, and forms a solid; while the caloric combines with the base of oxygen, and appears in the form of oxygen gas.

345 Properties.

4. Oxygen gas, thus obtained, possesses many of the properties of common air. It is colourless, invisible, elastic, and may be indefinitely expanded or compressed.

Oxygen gas possesses neither taste nor smell; its specific gravity, according to Mr Kirwan, is to that of water as 0.00135 to 1.0000. Being therefore 740 times lighter than its bulk of water, its weight to atmospherical air is in the proportion of 1103 to 1000; or 100 cubic inches of oxygen gas weigh 34 grs. while the same measure of atmospherical air weighs only 31 grs. the temperature being 60°, and the barometer being at 30 inches. According to Sir H. Davy's experiments, 100 cubic inches of oxygen gas weigh 35.05 grs.

Water does not sensibly absorb this gas. But by means of strong pressure, it may be made to combine with, and to retain in solution half its bulk. The water, thus impregnated, is not sensibly different from common water in taste or smell, but it is said to have proved a useful remedy in some diseases.

346 Combustion more brilliant in oxygen gas.

Combustible substances burn with greater brilliancy and rapidity in oxygen gas than in common air. Indeed it is owing to a certain quantity of the former, that the process of combustion goes on in the latter; and when the oxygen gas is exhausted, the process is interrupted. If a jar or phial is filled with this gas, a lighted candle introduced into it burns with greater splendour, and produces a greater degree of heat, than in a similar vessel filled with common air. If a candle be blown out, and while the snuff is red hot, introduced into a vessel filled with oxygen gas, it rekindles with a slight explosion, and burns with the same splendour. A candle in a vessel filled with oxygen gas burns much longer than in the same quantity of atmospherical air.

347 Animals live a longer time in it.

Oxygen gas is essentially necessary for respiration. No breathing animal can live in air which does not contain some proportion of oxygen gas. And the experiments of Dr Priestley and others prove, that animals live a much longer time in pure oxygen gas than in an equal bulk of atmospherical air. The experiments of Count Morozzo fully establish this fact. Into a vessel filled with common air, and inverted over water, he introduced a number of sparrows in succession, and observed the effects. The following are the results of his experiments:

	H.	M.
The first sparrow lived	3	0
The second	0	3
The third	0	1

The

(A) A lute, which answers this purpose sufficiently well, is composed of pipe clay and linseed oil well beaten together, and reduced to the consistence of glaziers putty. This is neatly applied to the joining, and if allowed to remain for eight or ten hours before it is exposed to the heat, it will afterwards bear the highest temperature.

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Oxygen.

The experiments were repeated by filling the same vessel with oxygen gas, and he obtained the following results:

	H.	M.
The first sparrow lived	5	23
The second	2	10
The third	1	30
The fourth	1	10
The fifth	0	30
The sixth	0	47
The seventh	0	27
The eighth	0	30
The ninth	0	22
The tenth	0	21

Two sparrows were then put in together; the one lived for an hour, but the other died in about 20 minutes.

348 Oxygen combines with bodies.

5. Oxygen combines with a great number of bodies, and forms compounds with them. It is always presented to us in a state of combination. In examining its properties, it is always as a compound; and these properties are only cognizable to our senses in that state.

When oxygen combines with metallic substances, they acquire new properties, and this combination is in chemical language denominated an *oxide*. Combined with many other substances, the nature of the substance is also changed, and the compound exhibits new properties. One of the most remarkable of these is the taste of the compound substance, which is often sour or acid; and because this circumstance was observed to be one of the most frequent and most remarkable which attend its combinations, the name of oxygen, or acidifying principle, was invented for it by Lavoisier. Oxygen gas is also necessary for the germination of the seeds of plants; and as the process of vegetation advances, it is given out in great abundance by the leaves during exposure to the solar ray. By this means the great waste of oxygen gas, in the processes of combustion and respiration, has been supposed to be fully repaired, and the balance between its consumption and supply to be preserved.

349 Origin of the name.

6. The following is the order of its affinity for the substances with which it enters into combination.

OXYGEN.
Charcoal,
Titanium,
Manganese,
Zinc,
Iron,
Tin,
Uranium,
Molybdena,
Tungsten,
Cobalt,
Antimony,
Hydrogen,
Phosphorus,
Sulphur,
Azote,
Nickel,
Arsenic,
Chromium,
Bismuth,
Lead,
Copper,
Tellurium,
Platina,
Mercury,
Silver,
Oxide of arsenic,
Nitrous gas,
Gold,
Muriatic acid,
White oxide of manganese,
White oxide of lead.

Azotic Gas.

CHAP. V. OF AZOTIC GAS.

1. AZOTIC gas was examined by Mr Scheele, the celebrated Swedish chemist, in 1776; and his experiments proved, that it is a fluid possessed of peculiar properties. It seems, however, to have been known to Dr Rutherford of Edinburgh, as early as the year 1772, as appears from his thesis published in that year, in which he treats of the effects of combustion and respiration on the atmosphere. 350 Discovery.

2. There are various methods by which this gas may be obtained. *a.* The process recommended by Berthollet is the following: Take a quantity of muscular flesh, or the fibrous part of the blood, which has been well washed. Cut the flesh into small pieces; introduce it into a retort, or a matrass to which a ground tube has been adapted. Pour over it diluted nitric acid, expose it to a heat of about 100°, and place the beak of the retort or the end of the tube in the pneumatic apparatus, that the gas which comes over may be received in proper vessels. The gas thus obtained, is *azotic gas*. *b.* If sulphuret of potash be exposed to the air of the atmosphere, inclosed in a bell-glass, over water; or, if sulphuret of iron be formed into a paste with water, and treated in the same way, and allowed to remain for some days, the quantity of air within the glass is greatly diminished, in consequence of part having been absorbed, and what remains is azotic gas. *c.* When the air of the atmosphere is inclosed in the same way, and exposed to the action of phosphorus, it also suffers diminution, part being absorbed. Azotic gas only remains. 351 Methods of procuring it.

3. Azotic gas, like common air, is invisible and elastic, and may be indefinitely condensed and dilated. Its specific gravity is less than that of atmospheric air It is estimated by Mr Kirwan at 0.00120, which is in the proportion of 985 to 1000; but according to Lavoisier's experiments, it is to atmospheric air as 942.6 to 1000, which makes its specific gravity only 0.00115. 352 Properties.

This gas is unfit for combustion. If into a jar or phial, filled with azotic gas, a lighted candle be introduced, it is immediately extinguished.

This gas is also extremely noxious to animals, and is therefore totally unfit for respiration.

4. No attempts which have yet been made have succeeded in decomposing azote, or the base of azotic gas. It must therefore be admitted among the number of simple substances. It has never been obtained in a separate state. It is therefore when it is combined with caloric, that is, in a gaseous state, that we are acquainted with its properties; and from its being unfit for respiration, it derived its name. From being the radical of the nitric acid, it is often named *nitrogen*. Some chemists have indeed considered it as a compound 353 Is a simple substance.

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Azotic Gas. compound substance. Dr Priestley supposed that it consisted of phlogiston and oxygen gas. On this account he called it *phlogisticated air*. According to the Stahlian theory, the process of combustion is the separation of phlogiston from the burning body. Oxygen gas having a strong affinity for phlogiston, combines with it during the combustion, and is even supposed to contribute to the separation of the phlogiston, by its affinity for it. And when this air is saturated with phlogiston, the process of combustion is at an end. The air that remains after this process is azotic gas. This theory, when first announced by Dr Priestley, was pretty generally received; but future experiments soon demonstrated, that the quantity of air in which a combustible body was burnt, diminished both in bulk and in weight; and therefore proved that the air, instead of receiving any addition, was on the contrary deprived of something.

Achard, about the year 1784, concluded, from some experiments which he had made, that azotic gas consists of water and fire. This theory has been supported by Westrumb, and more lately by Wiegleb. According to the experiments on which these chemists rest the truth of their theory, azotic gas is always the result when steam is made to pass through red-hot earthen, or even metallic tubes; but a series of very accurate experiments, instituted by the associated Dutch chemists, clearly proved that no azotic gas was produced, when the instruments employed were impenetrable by air *. Dr Priestley had long before shewn, that in similar experiments, when he employed earthenware retorts, containing moist clay, and exposed them to a temperature above boiling heat; instead of vapour issuing from the beak of the retort, a quantity of air, which was nearly equal in weight to the quantity of water introduced, passed over. The conclusion which he drew from these experiments, was, that the water was converted into air; for he found that it possessed nearly the same properties as common air. But he proved afterwards, by more accurate experiments, that water had made its way through the pores of the vessels, and that its place was supplied by the external air which was forced in by the pressure of the atmosphere. For it was clearly ascertained by the experiments of the Dutch chemists, that no gas was obtained, while perfectly sound glass or metallic tubes were employed.

* *Annal. de Chim.* vol. xxvi. p. 310.

Another theory has been proposed, of the composition of azotic gas, by Girtanner †. He supposes that azotic gas consists of hydrogen and oxygen gas, having a smaller proportion of oxygen gas than what enters into the composition of water ‡. But the experiments of other chemists, as Berthollet and Bouillon Lagrange, have afforded no such results (B).

† *Ibid.* vol. xxxiv. p. 3.

‡ *Ibid.* vol. xxxv. p. 23.

354 Combinations

355 with caloric.

5. There is no perceptible action between azotic gas and light. Combined with caloric, we have already seen it may be indefinitely expanded, but without undergoing any change in its properties.

Azotic gas, from its being found in such abundance in the air of the atmosphere, must act some important part in the economy of nature. It is given out, or seems to be given out, in great quantity, during the decomposition of animal and vegetable matters; but during these processes, it is the oxygen of the atmospherical air which is absorbed, and thus the residuary air is azotic gas. The base of azotic gas is unknown, and chemists are still unacquainted with its affinities.

Azotic gas combines with oxyen in different proportions, and forms compounds very different in their nature and properties. In one proportion it constitutes the air of the atmosphere; in another, what is called *nitrous oxide*, and in a third, *nitric oxide gas*. These we shall examine in their order in the following sections. 356 With oxygen in different proportions.

SECT. I. *Of Atmospheric Air.*

1. The air of the atmosphere is composed of azotic and oxygenous gases. It is an invisible elastic fluid, which may be indefinitely compressed and dilated. The specific gravity of atmospheric air is 0.0012, or about 816 times lighter than water. This is to be understood when the temperature is between 50° and 60°, and when the barometer is at 30 inches. The pressure of the air of the atmosphere is nearly equal to 15lb. on every square inch. 357 Properties.

2. Till the discoveries of modern chemistry, atmospheric air was considered one of the four simple elementary substances, of which all bodies are composed. But the experiments and researches of Priestley and of Scheele fully demonstrated the existence of two separate substances, totally distinct from each other in their nature and properties. Oxygenous gas, one of the component parts of atmospheric air, was, according to Dr Priestley, completely freed from phlogiston; and hence he calls it dephlogisticated air, which was in an eminent degree fit for respiration and combustion; but azotic gas, the other component part, was supposed to be saturated with phlogiston, and therefore unfit, as it was found to be, for these purposes. To the latter, the azotic gas, Scheele gave the name of *foul air*.

3. According to the experiments of Lavoisier, the proportions of the two gases which exist in atmospheric air, are 73 parts of azotic gas, and 27 of oxygen gas. But according to later experiments the proportions are found to be 78 of the former, and 22 of the latter, by bulk; or by weight, 74 and 26. 358 Proportions of azotic and oxygen gases

The proportions of these two gases in atmospheric air are uniform and constant. They have been found to be the same in all parts of the world, and in all seasons of the year. 359 always constant.

4. A question has arisen among philosophers concerning the constitution of the atmosphere, whether its component parts are to be considered merely as a mechanical mixture, or as a chemical combination. To the latter opinion the greater number of chemists are inclined, from the constancy of the proportions of the component parts of the atmosphere, these parts always being found in the same proportion at all heights, and never separating according to their specific gravities; from its possessing distinct properties; and from its continuing the same, whatever processes are carried on in 360 Constitution of the atmosphere. 361 Supposed to be a chemical combination.

(B) The component parts of water are oxygen and hydrogen, as we shall find afterwards.

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Azotic Gas. in it, or whatever proportions of oxygen may be absorbed during these processes.

362 or a mechanical mixture. A contrary opinion has been adopted by Mr Dalton, which he has endeavoured to establish by some very acute mathematical reasoning. According to his ingenious hypothesis, the elastic fluids which exist in the atmosphere have no mutual action whatever. The particles of one fluid are only attracted and repelled by each other, but are not acted upon by the particles of another fluid. The particles of the different fluids, with regard to each other, are subjected to the laws of inelastic bodies *.

* Manches. Mem. vol. v. p. 533.

Sect. II. *Of Nitrous Oxide Gas.*

363 Process for obtaining this gas. 1. This gas is most readily obtained by decomposing nitrate of ammonia, a salt composed of nitric acid and ammonia, the properties of which will be afterwards detailed. The crystals of this salt are put into a retort, and exposed to a temperature between 340° and 500°. It very soon melts after the heat is applied, and a great quantity of gas is emitted, at first in the form of white fumes, but afterwards transparent and colourless. This may be received in jars over water in the usual way. It is the nitrous oxide gas, the gaseous oxide of azotic, or, as it has been called by some, from the pleasurable sensations it excites on being respired, *the gas of paradise*. The first part of the gas which comes over is not quite so pure as the rest, which is given out slowly, and is transparent. When therefore it is respired, care should be taken to separate what comes off first, from the rest. This gas, as is obvious from the process, is obtained by the decomposition of the nitrate of ammonia; but the change which takes place will be better understood when we come to treat of the salt itself.

364 Discovery. 2. This gas was called by Dr Priestley dephlogisticated nitrous gas; and it was discovered by him in the year 1776. Its component parts were ascertained by the associated Dutch chemists; but its nature and properties were more fully and precisely investigated by Sir H. Davy *.

* Researches, 1800.

365 Properties. 3. In its physical properties, this gas resembles common air. It is elastic, transparent, and colourless. The specific gravity, as it has been estimated by Sir H. Davy, is 0.00197. One hundred cubic inches of it weigh 50.20 grains. Its component parts are 63.58 of azote, and 36.42 of oxygen; by measure, two volumes of azotic to one of oxygenous gas.

Some combustibles burn in this gas nearly as well as in oxygen gas, but with this difference, that they must be previously in a state of ignition.

Pyrophorus, which spontaneously inflames so low as the temperature of 40° in atmospheric air, will not burn in nitrous oxide gas, till it is raised to a temperature above 212°. A burning taper introduced into pure nitrous oxide gas, burns at first with a brilliant white light, and sparkles as in oxygen gas; but as the combustion goes on, the flame gradually lengthens, and is surrounded with a pale blue light. Phosphorus burns in it with a brilliancy much inferior to its combustion in oxygen gas.

366 Effects in respiring it. 4. It was at first supposed that this gas is unfit for respiration, but the experiments of Davy have shown the contrary; and the singular effects which it produces on the animal frame have excited much interest. From these experiments, and from many others which have been since repeated, it appears that it may be respired for some minutes without injury. In some cases it produces no effect whatever; but, in general, the sensations it excites are similar to those of intoxication; though rarely followed by its unpleasant effects. Sir H. Davy describes his own feelings when he respired this gas in the following words.

"Having previously closed my nostrils and exhausted my lungs, I breathed four quarts of nitrous oxide from and into a silk bag. The first feelings were giddiness, sense of fulness of the head, and indistinct sensation; but in less than half a minute, the respiration being continued, they diminished gradually, and were succeeded by a sensation analogous to gentle pressure on all the muscles, attended by a highly pleasurable thrilling, particularly in the chest and the extremities. The objects around me became dazzling, and my hearing more acute. Towards the last inspirations, the thrilling increased, the sense of muscular power became greater, and at last an irresistible propensity to action was indulged in; I recollect but indistinctly what followed; I know that my motions were various and violent.

"These effects very soon ceased after respiration. In ten minutes I had recovered my natural state of mind. The thrilling in the extremities continued longer than the other sensations.

"This experiment was made in the morning; no languor or exhaustion was consequent, my feelings throughout the day were as usual, and I passed the night in undisturbed repose *."

* Davy's Researches, p. 457.

But although it may be respired for a short time with impunity, not more than 3 or 4 minutes, yet animals that are confined in it soon become restless and uneasy, and at last expire. It is unfit for the support of animal life, and perhaps could not at all be respired, if the lungs were previously exhausted of atmospheric air.

367 Taste and smell. 5. The taste of nitrous oxide gas, when in a state of purity, is distinctly sweet to the tongue and palate; and it has an agreeable odour. Davy observes, that he often thought it produced a feeling somewhat analogous, as he expresses it, to taste in its application to the lungs; for in one or two experiments he perceived a distinct sense of warmth in the chest †.

† Ibid. p. 460.

368 Is absorbed by water. 6. Water absorbs nitrous oxide gas in considerable proportion. When the water is agitated, 0.54 parts of its bulk, or 0.27 of its weight, combine with it. The water becomes sweetish, and the whole of the gas may be expelled from it unchanged, by boiling.

7. No change takes place upon this gas by the action of light; except when it is exposed to a high temperature, as when the electric spark is sent through it, or when it is made to pass through a red-hot porcelain tube; it is then decomposed, and converted into common air and nitric acid.

Sect. III. *Of Nitric Oxide Gas.*

369 How procured. 1. If a quantity of pure copper filings be put into a matrass or retort, and diluted nitric acid be poured over them, a violent effervescence takes place, and a great quantity of gas is evolved. This is *nitric oxide gas*; sometimes

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Azotic Gas. sometimes called *nitrous gas*. It may be obtained also by substituting for the copper other metals, as iron, silver, and mercury.

This gas is mentioned by Dr Hales; but it is to the labours of Dr Priestley that we are indebted for a knowledge of its nature and properties.

370 Properties. 2. It is an elastic colourless fluid, without sensible taste, and does not redden the tincture of turnsole (c.)

According to Mr Kirwan, the specific gravity of nitrous gas is 0.001458, but by Davy's estimation it is 0.001343. The weight of 100 cubic inches of it is 34.26 grs. and it is composed of 53.40 oxygen, and 46.60 azote; or quantities which would make equal measures of these two principles in the state of gas ‡. This gas is totally unfit for respiration. Animals that breathe it are instantly suffocated.

‡ *Ibid.* p. 565.

Some combustibles burn in this gas. Phosphorus, when introduced into it in a state of active inflammation, burns with almost as much vividness as in oxygen gas ||. Homberg's pyrophorus, a substance which takes fire when exposed to the air, if introduced into this gas, instantly becomes red, and burns very vividly. In this experiment, and in the former with the phosphorus, these substances combine with the oxygen of the nitrous gas, while heat and light are emitted and azotic gas is left behind.

|| *Ibid.* p. 135.

371 Action of heat. 3. Nitric oxide gas, when exposed to the action of heat, by being made to pass through a red-hot porcelain tube, undergoes no change *. It is absorbed by water. When the water is freed from air, it absorbs about $\frac{1}{10}$ of its bulk of this gas, at the common temperature, and when it is boiled or frozen, the gas separates unchanged. The water thus impregnated has no peculiar taste, nor does it alter the colour of vegetable blues.

* *Lagrange*, vol. i. p. 122.

372 Combines with oxygen. 4. When a quantity of atmospheric air is introduced into a jar containing nitric oxide gas, a red colour appears from the mixture of the two gases; they are diminished in bulk, and heat is evolved. The product is nitrous acid. If oxygenous gas be employed instead of atmospheric air, the whole of the two gases will be converted into a liquid. The diminution of bulk is owing to the condensation of the elastic fluids, and the evolution of caloric must be ascribed to the change of state, from that of elastic fluid to that of liquid.

Azotic gas also enters into combination with oxygen in a different proportion from what has been stated above, forming nitrous and nitric acids; but these will come more properly to be treated of among the class of acids.

The following table exhibits at one view the different proportions of oxygen and azotic gases in the compounds formed by these two substances.

100 cubic inches.	Weight in grains	In 100 grains, Proportions of	
		Azote.	Oxygen.
Atmospheric air	31.10	73.00	27.00
Nitrous oxide	50.20	63.58	36.42
Nitric oxide	34.26	46.60	53.40
Nitric acid	76.00	25.97	74.03

Chap. VI. Of HYDROGEN.

Hydrogen

373 History. 1. This gas, in combination with carbon, has been long known under the name of the *fire-damp* of the miners. Its combustible property is described in the works of Boyle and Hales, of Boerhaave, and of Stahl; but it was not till the year 1766 that its properties were particularly ascertained, and the difference between it and atmospheric air pointed out by Mr Cavendish. Its properties and combinations were more fully investigated by Priestley and Scheele, Senebier, and Volta, under the name of *inflammable gas* or *air*. It is now distinguished by the name of hydrogen gas, and its base by that of hydrogen.

Like the two former, oxygen and azote, it is never obtained in an uncombined state. Its properties can only be examined in a state of gas.

2. Hydrogen gas may be obtained in a state of tolerable purity by the following process. Take one part of clean iron filings, and introduce them into a tubulated retort, and add two parts of sulphuric acid previously diluted with four times its bulk of water. A violent effervescence immediately takes place, and great abundance of air bubbles make their escape. Put in the stopper of the retort, place the beak of it under the shelf in the pneumatic trough, and let the gas which comes over be received in proper vessels. The gas thus obtained is *hydrogen gas*, which is distinguished by the following properties. 374 Method of procuring.

3. In its physical character it resembles common air. It is invisible and elastic, and may be indefinitely compressed and expanded. 375 Properties.

Its specific gravity has been variously estimated, owing, perhaps, to its different degrees of purity. According to Lavoisier, it is 0.000094, which is nearly 12 times lighter than atmospherical air; but according to Mr Kirwan, it is 0.00010.

Hydrogen gas is unfit for supporting combustion. If a lighted candle be suddenly plunged in a vessel filled with hydrogen gas, it is immediately extinguished; or if an inverted jar filled with it be suddenly brought over a lighted candle, it is extinguished in the same way. The latter experiment is the most effectual, on account of the small specific gravity of the gas, which is prevented from escaping by rising upwards when the jar is inverted.

It is also unfit for respiration.

When small animals are inclosed in a vessel filled with this gas, they are soon thrown into convulsions, and expire. Scheele, however, who first made the attempt, breathed it several times without much injury. Fontana made the same experiment, and he supposes that this was owing to the common air present in the lungs before respiration of the hydrogen gas: for when he made a full expiration, before he began to breathe the hydrogen gas, he could only inspire it three times, and these three produced great languor and oppression in the breast. This was confirmed by Sir H. Davy, who, in some experiments on himself found, that, after having exhausted the lungs as much as possible, he could

(c) This is a test for acid substances, which will be mentioned particularly afterwards.

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Hydrogen. could not respire this gas for half a minute. It produced uneasy feelings in the chest, momentary loss of muscular power, and sometimes a transient giddiness *. From these experiments it may be concluded, that hydrogen gas is totally incapable of supporting animal life.

* Davy's Researches, p. 401.

376 Is combustible. 4. But although hydrogen gas be unfit for the support of combustion, or for respiration, yet it is itself a highly combustible substance. If a jar be filled with hydrogen gas, and a burning taper be applied, the gas will take fire, and burn with a flame which is more or less coloured according to the purity of the gas. When the gas is in the purest state that can be obtained, it is of a dilute or blackish white colour; but when it holds charcoal in solution, it is of a reddish or bright white colour.

377 Combines with water only by pressure. 5. Hydrogen gas, if other gases be entirely excluded, undergoes no change when it is kept in contact with water, nor is any part of it absorbed by the water: But when artificial pressure is employed, water is said to absorb a third part of its bulk of the gas. 378 A remedy in disease. No perceptible change is observed in the taste of the water thus impregnated with hydrogen gas; it is recommended by Mr Paul as beneficial in nervous disorders, and in inflammatory fevers †.

† Phil. Mag. vol. xv. p. 93.

379 Employed in balloons. Hydrogen gas, on account of its being so much lighter than atmospheric air, has been employed for the purpose of filling air balloons. When perfectly pure, it is 12 or 13 times lighter than the same bulk of atmospheric air; but, in the usual way of obtaining it, the specific gravity of hydrogen gas is only seven or eight times less than that of common air. See AEROSTATION.

380 Explodes. 6. If hydrogen gas and atmospheric air be mixed together, they remain unaltered; but if one part of oxygen gas, and two parts of hydrogen gas be introduced into a phial, and a burning taper be applied to its mouth, the mixed gases will explode with a loud noise, and the 381 With atmospheric air. bulk will be greatly diminished. The whole of the oxygen of the atmospheric air disappears, and the azotic gas only remains. 382 And with oxygen gas. If one part of oxygen gas and two parts of hydrogen gas be mixed together in a phial, and exploded in the same way, they both disappear. This may be proved by mixing the two gases in a jar over water or mercury, and exploding them by means of the electric spark. The gases disappear; a vacuum is consequently formed in the jar, and the water or the mercury, by the pressure of the air, is forced up. If the experiment has been made over mercury, and if the inside of the jar was previously free from moisture, drops of water will appear, which have been formed by the combination of the two gases. Water, therefore, is composed of oxygen and hydrogen gas. This is a case of true combustion. Oxygen combines with the combustible body; light and caloric are evolved, and the result of this action and combination is one of the products of combustion, namely water. The discovery of the composition of water, undoubtedly one of the most important in modern chemistry, will be the subject of the following section.

SECT. I. *Of Water.*

1. Water acts so important a part in many chemical combinations, that its nature and properties should be early known. 383 Importance in chemistry. Before the discoveries of modern chemistry, it was considered as a simple substance, and one of the four elements which enter into the constitution of all bodies in nature.

The fortunate discovery of the composition of water, is undoubtedly one of the most important which has been made in chemical science. We have already mentioned, that the product of oxygen and hydrogen gases, when exploded together, is water; but in a subject of so much importance, it will be necessary to enter more into detail; and this we shall do, 1st, by stating the experiments forming the proofs of its composition; and, 2dly, by giving a short historical view of the progress of the discovery.

2. Various experiments have been made to ascertain this fact; but those which were made by Lavoisier being on a larger scale, and performed with such precautions as to insure accuracy and precision, an account of them will be the more satisfactory.

1. *Proof of the Composition of Water.*

384 Proof of the composition of water by analysis. *Exper. a.* Take a porcelain or glass tube from 8 to 12 lines diameter, and place it across the furnace EFCD, with a gentle inclination from E to F (D). The higher extremity of the tube is then luted to the glass retort A, containing a known quantity of distilled water. To the lower extremity F is luted the worm SS, the lower end of which is fixed in the neck of the bottle H, which bottle has the bent tube KK fixed to a second opening. Plate CXLII. Fig. 5. This bent tube is intended to carry off any elastic fluids which may escape into the bottle H. A fire is then lighted in the furnace EFCD, sufficient to keep the tube EF red hot, but not to melt it. The water in the retort A is kept boiling by a fire in the furnace VVXX. The water is gradually changed into steam by the heat of the two furnaces. It passes through the tube EF into the worm SS, where it is condensed, and then drops into the bottle H. When the whole water is evaporated, and all the communicating vessels are emptied into the bottle H, it is found to contain exactly the same quantity which was put into the retort. This experiment therefore is a simple distillation.

Exper. b. Every thing being disposed as in the last experiment, let 27 grains of pure charcoal, broken into small parts, and which has been exposed to a red heat in a close vessel, be introduced into the tube EF. The experiment is then performed in the same manner as the former. The water is evaporated, and a portion of it is again condensed in the worm SS, and then falls into the bottle H; but at the same time a considerable quantity of an elastic fluid escapes through the tube KK, which is received in vessels. When the water

(D) The tube EF, if of glass, should be such as can bear a strong heat without melting. It should also be coated over with a lute composed of clay and powdered stone-ware; and to prevent it from bending during the experiment, it must be supported about the middle by an iron bar.

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Hydrogen. ter is entirely evaporated, and the tube examined, the 28 grains of charcoal have wholly disappeared.

When the water in the bottle H is examined, it is found to have lost 85.7 grains of its weight; and when the elastic fluid which passed off by the tube KK is weighed, it is found to weigh 113.7 grains, which is exactly the weight which the water has lost, added to the 28 grains of charcoal which had disappeared. The elastic fluid, on examination, is discovered to be of two kinds; namely, 144 cubical inches of carbonic acid gas weighing 100 grains, and 380 cubical inches of a very light gas weighing only 13.7 grains. Now 100 grains of carbonic acid gas consist of 72 grains of oxygen, combined with 28 grains of carbon. It is therefore evident, that the 28 grains of charcoal must have acquired 72 grains of oxygen from the water. It is also evident, that 85.7 grains of water are composed of 72 grains of oxygen, combined with 13.7 grains of a gas capable of being burned.

Exper. c. Every thing being put in the same order as in the two former experiments, with this difference, that instead of the 28 grains of charcoal, 274 grains of soft iron, in thin plates rolled up spirally, are introduced into the tube EF. The tube is kept red hot while the water is evaporating from the retort.

After the water has been distilled, it is found to have lost 100 grains. The gas or elastic fluid weighs 15 grains, and the iron has gained 85 grains of additional weight, which put together make up 100 grains, the weight which the water has lost. The iron has all the qualities which it would have received by being burned in oxygen gas. It is a true oxide (or calx) of iron. We have the same result as in the last experiment, and have therefore another proof for concluding, that 100 grains of water consist of 85 grains of oxygen, and 15 of the base of hydrogen gas.

We have now exhibited two sufficient proofs, that water is composed of oxygen and hydrogen; but as the composition of water is so interesting and important a subject, M. Lavoisier was not satisfied with these proofs

385 Proved by synthesis.

alone. He justly concluded, that if water be a compound of two substances, it ought to follow, that by reuniting these two substances, water would be produced. He accordingly proved the truth of this conclusion by the following experiment.

Exper. d. He took a large crystal balloon A, fig. 4. containing about 30 pints, and having a large mouth; round which was cemented the plate of copper BC, pierced with four holes, through which four tubes pass. The first tube H *h* is intended to exhaust the balloon of its air, by adapting it to an air pump. The second tube *g g* communicates with a reservoir of oxygen gas placed at MM. The third tube *d* D ꝺ is connected with a reservoir of hydrogenous gas at NN. The fourth tube contains a metallic wire GL, having a knob at its lower extremity L, from which an electric spark is passed to ꝺ, in order to set fire to the hydrogen gas. The metallic wire is moveable in the tube, that the knob L may be either turned towards ꝺ, or away from it, as there is occasion. We must also add, that the three tubes H *h*, *g g*, *d* D ꝺ are furnished with stopcocks.

It is necessary that the oxygen gas, before being put into the reservoir, should be completely purified from carbonic acid. This may be done by keeping it for a long time in contact with a solution of caustic potash. The hydrogen gas ought to be purified in the same manner. The quantity employed ought to be double the bulk of the oxygen gas. It is best procured from water by means of iron, as was described in Experiment Third.

Great care must also be taken to deprive the oxygen and hydrogen gas of every particle of water. For this purpose they are made to pass in their way to the balloon A, though salts which have a strong attraction for water; as the acetite of potash (a compound of vinegar and vegetable alkali), or the muriate or nitrate of lime (the muriatic or nitric acid combined with lime). These salts are disposed in the tubes MM and NN of one inch diameter, and are reduced only to a coarse powder, that they may not unite into lumps, and interrupt the passage of the gases.

Every thing being thus prepared for the experiments, the balloon is exhausted of its air by the tube H *h*, and is filled with oxygen gas. The hydrogen gas is also pressed in through the tube *d* D ꝺ by a weight of one or two inches of water. As soon as the hydrogen gas enters the balloon, it is kindled by an electric spark. The combustion can be kept up as long as we please, by supplying the balloon with fresh quantities of these two gases. As the combustion advances, a quantity of water is collected on the sides of the balloon, and trickles down in drops to the bottom of it. By knowing the weight of the gases consumed, and the weight of the water produced, we shall find that they are precisely equal. M. Lavoisier and M. Meusnier found that it required 85 parts by weight of oxygen gas, and 15 parts of hydrogen gas, to produce 100 parts of water.

Thus we have complete proofs, both analytical and synthetical, that water is not a simple elementary substance, as it had been long supposed, but is compounded of two elements, oxygen and hydrogen.

But although the knowledge of the component parts of water was finally confirmed by Lavoisier and his friends, we shall find that science is indebted for the origin and progress of this discovery, chiefly, if not entirely, to the English philosophers.

2. *History of the Discovery of the Composition of Water.*

1. So early as the year 1776, an experiment was made by Macquer, to ascertain what would be the product of the combustion of hydrogen gas. He accordingly set fire to a bottle full of it, and held a saucer over the flame, but no soot appeared upon it as he expected, for it remained quite clean; and was bedewed with drops which were found to be pure water. Various conjectures were now formed about the nature of the product of the combustion of oxygen and hydrogen gases. By some it was supposed to be carbonic acid gas; by others it was conjectured it would be the sulphurous or sulphuric acid. The latter was the opinion of M. Lavoisier. Such were the experiments and opinions of the French chemists, previous to the year 1781. 386 Combustion of hydrogen yields water. 387 Conjectures.

2. About the beginning of that year, Mr Warltire, a lecturer in natural philosophy, had long entertained an opinion that the combustion of hydrogen gas with atmospheric air might determine the question, whether heat 388 Experiment by Warltire and Priestley.

Hydrogen. heat be a heavy body. Apprehensive of danger in making the experiment, he had for some time declined it; but was at last encouraged by Dr Priestley, and accordingly prepared an apparatus for the purpose. This was a copper vessel properly fitted, and filled with atmospherical air and hydrogen gas, which was exploded by making the electric spark pass through it. A loss of weight of two grs. was observed after the combustion. A similar experiment was repeated in close glass vessels, which, though clean and dry before the combustion, became immediately wet with moisture, and lined with a sooty matter. This sooty matter, Dr Priestley afterwards supposed, proceeded from the mercury which had been employed in filling the vessel.

389 By Cavendish.

3. During the same year, Mr Cavendish repeated the experiments of Mr Warltire and Dr Priestley. He performed them several times with atmospheric air and hydrogen gas, in a vessel which held 24,000 grs. of water, and he never could perceive a loss of weight more than $\frac{1}{5}$ gr. and often none at all. In all these experiments, not the least sooty matter appeared. To examine the nature of the dew which appeared in the inside of the glass, he burnt 500,000 grain measures of hydrogen gas with about $2\frac{1}{2}$ times that quantity of common air; and in this combustion he obtained 135 grs. of water, which had neither taste nor smell; and when it was evaporated, left no sensible sediment.

In another experiment, he exploded in a glass globe, 19,500 grain measures of oxygen gas, and 37,000 of hydrogen gas, by means of the electric spark. The result of the experiment was 30 grains of water, which contained a small quantity of nitric acid. The experiments of Mr Cavendish were made in the year 1781, and they were undoubtedly conclusive with regard to the composition of water.

390 Mr Watt's views.

4. It would appear, that Mr Watt entertained the same ideas on this subject. When he was informed by Dr Priestley of the result of these experiments, he observes; "Let us consider what obviously happens in the deflagration of hydrogen and oxygen gases. These two kinds of air unite with violence, they become red hot, and when cooling totally disappear. When the vessel is cooled, a quantity of water is found in it equal to the weight of the air employed. The water is then the only remaining product of the process; and water, light, and heat, are all the products, unless there be some other matter set free, which escapes our senses. Are we not then authorised to conclude, that water is composed of oxygen and hydrogen gases, deprived of part of their latent or elementary heat; that oxygen gas is composed of water, deprived of its hydrogen, and united to elementary heat and light; and that the latter are contained in it in a latent state, so as not to be sensible to the thermometer or to the eye. And if light be only a modification of heat, or a circumstance attending it, or a component part of the hydrogen gas, then oxygen gas is composed of water deprived of its hydrogen, and united to elementary heat *."

* *Philos. Trans.* 1784, p. 383.

Thus it appears that Mr Watt had a just view of the composition of water, and of the nature of the process by which its component parts pass to a liquid state from that of an elastic fluid.

5. Towards the end of the same year, M. Lavoisier had made some experiments, the result of which surprised him; for the product of the combustion of the oxygen and hydrogen gases, instead of being sulphuric or sulphurous acid, as he expected it, was pure water. This led him to procure an apparatus, with which the experiment might be performed on a large scale, and with more accuracy and precision. Accordingly the experiments, which we have already detailed were performed on the 24th of June 1783, in presence of several academicians, and also of Sir Charles Blagden, who who was at that time in Paris. A similar experiment was afterwards performed by M. Monge, with the same result; and it was repeated again by Lavoisier and Meusnier, on a scale so large as to put the matter beyond a doubt. The conclusion, therefore, from the whole was (as has been stated in detailing the experiments themselves), that water is composed of oxygen and hydrogen; and this fact, we believe, since Dr Priestley's death, is universally admitted.

391 Lavoisier's experiments. Hydrogen.

6. If farther proofs were necessary to establish the fact, we might refer the reader to an elaborate memoir on the combustion of hydrogen gas in close vessels by the celebrated chemists Fourcroy, Vauquelin, and Seguin, which was read at the academy of sciences in the year 1790 *. 392 Fourcroy's, &c.

* *Annal. de Chim.* vol. viii. p. 230.

7. Water exists in three different states; in the solid state or state of ice; in the liquid, and in the state of vapour or steam. Its principal properties have already been detailed, in treating of the effects of caloric. It assumes the solid form when it is cooled down to the temperature of 32°. The specific gravity of ice is less than that of water. 293 Water in three states. 394 Ice.

When ice is exposed to a temperature above 32°, it absorbs caloric, which then becomes latent, and is converted into the liquid state, or that of water. At the temperature of 40°, water has reached its maximum of density. According to the experiments of Lefevre Gineau †, a French cubic foot of distilled water, taken at its maximum of density, is equal to 70lb. 223 grs. French, = 529,452.9492 troy grains. An English cubic foot at the same temperature weighs 437,102.4946 grains troy. By Professor Robison's experiments it is ascertained, that a cubic foot of water at the temperature of 55° weighs 998.74 avoirdupois ounces, of 437.5 grains troy each, or about $1\frac{1}{4}$ ounce less than 1000 avoirdupois ounces. 395 Water or liquid.

† *Journ. de Phys.* tom. xlix. p. 171.

When water is exposed to the temperature of 212°, it boils; and if this temperature be continued, the whole is converted into an elastic invisible fluid, called vapour or steam. This, as has been already shewn, is owing to the absorption of a quantity of caloric, which is necessary to retain it in the fluid form. In this state it is about 1800 times its bulk when in the state of water. This shews what an expansive force it must exert when it is confined, and hence its application in the steam engine, of which it is the moving power. 396 Vapour.

Sect. II. *Of Ammonia.*

Hydrogen also enters into combination with azote, and forms a compound of great importance. When hydrogen and azotic gases are mixed together, no change takes place, nor has any process been yet discovered by which these two gases can be directly combined; but when

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Carbon. when in their nascent state, as it is called, or in the moment of evolution from the bodies with which they are formerly in combination, they unite together and form ammonia, or the volatile alkali. It is demonstrated also, by direct experiment, that this substance is composed of these two gases; but for the properties of it, we must refer to the chapter on alkalies, where they will be fully detained.

Chap. VII. Of CARBON.

397 The diamond combustible. 1. It may appear at first sight surprising, that the diamond, one of the hardest and most indestructible substances in nature, should be arranged among combustible bodies. This, however, was conjectured by Newton, when he considered its great refracting power, referring it to the general law, that combustible bodies have this power in greatest perfection. The sagacious conjecture of this great philosopher has been fully verified. The first experiment to ascertain the combustibility of the diamond was made in the year 1694, in the presence of Cosmo III. grand duke of Tuscany, by the
398 Proved by experiment. Florentine academicians. In this experiment, the diamond, exposed to the heat of a burning-glass, first became dull and tarnished, lost weight, and was at last entirely dissipated, without the smallest residue. Some years afterwards, a series of experiments was made before Francis I. emperor of Germany, in which diamonds were consumed in the heat of a furnace. In the year 1771, Macquer first observed the diamond swell up and burn with a very sensible flame. Rouelle the younger, Cadet, Mitouart, and Darcet, repeated the same experiments, all which tended to establish the volatility and combustibility of the diamond.

But it is to the celebrated Lavoisier that we are indebted for ascertaining the nature and product of this combustion.

399 Found in the torrid zone. 2. But for the sake of comparison we shall mention some of the general properties of the diamond. This precious stone is found in the warmer regions of the earth, and chiefly in the East Indies and the Brazils. It is found crystallized in regular octahedrons, which is its primitive form; that of the integrant molecules
400 Form. is the regular tetrahedron. The most common form is the six-sided prism, terminating in a six-sided pyramid. What are called spheroidal diamonds have 48 curvilineal, triangular faces, which form of crystal is owing, according to Hauy, to a regular decrement, which may be determined by caculation. The lapidaries are well acquainted with the direction of the laminæ of the diamond, because in that direction it is found to be most easily polished. The hardest diamonds are found to have their fibres twisted, which by the lapidaries are called *natural* diamonds.

401 Properties. 3. The diamond is the hardest body known. It can only be polished with the powder of itself, which is procured by rubbing one diamond against another. The specific gravity of the diamond is 3.5, water being 1. Its most remarkable property is brilliancy. When exposed to the light of the sun for some time, and afterwards carried into a dark place, it appears luminous, so that it has the property of absorbing light. It becomes very sensibly electric by friction, and is therefore a nonconductor of electricity.

402 Product of its combustion. 4. As it was now ascertained, that the diamond exposed to a strong heat was susceptible of combustion, and might be entirely dissipated, Lavoisier directed his attention in the year 1772 to discover the product which was thus obtained; and he found by experiment, that the quantity of the diamond, exposed to the heat of a burning-glass in oxygen gas, consumed, was in exact proportion to the quantity of air absorbed. The air was converted into carbonic acid gas (F). The quantity of the carbonic acid obtained being found proportional to the quantity of diamond consumed, it was concluded that diamond was nothing else but pure carbon. This furnished a striking analogy between the diamond and charcoal, from the combustion of which a similar product is obtained. An experiment made by Guyton in the year 1785, and a similar one repeated in 1797 by Mr Tennant, proved that the diamond is combustible, and that it burns like charcoal when thrown into melted nitre. The conclusion from which was, that the diamond and charcoal consist of the same substance.

403 A simple substance. 5. We shall find, in investigating the properties of charcoal in the following section, that the one is a simple the other a compound substance, which will enable us to explain the remarkable difference between many of the properties of the diamond and charcoal.
404 Compared with charcoal, which is a compound. Charcoal burns in the heat of an ordinary fire, but the diamond requires for its combustion a temperature not less than 5000°; nor is the difference between these two bodies in specific gravity, hardness, and colour, less striking. Lavoisier had ascertained that 100 parts of carbonic acid contained

28	charcoal,
72	oxygen.
100	

In the experiments made by Guyton on the diamond, it appeared that carbonic acid gas is composed of

17.88	diamond,
82.12	oxygen.
100.00*.	

* *Ann. de Chim.* tom. xxi. p. 99.

If then 100 parts of carbonic acid gas are composed of the same proportions of constituent parts, and these proportions are obtained both by the combustion of the diamond and charcoal, it must necessarily follow that the charcoal, which requires a smaller proportion of oxygen to make up the 100 parts of carbonic acid gas, must contain the difference of the quantity of oxygen between the quantity with which it combines, and the quantity necessary to saturate the diamond. Hence it was inferred, that 100 parts of charcoal consist of 63.86 diamond, and 36.14 oxygen. But in more recent and more

(F) Carbonic acid gas, as will appear afterwards, is composed of carbon and oxygen.

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Carbon. more accurate experiments, it is found that the purest charcoal contains no oxygen whatever; and that it differs from diamond only in compactness of texture. From this account, therefore, of the nature and properties of the diamond, it must be considered as a simple substance, and that substance which has received the name of carbon in the new chemical nomenclature; or pure charcoal in a highly condensed form.

405 Charcoal very abundant. 1. Charcoal exists in great abundance in animal and vegetable matters, and it is obtained by the partial decomposition of these substances. It may be procured by burning wood in close vessels; and the matter that remains after this combustion is a black, shining, brittle substance, which is well known under the name of charred wood, or charcoal.

406 Method of preparing and purifying. To obtain charcoal pure, it must be repeatedly washed with pure water, and be afterwards exposed for some time to a strong heat in close vessels. Thus prepared, if it be entirely deprived of moisture and excluded from air, it may be exposed to the strongest heat without any change.

407 Properties. 2. Charcoal is a good conductor of electricity. When it is new made, it is found to have the property of removing the disagreeable odour with which animal matters beginning to putrify, clothes and other substances, are tainted. On account of this property, perhaps, and also on account of its mechanical effects, it is greatly recommended as an excellent tooth powder. Charcoal seems to be quite indestructible. Hence charring is the best method of preserving wood from decay, which is exposed to the effects of air and moisture. Stakes charred on the outside have remained in the ground for some thousand years, and are still in perfect preservation. This seems to have been a common practice among the ancients.

3. Charcoal has neither taste nor smell. It is insoluble in water, but it absorbs moisture in considerable proportion. When well dried, charcoal attracts the air very greedily. A piece of charcoal well dried, placed under a jar over mercury, absorbs the air, and the mercury ascends rapidly; but if a little water be introduced into the jar, the charcoal absorbs the moisture, gives out the air, and the mercury descends. In some experiments made with this view, it appeared that charcoal absorbed four times its bulk of air; and when the charcoal was plunged into water, a fifth part of this air was disengaged, which being examined, a quantity of oxygen had disappeared. In another experiment, the charcoal was introduced into a vessel filled with oxygen gas, when it absorbed eight times its bulk of the gas, and being plunged into water, gave out a fourth part. These experiments were made by Delametherie †.

† *Journ. de Phys.* vol. xxv.

The experiments of Senebier seem to prove, that it was only the oxygen gas of the atmospheric air that was absorbed by charcoal; but it has been since demonstrated, that this only takes place when the charcoal is hot. The atmospheric air is absorbed unchanged when the charcoal is cold.

408 Chemical habitudes. 4. When the temperature of pure charcoal is raised to redness, and if it be then introduced into a jar of oxygen gas, it burns rapidly, giving out brilliant sparks, but with little flame. The charcoal disappears, and the oxygen gas is totally changed. By its combination with the charcoal during the combustion, it is converted into a peculiar gas, which has received the name of *carbonic acid gas*, the component parts of which were discovered by M. Lavoisier, to be

28 charcoal,
72 oxygen.

100

The properties of this acid will be fully described in its place among the class of acids.

There is no direct action between carbon and azotic gas; but by the action of a third substance. Compounds of azote, hydrogen and carbon, which are combined also with a greater or lesser proportion of oxygen, frequently exist among vegetable and animal matters.

SECT. I. *Of the* COMBINATIONS *of* CARBON *with* OXYGEN, *particularly* CARBONIC OXIDE GAS.

Carbon enters into combination with oxygen in two proportions. 1. In that which forms carbonic oxide gas. 2. In that which forms carbonic acid gas. Of the first of these we are now to treat: the other will be considered under the head of ACIDS.

1. A peculiar inflammable gas, which was at first 409 History.
considered of the same nature with the carbonated hydrogen gas to be described in the next section, was announced by Dr Priestley, from the manner of its production and properties, as a confirmation of the truth of the phlogistic theory. His experiments were soon repeated by many other chemists, and particularly by Mr Cruickshank of Woolwich, who published a very satisfactory account of the nature, composition, and properties of this gas. He gave it the name of the *gaseous oxide of carbon*. He considered it as consisting of carbon united with oxygen; the oxygen and carbon existing in it being nearly in the proportion of two to one. Dr Priestley obtained it from the grey 410 Methods of procuring.
oxide or forge scales of iron and charcoal. Mr Cruickshank also obtained it by a similar process. He employed the oxides of zinc and copper; the black oxide of manganese and litharge. The gas which is obtained from these substances is a mixture of carbonic acid and carbonic oxide. Mr Cruickshank found, that the oxides which most readily part with their oxygen, afford the greatest proportion of carbonic acid; but the oxides which retain their oxygen more strongly, give the greatest proportion of the carbonic oxide. At the beginning of the process, carbonic acid comes over in greatest abundance; it then diminishes, and afterwards carbonic oxide is extricated pure.

It is also obtained by exposing to a strong heat one part of pure charcoal and three parts of carbonate of lime, strontites, or barytes, in an iron retort. The carbonic acid which is in combination with the earths is partly disengaged unchanged, and partly decomposed by the charcoal, and converted by the action of this substance into the carbonic oxide. The gas which is obtained in this process is composed of one part of carbonic acid and five parts of oxide ‡.

‡ *Annal. de Chim.* tom. xxxix. p. 45.

The same gases are also obtained, by employing iron filings with the earthy carbonates, and the quantity is considerably increased when pure iron is used. Mr Cruickshank and the French chemists also obtained

Carbon. ed it, by making carbonic acid gas pass through red-hot charcoal in an iron or porcelain tube. The carbonic acid is decomposed, and the gaseous oxide is formed.

The carbonic acid which is mixed with the carbonic oxide obtained in all these processes, may be separated by washing the gas with lime water, and the oxide remains in a state of purity.

411 Properties. 2. This gas is invisible and elastic like common air. Its specific gravity is 0.001167; 100 cubic inches weigh 30 grains.

It is unfit for respiration. Small animals introduced into it are instantaneously suffocated; and in some persons who attempted to breathe it, it produced faintness and giddiness. Desormes and Clement think that it is probably owing to this gas disengaged from burning charcoal, that sudden death is induced in close apartments. It is not altered by passing it through a red-hot tube, nor does it undergo any change by being exposed to light; and it is neither inflamed nor diminished by passing the electric spark through it. This gas in contact with common air, when set fire to, burns with a blue flame. When made to traverse a red-hot tube full of air, it produces slight detonations. The residue of these combustions is carbonic acid and azote.

3. With oxygen gas, if in considerable proportion, the combustion is very rapid; a red flame is produced, and the whole of the gas is consumed. The residue in this combustion is carbonic acid †.

† Ibid. p. 58.

According to Mr Cruickshank, the carbonic oxide is a compound of carbon and oxygen. Thirty grains of it obtained from charcoal and metallic oxides, required 15 grains of oxygen to saturate it, and the quantity of carbonic acid produced was 35.5. Thirty grains obtained from iron filings and earthy carbonate, required 13.6 grains of oxygen, which gave 43.2 grains of carbonic acid.

4. But according to the experiments and conclusions of Berthollet, this gaseous oxide of carbon contains a certain portion of hydrogen in its composition. This quantity, he thinks, amounts to about $.04 = \frac{1}{25}$. He distinguishes two species of inflammable gas, which contain carbon; the one consists entirely of hydrogen and carbon, which he proposes to denominate *carbonated hydrogen gas*, which will be treated of in the next section. The other species of inflammable gas is also formed of hydrogen and carbon, but contains a certain portion of oxygen. To this he proposes to give the name of oxycarbonated hydrogen gas. But the results of the experiments of Cruickshank and others do not correspond with the experiments and conclusions of Berthollet, in admitting any proportion of hydrogen as a component part of his oxycarbonated hydrogen gas, or of carbonic oxide gas. For an account of his observations and reasonings on this subject, see *Memoires de l'Institut. Nationale*, tom. iv. p. 269. 319, and 325.

Sect. II. *Of Carbureted Hydrogen Gas.*

412 Method of procuring. 1. If a quantity of wet charcoal be introduced into a retort, and exposed to a red heat, a great quantity of gas passes over, which may be collected in jars in the pneumatic apparatus in the usual way. It may be also obtained by making the vapour of water pass through red-hot charcoal in a porcelain or iron tube placed across a furnace. The water is decomposed; the hydrogen, one of its component parts, combines with the carbon of the charcoal. The gas obtained by these processes has been called *light inflammable air*. A similar gas may be procured from ether, spirits of wine, or camphor, by making the vapour of these substances pass through red-hot porcelain tubes. This gas, from its greater specific gravity, has been called *heavy inflammable air*. The proportions of the substances which enter into the composition of this gas vary considerably, according to the process employed, or the materials from which it is obtained. It is the same gas which is given out in great abundance during hot weather, from stagnant waters.

413 Properties. 2. This gas, like common air, is invisible and elastic. When a candle is applied to it, it burns with a blue, lambent flame. If it be mixed with atmospheric air, the combustion is more rapid and brilliant, and still more so when it is mixed with oxygen gas, but without any detonation. The products of this combustion are carbonic acid and water. The oxygen combines partly with the carbon to form carbonic acid; and partly with the hydrogen to form water.

3. It is totally unfit for respiration. Animals introduced into it are instantly suffocated. It is also unfit for supporting combustion.

One of the most remarkable properties of this gas is, when it is mixed in a tube with common air or oxygen gas, about $\frac{2}{3}$ds its bulk of the latter, and fired by the electric spark, there is a considerable increase of volume.

414 Composition. The component parts of carbureted hydrogen gas obtained from different substances, as they have been ascertained by Mr Cruickshank, are the following. When it is procured from ether, camphor, or stagnated water, it contains the largest proportion of carbon. The specific gravity is 0.000804, and it is to common air nearly as two to three. One part by weight of hydrogen gas holds in solution $5\frac{1}{2}$ parts of carbon;

100 parts contain	52.35	carbon,
	9.60	hydrogen,
	38.05	water instead of vapour.
	100.00	

When it is obtained from ether, the specific gravity is 0.000787:

100 parts contain	45	carbon,
	15	hydrogen,
	40	water.
	100	

When it is obtained from spirit of wine, the specific gravity is 0.00063:

100 parts contain	44.1	carbon,
	11.8	hydrogen,
	44.1	water.
	100.0	

The lightest is obtained from distilling wet charcoal, or passing the vapour of water through red-hot charcoal. It contains one part by weight of hydrogen gas, holding three parts of carbon in solution. The specific

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Carbon.

fic gravity is 0.000554. It is to common air nearly as one to two;

100 parts contain 28 carbon,
9 hydrogen,
63 water. †

100

† Nichol-son's Jour. vol. v. p. 1.

Mr Cruickshank has discovered a very easy method of distinguishing carbonic oxide from the carbureted hydrogen gas. A mixture of the latter and oxymuriatic acid gas may be exploded by passing electric sparks through it. But a mixture of oxymuriatic acid gas and carbonic oxide suffers no change by the action of electricity.

The following table, drawn up by Mr Cruickshank, exhibits the results of his experiments on these two gases.

A Table, shewing the Analysis, &c. of the different Species of Carbureted Hydrogen Gas, or Hydrocarbonates, and of Carbonic Oxides.

Gases, and the different Substances from which the Gases are obtained, &c.	Weight of 100 Cubic Inches, or Grains.	Proportion of Oxygen necessary to saturate 100 Measures of the Gas.		Products when combined with Oxygen. Carbonic Acid.		Water produced.	Water held in Solution by the Gas.	Hence the Gases consist of			
	Grains.	Meas.	Quan. of Grains.	In Vol. Meas.	In Quan. Grains.	Grains.	Grains.	Oxyg.	Carbon.	Hydro.	Water.
Pure carbureted hydrogen gas from camphor, &c.	21	176	59,8	116	54,5	18	8 or 9	none	11	2+	8 or 9
—— from ether	20	170	58	108	50,5	18	9	none	9	3	8
—— from alcohol	16	118	40	75	36	13	7	none	7	1,9	7
—— wet charcoal -	14.5	66	22,4	40	19	9	9	none	4	1,3	9
Carbonic oxide from charcoal and metallic oxides	30	44	15	76	35,5	about 8	prob^y none	about 15	nearly 15	1+	uncertain
—— from iron filings, and carbonate of lime, or barytes.	30	40	13,6	92	43,2	none	none	21+	8.6	none	none

Chap. VIII. Of PHOSPHORUS.

415 History.

1. This singular substance was accidentally discovered in 1677, by an alchemist of Hamburgh, named Brandt, while engaged in searching for the philosopher's stone. Kunkel, another chemist, who had seen the new product, associated himself with one of his friends named Krafft, to purchase the secret of its preparation; but the latter deceiving his friend, made the purchase for himself, and refused to communicate it. Kunkel, who at this time knew nothing farther of its preparation, than that it was obtained by certain processes from urine, undertook the task, and succeeded. It is on this account that this substance long went under the name of Kunkel's phosphorus. Mr Boyle is also considered as one of the discoverers of phosphorus. He communicated the secret of the process for preparing it to the Royal Society of London in 1680. It is asserted, indeed, by Krafft, that he discovered the secret to Mr Boyle, having in the year 1678 carried a small piece of it to London, to shew it to the royal family; but there is little probability, that a man of such integrity as Mr Boyle would claim the discovery of the process as his own, and communicate it to the Royal Society, if this had not been the case.

Mr Boyle communicated the process to Godfrey Hankwitz, an apothecary of London, who for many years supplied Europe with phosphorus; and hence it went under the name of *English phosphorus*. Many chemists now attempted to produce phosphorus, and different processes had been published for the purpose; but it would appear that they rarely succeeded.

In the year 1737, a stranger having sold to the French government a process for making phosphorus, the Academy of Sciences charged Dufay, Geoffroy, Duhamel, and Hellot, to superintend it. The latter published an account of the experiment, which succeeded. Rouelle the Elder exhibited phosphorus which he had prepared, in a course of lectures which he opened at Paris some years after. In the year 1743, Margraaf made a great improvement in the process, but still it continued to be obtained with difficulty, and in very small quantity. It was not till 30 years after that considerable improvement was made in the process for procuring phosphorus.

416 Exists in bones.

In the year 1774, the Swedish chemists Gahn and Scheele, made the important discovery, that phosphorus is contained in the bones of animals, and they improved the processes for procuring it.

2. The most convenient process for obtaining phosphorus seems to be that recommended by Fourcroy and Vauquelin ‡. Take a quantity of burnt bones, and reduce

‡ Mem. de l'Inst. tom. ii. p. 281.

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Phosphorus. duce them to powder. Put 100 parts of this powder into a porcelain or stone-ware bason, and dilute it with four times its weight of water. Forty parts of sulphuric acid are then to be added in small portions, taking care to stir the mixture after the addition of every portion. A violent effervescence takes place, and a great quantity of air is disengaged. Let the mixture remain for 24 hours, stirring it occasionally, to expose every part of the powder to the action of the acid. The burnt bones consist chiefly of phosphoric acid and lime; but the sulphuric acid has a greater affinity for the lime than the phosphoric acid. The action of the sulphuric acid uniting with the lime, and the separation of the phosphoric acid, occasion the effervescence. The sulphuric acid and the lime combine together, being insoluble, and fall to the bottom.

417 Process for obtaining

Pour the whole mixture on a cloth filter, so that the liquid part which is to be received in a porcelain vessel may pass through. A white powder, which is the insoluble sulphate of lime, remains on the filter. After this has been repeatedly washed with water, it may be thrown away, but the water is to be added to that part of the liquid which passed through the filter.

Take a solution of sugar of lead in water, and pour it gradually into the liquid in the porcelain bason. A white powder falls to the bottom, and the sugar of lead must be added so long as any precipitation takes place. The whole is again to be poured upon a filter, and the white powder which remains is to be well washed and dried. The dried powder is then to be mixed with one-sixth of its weight of charcoal powder. Put this mixture into an earthen-ware retort, and place it in a sand bath with the beak plunged into a vessel of water. Apply heat, and let it be gradually increased, till the retort becomes red hot. As the heat increases, air-bubbles rush in abundance through the beak of the retort, some of which are inflamed when they come in contact with the air at the surface of the water. A substance at last drops out similar to melted wax, which congeals under the water. This is phosphorus.

418 and purifying it.

In this state the phosphorus is not quite pure. It is generally mixed with some charcoal powder, and a portion of half burnt phosphorus, which give it a brown colour. To have it quite pure, melt it in warm water, and strain it several times through a piece of shamoy leather under the surface of the water. The leather should only be employed once, for phosphorus strained through it afterwards will be coloured. To mould it into sticks, take a glass funnel with a long tube, which must be stopped with a cork. Fill it with water, and put the phosphorus into it. Immerse the funnel in boiling water, and when the phosphorus is melted, and flows into the tube of the funnel, then plunge it into cold water, and when the phosphorus has become solid, remove the cork, and push the phosphorus from the mould with a piece of wood. Thus prepared, it must be preserved in close vessels containing pure water.

419 Properties.

3. Phosphorus, when perfectly pure, is semitransparent, and has the consistence of wax. It is so soft that it may be cut with a knife. Its specific gravity is from 1.770 to 2.033. It has an acrid and disagreeable taste, and a peculiar smell resembling that of garlic. When a stick of phosphorus is broken, it exhibits some appearance of crystallization. The crystals are needle-shaped, or long octahedrons; but to obtain them in their most perfect state, the surface of the phosphorus, just when it becomes solid, should be pierced, that the internal liquid phosphorus may flow out, and leave a cavity for their formation.

4. When phosphorus is exposed to the light, it acquires a reddish colour, which appears to be the effect of an incipient combustion. It is therefore necessary to preserve it in a dark place. At the temperature of 99° it becomes liquid, and if air be entirely excluded, it evaporates at 219°, and boils at 554°. At the temperature of 43° or 44°, it gives out a white smoke, and is luminous in the dark. This is a slow combustion of the phosphorus, which becomes more rapid as the temperature is raised. When heated to the temperature of 148°, phosphorus takes fire, burns with a bright flame, and gives out a great quantity of white smoke.

420 Action of light.

421 Of heat.

Phosphorus enters into combination with oxygen, azote, hydrogen, and carbon.

Sect. I. *Of the Combinations of Phosphorus with Oxygen.*

Phosphorus enters into combinations with oxygen in different proportions.

1. Oxide of Phosphorus.

Phosphorus, when exposed to the light, or kept in water that is not freed from air, soon acquires an opaque white colour, and afterwards changes to a brown. This is the first combination of oxygen with it, and being in the smallest proportion, and giving no acid properties to the compound, it has been denominated an *oxide of phosphorus*. This shews that it is necessary to keep it excluded from air and light. But phosphorus thus changed on the surface may be freed from that part which is oxidated by a very simple process. Dissolve the phosphorus in warm water, the whole melts except the oxidated part, which remains at the surface, not being fusible at the same temperature.

422 To separate the oxide.

2. Acids.

1. When phosphorus is burned in common air confined in a vessel, the combustion is pretty rapid, and continues till the whole of the oxygen is consumed. A great quantity of white fumes are produced, and when these fumes are mixed with water which absorbs them, it is found to have acid properties. This is the *phosphorous acid*, in which the oxygen is in smaller proportion than in the following, but greater than in the oxide.

423 Production.

2. But when a small bit of phosphorus is introduced into a jar filled with oxygen gas at the temperature of 60°, it dissolves slowly, but does not appear luminous till the temperature be raised to 80°, which shews that phosphorus requires a higher temperature to burn in oxygen gas than in common air. And if the phosphorus be introduced into the oxygen gas, which is perfectly pure at a lower temperature, it undergoes no change, gives out no smoke, and is not luminous in the dark. But when it is immersed in a state of ignition into oxygen gas, it exhibits a most brilliant combustion. The light emitted is almost as splendid as that of the sun, and too powerful for the eye. During this combustion the oxygen gas disappears, loses its gaseous form,

424 Splendid combustion.

Phosphorus. form, and becomes solid in combination with the phosphorus. It is during this change from the fluid to the solid state that the caloric is emitted; and the light, according to Gren's theory of combustion, is given out by the phosphorus. The product is a concrete substance which adheres to the sides of the jar. This is the *phosphoric acid*, in which there is a greater proportion of oxygen in combination with the phosphorus. These acids will be treated of in the chapter on acids.

Sect. II. *Of Phosphureted Azotic Gas.*

425 Phosphorus combines with azotic gas without emitting light.

1. At first sight it seems difficult to explain the reason that phosphorus requires a higher temperature for its combustion in oxygen gas than in common air. But the cause of this singular phenomenon appears by examining the effects of azotic gas on phosphorus. The phosphorus, which is readily converted into vapour at a low temperature, combines with the azotic gas without combustion, and therefore without giving out any light. The azotic gas is thus saturated with the phosphorus, and its bulk is increased about $\frac{1}{40}$. The combination is denominated *phosphureted azotic gas*. In this state the phosphorus being minutely divided, takes fire at a lower temperature.

2. When oxygen gas is introduced into a jar filled with this gas, it becomes luminous, because there is a combustion of the phosphorus which is held in solution by the azotic gas. The combustion is more rapid and brilliant when the phosphorated azotic gas is let up into the jar of oxygen gas.

Sect. III. *Of Phosphorized and Phosphureted Hydrogen Gas.*

426 Phosphorus dissolved in hydrogen gas.

1. When a piece of phosphorus is put into a jar filled with hydrogen gas, it does not appear luminous in the dark. But, after having remained for several hours, part of the phosphorus is dissolved. When this gas, to which Fourcroy and Vauquelin have given the name of phosphorized hydrogen gas, is introduced into a jar of oxygen gas, each bubble, as it passes up and comes in contact with the gas, produces a very brilliant bluish flame, which fills the whole vessel. This effect does not take place in atmospheric air. This gas holds in solution only a small proportion of phosphorus; but it is owing to the combustion of this portion that the flame appears in the oxygen gas. This gas has a less fetid odour than that which is next to be described. It has, however, a slight smell of garlic §.

§ *Ann. de Chim.* vol. xxi. p. 203.

427 History.

2. Phosphureted hydrogen gas was discovered by M. Gengembre in 1783, by boiling a solution of potash on phosphorus; and by Mr Kirwan in the following year. Its nature and properties have been more completely investigated by M. Raymond, in two papers in the *Annales de Chimie* for 1791 and 1800. It may be obtained by introducing a bit of phosphorus into a jar of hydrogen gas standing over mercury, and melting the phosphorus by means of a burning glass. The phosphorus is thus converted into the state of vapour, when the hydrogen gas dissolves a much greater proportion. But a more simple process has been recommended by Raymond.

Take two ounces of quicklime, slaked in the air, about 60 grs. of phosphorus, and half an ounce of water; reduce the whole to a paste, and put it immediately into a small glass or stone-ware retort, the body of which may be filled with the materials. Immerse the beak of the retort under water in the pneumatic trough, and apply a moderate heat. As soon as the retort is heated, the gas begins to come over; and when the bubbles come to the surface of the water in contact with the air, they explode with flame and smoke. When the gas passes off slowly the bubbles are larger; and when they reach the surface they exhibit an elegant appearance, forming, after explosion, a beautiful coronet of white smoke, which rises with an undulatory motion to the ceiling, when the air is still. When this gas is brought into contact with oxygen gas, the combustion is more rapid and more brilliant.

Sulphur. 428 Process for obtaining it.

The products of the combustion of this gas are phosphoric acid and water. The phosphorus, held in solution by the hydrogen, combines with the oxygen, and forms phosphoric acid; while the hydrogen unites with another portion of oxygen and forms water. 429 Products by combustion.

This gas has a very fetid odour, which has some resemblance to the smell of putrid fish. Pure water agitated in contact with this gas, absorbs about one-fourth of its bulk at the temperature of 50°. The colour of the solution is not quite so deep as that of roll sulphur. The smell is strong and disagreeable, and the taste extremely bitter. It does not appear luminous in the dark. But when it is exposed nearly to the temperature of boiling, the whole of the phosphorated hydrogen gas is driven off unchanged, and the water remains behind perfectly pure. When the solution is exposed to the air, the oxide of phosphorus is deposited, and the hydrogen gas escapes †. 430 Properties.

† *Annal. de Chim.* vol. xxxv. p. 234.

Sect. IV. *Phosphuret of Carbon.*

Phosphorus enters into combination with charcoal, and forms what Proust, who discovered it, denominates *phosphuret of carbon*. It is produced during the distillation of phosphorus, and remains behind on the leather, when it is strained through it to purify it from this substance. It is of a red colour, and does not melt like pure phosphorus. If it be distilled with a gentle heat, a small portion of phosphorus, which it contains in excess, is separated. But the true compound of phosphuret of carbon is not decomposed without a very strong heat. When the vessels have cooled, there is found a light, flocculent powder, of a lively orange red, which M. Proust considers as the phosphuret of carbon. If it be exposed to a red heat in the retort in which it is formed, the whole of the phosphorus is driven off, and the charcoal remains behind. When this phosphuret is exposed to the open air on a heated metallic plate, it burns rapidly; but the charcoal which absorbs the phosphoric acid, as it is formed, escapes the combustion. It loses, in a short time, the property of burning, by being exposed to the air, and then it may be preserved without any risk of spontaneously catching fire. ‡ 430 How produced. 431 Action of heat.

‡ *Ibid.* p. 44.

Chap. IX. Of SULPHUR.

1. Sulphur is a simple undecompounded combustible substance, which is universely diffused in nature; but 432 A simple substance.

Sulphur. but most commonly in a state of combination with mineral, vegetable, or animal matters. It is found in some mineral waters, but in greatest abundance in volcanic countries, where it is a valuable article of commerce.

433 Properties. 2. Sulphur, as it is extracted from minerals and purified by art, is a hard brittle substance of a yellow colour, which can easily be reduced to powder. It is always opaque, has a lamellated fracture, and becomes electric by friction. The specific gravity, after it is melted, does not exceed 1.9907. It has no smell, and very little perceptible taste. When rubbed some time, it is volatilized, and diffuses a peculiar and slightly fetid odour, by which it is easily distinguished. It leaves on the skin which has been in contact with it a very strong smell, which remains for some hours. It is insoluble in water.

434 Action of heat. 3. Light has no sensible effect on sulphur. But if a roll of sulphur be held in the hand for a little, it begins to crackle, and at last it breaks to pieces. When a temperature equal to that of boiling water is applied to sulphur, it melts, becomes liquid and transparent, and changes to a brown red colour; but, in cooling, if the fusion is not too long continued, it resumes the yellow colour. When permitted to cool slowly, it crystallizes in prismatic needles. The crystals are better formed by pouring out part of the liquid sulphur as soon as the surface has become solid.

435 Crystallizes.

436 Becomes viscid. 4. If the heat be continued, it becomes thick and viscid; and if it be then poured into cold water, it retains its softness, and in this state is employed for taking impressions of seals and medals, which are called *sulphurs*. When sulphur is exposed to heat in close vessels, it is volatilized or sublimed in the form of a very fine powder, known under the name of FLOWERS OF SULPHUR.

437 Is sublimed.

Sulphur enters into combination with oxygen, azote, hydrogen, carbon, and phosphorus.

438 With azotic gas. The combination of sulphur with azotic gas has been little examined. Part of the sulphur is dissolved, when it is heated in a vessel filled with the gas. This *sulphurated azotic gas*, as it is called, has a fetid odour. When the temperature is diminished, part of the sulphur is deposited. It has been lately discovered in the mineral waters of Aix-la-Chapelle.—We shall consider the other combinations of sulphur in the following sections.

SECT. I. *Sulphur combined with Oxygen.*

439 Oxide. 1. When sulphur is kept some time in fusion in an open vessel, it assumes a red colour, and becomes viscid. When cooled, it retains its red colour, which is owing to the combination of oxygen in small proportion with the sulphur. In this state it has been denominated the *oxide of sulphur*. According to the experiments of Dr Thomson, the oxide of sulphur, formed by melting the substance in a deep vessel, is of a dark violet colour, fibrous fracture, and tough consistence; the specific gravity is 2.325. It contained $2\frac{7}{10}$ per cent. of oxygen. Another oxide, containing 6.2 per cent. of oxygen, was formed by passing a current of oxymuriatic acid gas through flowers of sulphur †.

† *Syst. of Chem.* vol. iv. p. 763.

440 Burnt in common air. 2. Sulphur, when burnt in the open air, emits a pale blue flame, with a great quantity of white smoke. When these fumes are mixed with water, the liquid is found to possess acid properties. This is a combination of sulphur with a greater proportion of oxygen than exists in the oxide, and is called *sulphurous acid*.

3. But when sulphur is burnt in oxygen gas, a very rapid combustion takes place with a reddish white flame, and it combines with a larger proportion of oxygen. When the fumes which are copiously emitted during this combustion are collected and mixed with water, it exhibits the properties of an acid, which is the *sulphuric acid*. Thus it appears, that sulphur combines with oxygen in four different proportions. In two of these, in which the proportions are smallest, the compounds are denominated oxides; but in the two others, in which the proportion of oxygen is increased, the compounds are acids, the properties of which will be afterwards investigated. 441 In oxygen gas.

SECT. II. *Sulphureted Hydrogen Gas.*

1. This gas may be procured by various processes. It may be obtained by making hydrogen gas pass through melted sulphur. In this way the hydrogen gas enters into combination with sulphur. The same gas may also be obtained by melting together in a crucible equal parts of iron filings and sulphur, by which means a black brittle mass is formed, which is to be reduced to powder, and introduced into a glass vessel (fig. 6.) with two mouths, the one of which has a stopper A, and the other a bent tube B, accurately ground to fit the mouths C, D. When the mixture of iron filings and sulphur has been introduced into the phial, the bent tube is to be fitted into the mouth, with the other end under the surface of the water in the trough E. The apparatus being thus prepared, pour in muriatic acid through the other opening, and immediately close it with the ground stopper. The sulphureted hydrogen gas is copiously disengaged, and fills the glass jar F, which is previously placed on the shelf to receive it. This gas was formerly known by the name of *hepatic gas*. 442 Method of procuring.

2. The odour is extremely fetid, resembling that from the washings of a gun, or from rotten eggs, which arises from the extrication of the same gas. The specific gravity of this gas is 0.00135. 443 Properties.

It is unfit for respiration, and for supporting combustion. A taper immersed in it is extinguished. When it is inflamed in contact with atmospheric air or oxygenous gas, it burns with a reddish flame, and deposits a quantity of sulphur. Sulphur also is deposited by simple exposure to the air. From this it appears, that the affinity of hydrogen for oxygen is stronger than for sulphur. During the combustion, the hydrogen unites with the oxygen, and the sulphur is deposited. It is from this deposition that the sulphur found about mineral springs, the waters of which contain this gas, is derived.

3. According to the experiments of Thenard, 100 parts by weight of sulphureted hydrogen gas contain 444 Composition.

70.857 sulphur,
29.143 hydrogen.

100.000 *.

* *Ann. de Chim.* vol. xxxii. p. 267.

4. Sulphureted hydrogen gas has the property of dissolving phosphorus. Fourcroy and Vauquelin introdu-

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ced pieces of phosphorus into a jar filled with this gas over mercury. After the phosphorus had been exposed to the gas for twelve hours, the atmospheric air was admitted, and a bluish voluminous flame instantly appeared. The bubbles of the gas diffused in the air, presented by day light a white vapour, which seemed to adhere like viscid matter to the surface of the mercury; but in the dark, exhibited a very brilliant light. The mercury in the trough in which the experiment was made, continued for some minutes to give out sparks of light by agitation. The hands plunged into this gas, continued luminous for some minutes, and a sponge introduced into it retained the same property for some time in the air †.

445 Dissolves phosphorus.

† *Ibid.* vol. xxi. p. 207.

5. Sulphureted hydrogen gas is very readily absorbed by water, and in this state it changes vegetable blues to a red colour, and forms neutral salts with different bases. On this account it is now justly ranked among the acids.

Sect. III. *Carburet of Sulphur*.

446 With carbon in different proportions.

1. Sulphur and carbon combine together at a high temperature, and probably in different proportions; one of these combinations is liquid at the ordinary temperature and pressure of the atmosphere. This is the carburet of sulphur. The following method of preparing it is given by Clement and Desormes, who have particularly investigated the action of sulphur and charcoal.

447 Preparation.

2. Put a quantity of charcoal in small pieces, or in powder previously dried, into a porcelain tube, which is to pass through a furnace that it may be exposed to a red heat. The gas from the charcoal is to be allowed to escape, before the other part of the apparatus is adjusted. To that extremity of the porcelain tube which contains the charcoal, fit a long glass tube, sufficiently wide to contain a number of small pieces of sulphur, which may be pushed successively into the porcelain tube with an iron rod passing through a cock which closes the end of the tube. To the other extremity there is to be fitted another glass tube, bent at the end, that it may be immersed in a vessel of water in the pneumatic trough. Heat is then to be applied till the porcelain tube and the charcoal become red hot, when the pieces of sulphur are to be pushed slowly forwards into the tube, and when it acts on the charcoal a yellow liquid of an oily appearance passes through the tube. The heat being continued, it evaporates, and is condensed in the water of the vessel in which the tube terminates, traversing it in globules, which collect together at the bottom.

448 Precautions.

The success of this experiment is somewhat precarious. When sulphur is exposed suddenly to a strong heat, instead of being sublimed, it appears in some measure fixed, and becomes soft by fusion. Sometimes it passes too rapidly through the charcoal to unite with it; the pieces of sulphur, therefore, should be slowly introduced, and the tube, in passing through the furnace, should be inclined from that extremity at which the sulphur is introduced.

449 Properties.

3. The carburet of sulphur, when pure, is transparent and colourless, but frequently has a greenish-yellow tinge. It has a disagreeable pungent odour. The taste is at first cooling, but afterwards becomes extremely pungent. It is heavier than water, does not mix with it, and therefore remains at the bottom of the vessel. The specific gravity of this liquor is various. In one trial it was found to be 1.3.

450 Evaporates.

4. This compound evaporates at the ordinary temperature of the atmosphere, and increases its volume nearly as much as ether. When a quantity of this liquor in a vessel of water is placed under the receiver of an air pump, and the air exhausted, it rises through the water in bubbles, and assumes the gaseous form; and when the pressure of the air is restored, the gas is instantly condensed, and returns to the liquid state.

451 Combustible.

5. The carburet of sulphur burns with great facility, and during combustion emits a strong odour of sulphurous acid, deposites a little sulphur, which afterwards burns, and some black charcoal remains in its usual combustible state. Air holding carburet of sulphur in solution, burns quietly; but when impregnated with oxygen gas, and brought in contact with a burning body, explodes with prodigious violence, and not without considerable danger.

6. This substance unites with phosphorus, which it very readily dissolves, but the solution is not more inflammable than the phosphorus itself. It combines also with a small quantity of sulphur, but without any other change in its properties than becoming a little deeper coloured. It seems to have no action on charcoal *.

* *Ann. de Chim.* vol. xlii. p. 134.

Sect. IV. *Sulphuret of Phosphorus*.

452 Preparations.

1. Sulphur and phosphorus combine together in all proportions. If one part of phosphorus with eight times its weight of sulphur, be put into a matrass, with 32 parts of distilled water; on the application of a gentle heat, the phosphorus melts and dissolves the sulphur. The new compound assumes a yellow colour, and remains fluid, till it is cooled down to the temperature of 77°, when it becomes solid. This substance is the *sulphuret of phosphorus*. In other cases, when the proportion of phosphorus exceeds that of the sulphur, it is called a *phosphuret of sulphur*.

453 Combined with sulphur more fusible.

2. The compounds of sulphur and phosphorus have been particularly investigated by Pelletier, and he has found that the compound is always more fusible than either of the uncombined constituents. The following table exhibits the results of his experiments †.

† *Fourcroy Connaiss. Chim.* tom. i. p. 202.

8 Phosphorus, 1 Sulphur	remain fluid at 95°
4 Phosphorus, 1 Sulphur	59
1 Phosphorus, ½ Sulphur	50
1 Phosphorus, 1 Sulphur	41
1 Phosphorus, 2 Sulphur	72
1 Phosphorus, 3 Sulphur	99

Thus, all these compounds are more fusible than the phosphorus itself, and much more so than the sulphur.

454 Danger in the process.

3. In making these combinations, great caution should be observed; for if the heat be applied suddenly, even

Acids. even when the substances are under water, a violent explosion sometimes takes place, from the sudden formation and extrication of the sulphureted and phosphureted hydrogen gases.

Chap. X. Of ACIDS.

455 Oxides. 1. We have seen, in describing the different substances which have been treated of in the five preceding chapters, that they all, excepting one, combine with oxygen in different proportions. Hydrogen combines with oxygen only in one proportion, and this compound is water. The first portion of oxygen which combines with the other four substances, namely azote, carbon, phosphorus, and sulphur, forms with them compounds which, possessing no acid properties, have received the name of oxides.

456 Acids. 2. But when these substances combine with a greater proportion of oxygen, the compounds exhibit very different properties; and possessed of these properties, they are ranked among the class of acids. The following are the properties of the substances referred to this class.

457 Distinctive characters. *a.* They redden blue vegetable colours (K).

b. They possess a peculiar taste, which is well known by the terms *acid* or *sour*.

c. They combine with water in all proportions.

d. They enter into chemical combination with alkalies, with earths, and metallic oxides, and form with them compounds which have been denominated *salts*.

458 Importance of acids. 3. The acids are a very important class of bodies, and not merely on account of their peculiar properties, and the singular and useful compounds which they form with other substances, but also as they are the instruments of analysis in the hands of the chemist for discovering the properties and combinations of the objects of his science. It is therefore necessary to become early acquainted with their nature.

459 Nomenclature. 4. Acids which have the same radical or base, contain oxygen in different proportions. Thus, for instance, sulphur combines with oxygen in two proportions. 100 parts of one compound contain 32 of oxygen, and 100 parts of the other contain 38 parts. The characteristic properties of these compounds are totally different. It is therefore necessary that they should be distinguished by some appropriate name, and this accordingly has been attended to in the construction of the present chemical nomenclature. The name of the acid is derived from the base, and this name has a different termination according to the proportion of the oxygen combined with its radical. With the smallest proportion the name terminates in the syllable *ous:* with the greater proportion, it terminates in the syllable *ic*. Thus, in the case of the acid formed with sulphur, that compound in which there is the smaller proportion of oxygen is denominated the *sulphurous acid;* the other, which has the greater proportion of oxygen is the *sulphuric acid*. In the same way when phosphorus combines with oxygen in the smallest proportion which gives it acid properties, it is called the *phosphorous acid;* in the greater proportion, the *phosphoric acid*. And thus by the simple change of the termination, the name becomes descriptive of the peculiar state of the proportions in the compound.

Sect. I. *Of Sulphuric Acid.*

1. The name of sulphuric acid is given to the combination of sulphur and of oxygen, with the greatest proportion of the latter. It was formerly called vitriolic acid, because it was obtained by distillation from vitriol, which is a compound of sulphuric acid and an oxide of iron. When it is strongly concentrated, it has a sluggish appearance; hence it was called *oil of vitriol*. It has also been denominated *oleum sulphuris per campanam*, because it was obtained by burning sulphur under a glass bell. 460 Names.

2. The ancients were unacquainted with this acid. Pliny speaks of vitriols, which were used for different purposes, in some of which it was probably decomposed. Sulphur was burnt in sacrifices, but in neither case was the product attended to. Basil Valentine is the first who mentions this acid, about the end of the 15th century. Agricola and Paracelsus have also spoken of it, but Dornæus is the first who described it distinctly, in the year 1570. 461 History.

3. If a quantity of flowers of sulphur be exposed to a degree of heat sufficient to inflame it, and if, when it is in a state of ignition, it be introduced into a jar filled with oxygen gas, it burns with great splendour, and emits a great quantity of white fumes. These fumes may be condensed, by pouring a small quantity of water into the jar, and when this is examined, it is found to possess acid properties. This is the *sulphuric acid*. It is procured, as appears by this experiment, by burning sulphur in oxygen gas. 462 Formation by experiment.

4. The process for obtaining sulphuric acid in the large way is the following. A mixture of sulphur and nitre is burnt in leaden chambers. The use of the nitre is to supply a quantity of oxygen for the combustion of the sulphur. There is a little water in the bottom of the vessel, which serves to condense the vapours given out during the combustion. The acid which is obtained in this way is very weak, for it is diluted with the water in which it was condensed, which water may be separated by distillation. Even after this it is usually contaminated with a little lead from the vessels, some potash, and sometimes nitric and sulphurous acids. To obtain it perfectly pure, the sulphuric acid of commerce must be distilled. This process is conducted by putting a quantity of the acid into a retort, and exposing it to a degree of heat sufficient to make it boil. The beak of the retort is put into a receiver, in which the acid, as it comes over, is condensed. 463 And in the large way. 464 Purification.

5. The acid, thus purified, is a transparent colourless liquid, of oily consistency. It has no smell, but a strong 465 Properties.

(K) Hence vegetable blue infusions, or paper stained with them, are employed as tests to discover acids. These are sometimes called re-agents. A great variety of substances are employed for this purpose, such as the infusion and tincture of litmus and of turnsole, the syrup of violets, and the infusion of the flowers of mallow or red cabbage.

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Acids.

strong acid taste. It destroys all animal and vegetable substances. It reddens all vegetable blues. It always contains water. When this is driven off by a moderate heat, the acid is said to be concentrated. When as much concentrated as possible, the specific gravity is 2, or double that of water; but it can rarely be obtained of greater density than 1.84.

466 Action of heat.

6. Sulphuric acid suffers no change from being exposed to the light. It boils at the temperature of 546°, or, according to Bergman, 540°. When this acid is deprived of its caloric, it is susceptible of congelation, and even of crystallization, in flat, six-sided prisms, terminated in a six-sided pyramid. It crystallizes most readily, when it is neither too much concentrated, nor diluted with water. Of the specific gravity of 1.65 it crystallizes at the temperature of a few degrees below the freezing point of water. Of the specific gravity of 1.84 it resists the greatest degree of cold. Chaptal observed it crystallize at the temperature of 48°, and Mr Keir found that it froze at 45° of the specific gravity of 1.78.

467 Attracts water strongly.

7. Sulphuric acid has a strong attraction for water. In some experiments that have been made, this acid, when exposed to the atmosphere, attracted above six times its weight of water. When four parts of concentrated sulphuric acid, and one part of ice at the temperature of 32°, are mixed together, the moment they come in contact the ice melts, and the temperature rises to 212°. A greater quantity of caloric is given out when the two bodies are mixed together in the liquid state. If four parts of the acid and one of water are suddenly mixed together, the temperature of the mixture rises to about 300°. This extrication of caloric, it is obvious, arises from the sudden condensation of the two liquids, the medium bulk of which is considerably less than the two taken together.

468 Method of determining the quantity.

8. So great is the attraction of this acid for water, that the strongest that can be prepared can scarcely be supposed to be entirely free from it. It has therefore greatly occupied the attention of chemical philosophers to determine the proportions of real acid and water, in sulphuric acid of any given specific gravity. This subject has been investigated by Wenzel, Wiegleb, and Bergman, and more lately and successfully by Mr Kirwan.

469 Mr Kirwan's.

His method was the following. Eighty-six grains of potash, dissolved in water, were saturated with sulphuric acid of a known specific gravity. The solution being turbid, water was added till the specific gravity was 1.03 at temperature 60°. The whole weight was now equal to 3694 grains. Forty-five grains of sulphate of potash dissolved in 1017 grains of distilled water, had the same specific gravity at the temperature 60°. Hence the proportion of salt in each solution was equal. But in the last, the quantity of salt was $\frac{1}{22.6}$, then the quantity of salt in the former was $\frac{3694}{22.6}=$ 163.45 grains. Of this quantity only 86 were alkali; the remainder, therefore, viz. 77.45 grains, were acid, or acid and water. The quantity of acid employed in the saturation amounted to 79 grains standard; but the quantity of acid taken up was only 77.45 grains; therefore 1.55 were rejected, and consequently were mere water, therefore the acid taken up is stronger than standard; and since 79 parts standard lose 1.55 by combining with pure potash, 100 parts standard should lose 1.96; or 98.04 parts of acid of the strength of what is found in sulphate of potash, contains as much real acid as 100 parts standard. Hence 100 parts of this strong acid are nearly equivalent to 102 of standard. Therefore, 100 parts of potash take up nearly 92 of standard sulphuric acid, or 82 of the strongest, and afford 182 of sulphate of potash. Mr Kirwan thinks there is no reason to suppose that the sulphate of potash contains any water of crystallization. One hundred grs. exposed to a red heat for half an hour, fell into powder and lost only a single grain *.

* Irish Trans. vol. iv. p. 18.

It having been suggested by Guyton Morveau, Mr Kirwan observes, that the densities of mixtures of sulphuric acid and water being greater than what is found by calculation, should be ascribed to the condensation of the aqueous part, rather than to that of the acid; this led him to consider of a different method from what he had formerly employed in determining the quantity of real acid in sulphuric acid of different densities. Sulphuric acid of the specific gravity of 2.000, which is the strongest that can be produced by art, was taken as the standard of the strength of all other acids. He could not procure the acid of this strength at the temperature of 60°. But from many experiments made with acids of inferior density, as 1.8846, 1.8689, 1.8042, 1.7500, he concludes, that the condensation of equal weights of this standard acid and water amounts to $\frac{1}{73}$th of the whole. Then by applying Mr Pouget's formula (L) for investigating the increased densities of inferior proportions of acid and water, the successive increments of density will be found as in the following table.

Parts

(L) The formula here alluded to was invented by M. Pouget in the investigation of the specific gravity of alcohol mixed with water in different proportions; and he has given a detailed account of his method in a letter addressed to Mr Kirwan, which is inserted in the Transactions of the Royal Irish Academy, vol. iii. p. 157.

Having purified alcohol by repeated distillations, the specific gravity at the temperature 65.75* was found to be 0.0399. This he took for his standard. And considering the specific gravity as the means of discovering the increase of density, or the diminution of volume, he thought the quantities in the mixture would be best determined, not by the difference of weight, but of volume. He therefore took ten mixtures, the first containing nine measures of alcohol and one of water, the second eight measures of alcohol and two of water, and so on to the last, which contained only one measure of alcohol and nine of water. But as the real measures are always uncertain, he weighed them to ascertain the specific gravity. Thus 10,000 grains of water, and 8199 of alcohol formed a mixture of equal parts in bulk. Knowing the real specific gravities of mixtures of alcohol and water, taking a mean of a great number of observations made at the same temperature,

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Acids.

Parts Water.	Standard.	Increment of Density.
5	95	,0252
10	90	,0479
15	85	,0679
20	80	,0856
25	75	,0699
30	70	,1119
35	65	,1213
40	60	,1279
45	55	,1319
50	50	,1333

"By adding, says Mr Kirwan, these increments to the specific gravities found by calculation, and taking arithmetical mediums for the intermediate quantities of standard, I made out the first 50 numbers of the following table; the remainder was formed by actual observation in the following manner, premising that the specific gravities were always taken between 59,5° and 60°, or at most 60,5° of Fahrenheit.

"1st, I found by the preceding part of the table that 100 parts of sulphuric acid, whose specific gravity was 1.8472, contained 88.5 parts standard; consequently 400 grs. of this acid contain 354.

"2dly, I then took six portions of this acid, each containing 400 grs. and added to them as much water as made them contain respectively 48. 46. 44. 42. 40. and 38. grains standard. To find the proportion of water that should be added to each portion of acid, in order that it should contain the given proportion of standard, I

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temperature, and comparing them with the specific gravities found directly by calculation, he thus deduces the increase of density, or the diminution of volume produced in the whole mass by the mutual penetration of the fluids. For calling A the real specific gravity, and B the specific gravity found by calculation, n the number of measures which compose the whole mass, $n-x$ that to which it is reduced by mutual penetration, it is evident, since this increase of density does not diminish the weight of the whole mass, that $n\,B = \overline{n-x} \times A$. Then $x = \frac{A-B}{A} \times n$, or making $n = 1\ \frac{A-B}{A}$, which expresses the diminutions of bulk, or the quantity of fluid absorbed during the mixture.

The following table contains the result of Pouget's experiments, or the diminutions of volume which is supposed to be $= 1$ of the mixtures, calculated according to the formula.

Number of measures of		Diminution of the whole volume $=1$ by experiment.	By Calculation.
Water.	Alcohol.		
1	9	0.0109	0.0103
2	8	0.0187	0.0184
3	7	0.0242	0.0242
4	6	0.0268	0.0276
5	5	0.0288	
6	4	0.0266	0.0276
7	3	0.0207	0.0242
8	2	0.0123	0.0184
9	1	0.0044	0.0103

From this table it appears that the numbers which express the diminution of bulk follow a regular progression. The greatest correspond to the mixtures of equal parts, and they decrease towards each end of the progression. They must therefore be regulated by some general law. M. Pouget thinks that the alcohol may be conceived as being dissolved in the water which has absorbed or retained part of it in its pores. The quantity absorbed ought to be in the ratio of that of the solvent and the body dissolved, and each measure of water will retain quantities of alcohol proportional to the number of measures of this fluid in the mixture. Thus, for example, in a mixture formed of nine measures of alcohol and one of water, this measure of water will absorb a quantity of alcohol $= 9$: and in another mixture of eight measures of alcohol with two of water, each measure of water will contain a quantity of alcohol $= 8$. Consequently the diminutions of bulk of each mixture are in a ratio compounded of the number of measures of alcohol and of water which form it; and in the table above, as 1×9, 2×8, 3×7, 4×6, 5×5, &c. And in general taking for a constant quantity the diminution of bulk with equal measures, and calling it e; calling the whole number of measures n; the number of

Acids.

I used the following analogy: Let the quantity of water to be added to 400 parts of the acid, that the mixture may contain 48 per cent. standard be x.

Then $400+x$. 354 :: 100. 48, then $19200+48x=35400$.

And $48x=35400-19200=16200$. And $x=\frac{16200}{48}=337,5$.

"In this manner I found the quantities of water to be added to each of the other portions. The mixtures being made, they were set by for three days. stirring them with a glass rod (that remained in them) each day, and the 5th day they were tried; after which the half of each was taken out and as much water added to them, and then set by for three days, by which means the specific gravities corresponding to 24. 23. 22. 21. 20. and 19. per cent. standard were found. after which six more portions of 400 grs. each of the concentrated acid, whose specific gravity was 1,8393, were taken, the proper proportion of water added to each, and after three days rest and repeated agitation, their densities in temperature 60° were examined as above, by which means the specific gravities corresponding to 36. 34. 32. 30. 28. and 26. per cent. standard were obtained, and half these portions mixed with half water exhibited, after three days rest and agitation, the densities corresponding to 18. 17. 16. 15. 14. and 13. per cent. standard in the above temperature. The balance I used turned with $\frac{1}{10}$ of a grain when charged with two ounces, and the solid employed was a small glass ball containing mercury, which lost 27,88 grs. of its weight when weighed in water in temperature 56°, suspended commonly by a horse hair, but when dipped in strong nitrous and marine acids it is suspended by a fine gold wire, and then lost 27,78 grs of its weight in water.

"I also examined and rectified, in some instances, many parts of the first 50 numbers of the table in the same manner, but in general I found them just.

TABLE

---

of measures of alcohol in any mixture, x, and the increase of density or diminution of volume z, we shall have $c : z :: \frac{n}{2}\times\frac{n}{2} : \overline{n-x}\times x$: and $z=\frac{4c}{n2}\times\overline{nx-x^2}$: or making $n=1$, $4cx-4cx^2$. The increase of density, calculated according to the formula, corresponds pretty nearly with experiments; for in all mixtures in which the alcohol is in greater quantity than water, but not in those cases in which the water is in greatest proportion, the real increase of density is much less than by calculation, and the differences become more considerable as the quantity of water is increased. M. Pouget thinks, that when the quantity of water is greater than that of alcohol, the law of absorption is disturbed; and he conjectures that it is owing to the attraction of the particles of the water among themselves, which consequently oppose their union with any other substance. But when the alcohol forms at least the half of the whole mass, the diminutions of bulk are as the products of the numbers which express the proportions of alcohol and water forming the mixture: they may be represented by the formula $z=\frac{4cnx-4cx^2}{n^2}$. By this formula may be determined the strength of spirits of wine of commerce, or the number of parts of water and standard alcohol of which they are composed.

The number of measures of the whole mass or the bulk	$=1$
The number of measures of alcohol in any mixture	$=x$
The diminution of bulk of equal parts by experiment	$=c$
The diminution of bulk of a mixture containing x measures of alcohol by hypothesis	$=4cx-4cx^2$
The specific gravity of water	$=a$
Specific gravity of alcohol	$=b$
Specific gravity of the unknown mixture	$=y$

Since the increase of density does not change the weight of the mass, we shall have $\overline{1-x}\times a+bx=\overline{1-4cx+4cx^2}\times y$.

By this equation may be found the value of x or the proportion of alcohol, having previously ascertained the specific gravity of the mixture, and to determine this specific gravity, or the value of y by knowing the property of alcohol. Hence,

$$x=0.5\frac{a-b}{8cy}+\sqrt[2]{\frac{a-y}{4cy}+\left(\frac{a-b}{8cy}-0.5\right)^2}$$

$$y=\frac{a-ax+bx}{1-4cx+4cx^2}$$

And making $a=1$, $b=0.8199$, $c=0.0288$

$$x=0.5\frac{0.1801}{0.2304y}+\sqrt[2]{\frac{1-y}{0.1152y}+\left(\frac{0.1801}{0.2304y}-0.5\right)}$$

$$y=\frac{1-0.1801x}{1-0.1152x+0.1152x}.$$

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TABLE of the Quantity of the Standard Sulphuric Acid 2,000 in Sulphuric Acid of inferior Density.

100 Parts.	Standard Temp. 60°	100 Parts.	Standard.	100 Parts.	Standard.
2,000	100	1,6217	67	1,2847	34
1,9859	99	1,6122	66	1,2757	33
1,9719	98	1,6027	65	1,2668	32
1,9579	97	1,5932	64	1,2589	31
1,9439	96	1,5840	63	1,2510	30
1,9299	95	1,5748	62	1,2415	29
1,9168	94	1,5656	61	1,2320	28
1,9041	93	1,5564	60	1,2210	27
1,8914	92	1,5473	59	1,2101	26
1,8787	91	1,5385	58	1,2009	25
1,8660	90	1,5292	57	1,1918	24
1,8542	89	1,5205	56	1,1836	23
1,8424	88	1,5112	55	1,1746	22
1,8306	87	1,5022	54	1,1678	21
1,8188	86	1,4933	53	1,1614	20
1,8070	85	1,4844	52	1,1531	19
1,7959	84	1,4755	51	1,1398	18
1,7849	83	1,4666	50	1,1309	17
1,7738	82	1,4427	49	1,1208	16
1,7629	81	1,4189	48	1,1129	15
1,7519	80	1,4099	47	1,1811	14
1,7416	79	1,4010	46	1,0955	13
1,7312	78	1,3875	45	1,0896	12
1,7208	77	1,3741	44	1,0833	11
1,7104	76	1,3663	43	1,0780	10
1,7000	75	1,3586	42	1,0725	9
1,6899	74	1,3473	41	1,0666	8
1,6800	73	1,3360	40	1,0610	7
1,6701	72	1,3254	39	1,0555	6
1,6602	71	1,3149	38	1,0492	5
1,6503	70	1,3102	37	1,0450	4
1,6407	69	1,3056	36	1,0396	3
1,6312	68	1,2951	35	1,0343	2

"The last eleven numbers were only found by analogy, observing the series of decrements in the four preceding densities, and therefore are to be considered barely as approximations.

"To reduce vitriolic acids of given densities, at any degree of temperature between 49° and 70°, to that which they should have at temperature 60°, in order that their proportion of standard may be thereby investigated, I made the following experiments:

Degrees of Temperature.	Sp. Gr. of A.	Sp. Gr. of B.	Sp. Gr. of C.
70°	1,8292	1,6969	1,3845
65	1,8317	1,6983	1,3866
60	1,8360	1,7005	1,3888
55	1,8382	1,7037	1,3898
50	1,8403	1,7062	- -
49	1,8403	- -	1,3926

"Hence we see that vitriolic acid, whose density at any degree between 49° and 60° resembles or approaches the corresponding density in the column A, gains or loses 0,00126 of its specific gravity by *every two* degrees between 60° and 70° of Fahrenheit, and 0,0086 by *every two* degrees between 49° and 60°.

"Secondly, That any vitriolic acid, whose density at any degree between 50° and 70° resembles or approaches to the corresponding density in the column B, gains or loses 0,00158 for every two degrees between 60° and 70°; and 0,0017 by every two degrees between 50° and 60°. Whence it appears that the stronger acid is less altered by variations of temperature than the weaker, which formerly appeared to me an irregularity, but now seems to proceed from the increase of the accrued density, when larger proportions of water are mixed with the stronger acid.

"3dly, Sulphuric acid, whose density at any degree between 50° and 70° resembles the corresponding at the same degree in the column C, gains or loses 0.00086 for every two degrees between 60° and 70° inclusively, and 0.00076 between 50° and 60°. Between 45° and 50° I could perceive no difference *.

* Irish Trans. vol. iv. p. 7.

470 Composition.

9. Attempts have been made to determine the proportion of oxygen and sulphur, which enter into the composition of sulphuric acid. According to the experiments of Lavoisier, in which he measured the quantity of oxygen absorbed, by a given weight of sulphur during combustion, the proportions are,

71 sulphur,
29 oxygen.

100

But other methods have been adopted, which promise more accurate results. These are, by decomposing other substances which contain oxygen, by means of sulphur. According to the experiments of Mr Chenevix, conducted in this way, the sulphuric acid consists of

61.5 sulphur,
38.5 oxygen.

100.0

10. Sulphuric acid does not combine with oxygen, nor has it any action with azotic gas.

11. It appears that hydrogen has a greater affinity for oxygen, than the sulphur has, and therefore the sulphuric acid is decomposed by means of hydrogen gas. In the cold there is no action between hydrogen gas and sulphuric acid; but if they are made to pass through a red-hot porcelain tube, the acid is decomposed; water is formed and sulphur is precipitated. When hydrogen gas is employed in a greater proportion than the half of the acid, the superabundant gas dissolves the sulphur, and is disengaged in the form of sulphureted hydrogen gas. 471 Action with hydrogen.

12. Charcoal has no action on sulphuric acid in the cold; but at the boiling temperature, it decomposes it, and converts it into sulphurous acid. If a piece of red-hot charcoal be immersed in a quantity of concentrated sulphuric acid, part of the acid is suddenly disengaged under the form of thick white fumes, accompanied with sulphurous acid gas. The sulphuric acid is decomposed; part of its oxygen is attracted by the charcoal, forming carbonic acid, and thus it is reduced to 472 Charcoal.

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to the lowest proportion of oxygen, in the state of sulphurous acid.

473 Phosphorus. 13. A similar effect is produced by phosphorus. Phosphorus, with the assistance of heat, partially decomposes the sulphuric acid, by abstracting part of its oxygen. Phosphoric acid is formed, and sulphurous acid driven off.

474 Sulphur. 14. In the cold, sulphur has no action on sulphuric acid; but, when they are boiled together, the sulphur is partly dissolved in the acid, and converts it into sulphurous acid. The sulphur which has been added combines with the oxygen, which is necessary for the constitution of sulphuric acid, and thus the whole is converted into sulphurous acid.

475 Sulphates. 15. Sulphuric acid combines with alkalies, the earths, and the metals, forming salts; which, in the present language of chemistry, are denominated *sulphates*.

476 Uses. 16. This acid is employed in great quantity in many arts and manufactures. It is employed also in medicine and pharmacy; the preparation of it, therefore, has long been an object of considerable importance.

477 Affinities. 17. The order of the affinities of sulphuric acid is the following:

Barytes,
Strontites,
Potash,
Soda,
Lime,
Magnesia,
Ammonia,
Glucina,
Yttria,
Alumina,
Zirconia,
Oxide of Zinc,
Iron,
Manganese,
Cobalt,
Nickel,
Lead,
Tin,
Copper,
Bismuth,
Antimony,
Arsenic,
Mercury,
Silver,
Gold,
Platina.

Sect. II. *Of Sulphurous Acid.*

478 Names. 1. According to the received nomenclature of the acids, the term *sulphurous* signifies that this acid contains a smaller proportion of oxygen. It was formerly called *spirit of sulphur*, and *volatile sulphurous acid*.

479 History. Although the ancients must have been acquainted with some of its properties, as it is formed during the slow combustion of sulphur, Stahl is the first chemist who examined it with attention. He supposed that it was the sulphuric acid combined with his imaginary principle of phlogiston. Hence he called it *phlogisticated* sulphuric acid. It was not till the year 1774 that its nature and composition were discovered by the labours of Priestley and Lavoisier. Berthollet afterwards investigated the formation, decomposition, combinations, and uses of this acid. Fourcroy and Vauquelin * also have examined many of its properties, especially the saline compounds which it forms.

* *Ann. de Chim.* tom. xxiv. p. 229.

2. The sulphurous acid exists in nature in great abundance, particularly in the neighbourhood of volcanoes. It is disengaged from some lavas while in a state of fusion, and from the soil which is impregnated with sulphur, when a sufficient degree of heat is applied. 480 Abundant in nature.
It was by the vapours of sulphurous acid that Pliny the naturalist was suffocated in the eruption of Mount Vesuvius, which destroyed Herculaneum, in the 79th year before the Christian era. 481 Fatal to Pliny.

3. When sulphur is burnt in the open air, the fumes generated by this slow combustion, are sulphurous acid. It was in this way that this acid was formerly obtained. The method of procuring it, which is now followed, is to decompose the sulphuric acid by means of any substance which deprives it of part of its oxygen. If one part of mercury and two parts of concentrated sulphuric acid be exposed to heat in a glass retort, the mixture effervesces, and a gas is disengaged, which may be collected in jars over mercury. In this process the mercury attracts part of the oxygen of the sulphuric acid, and leaves behind that portion which constitutes the sulphurous acid. 482 Formation.

4. Sulphurous acid thus obtained is in the state of gas, and it is an elastic, invisible, and colourless fluid, like common air. 483 In the state of gas. It is rather more than double the weight of atmospheric air. Its specific gravity is 0.00246; 100 cubic inches weigh nearly 63 grains. It has a pungent smell; is unfit for respiration, and for supporting combustion. It at first reddens vegetable blues, and then destroys the greater number of them. It is on account of this property that the fumes of sulphur are employed to remove the stains of fruit from linen, and that the sulphurous acid is often used in bleaching. 484 Properties.

5. Sulphurous acid gas refracts the light strongly, without undergoing any change. When strongly heated, as in a red-hot porcelain tube, it remains unaltered, according to the experiments of Fourcroy. But Dr Priestley and Berthollet found that it deposited sulphur after long exposure to heat. At the temperature of — 31° it becomes liquid. This property, which distinguishes it from other gases, and which was discovered by Monge and Clouet, is ascribed by Fourcroy to the water it holds in solution. 485 Action with caloric.

6. When sulphurous acid is in the form of gas, it does not readily combine with oxygen. In its fluid form it unites with it more freely, and is converted into sulphuric acid. A mixture of sulphurous acid gas and oxygen, in passing through a red-hot tube, combine together, and are converted into sulphuric acid. There seems to be no action between sulphurous acid and azotic gas. 486 With oxygen gas, &c.

7. Hydrogen gas has no action on sulphurous acid gas in the cold; but when a mixture of these gases is made to pass through a red-hot tube, sulphurous acid is decomposed; the hydrogen combines with the oxygen and forms water, and sulphur is deposited. If the hydrogen gas be in greater proportion than the oxygen 487 With hydrogen gas.

 contained

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contained in the sulphurous acid, it dissolves part of the sulphur, and passes off in the form of sulphurated hydrogen gas.

488 With charcoal. 8. Its action with charcoal is somewhat similar. In the cold there is none; but exposed together to a red heat, carbonic acid is formed by the union of carbon and oxygen, and sulphur is deposited.

489 With phosphureted hydrogen gas. 9. There is no action whatever between phosphorus and sulphurous acid gas; but phosphureted hydrogen gas is decomposed by this acid. When the two gases come in contact, a white thick vapour is produced; sulphur combined with phosphorus in the solid state is deposited, and water is formed.

490 Sulphureted hydrogen gas. 10. Sulphur has no action on this acid; but sulphureted hydrogen gas, at the instant it comes in contact with sulphurous acid gas, is condensed; solid sulphur is deposited, and water is formed, with the extrication of caloric.

491 With water. 11. Water has a strong attraction for sulphurous acid gas. A piece of ice brought in contact with it, is immediately melted without any perceptible change of temperature. Water saturated with this gas is known by the name of *liquid sulphurous acid*. The specific gravity is 1.040. At the temperature of 43° water combines with $\frac{1}{3}$ of its weight of sulphurous acid gas †; but as the temperature increases, it absorbs it in smaller proportions. It freezes at a temperature a few degrees below 32°, and it passes into the solid state without parting with any of its acid. Liquid sulphurous acid has the smell, taste, and other properties of the gas, and particularly that of destroying vegetable colours. When exposed to the atmosphere, it gradually absorbs oxygen, and passes into the state of sulphuric acid. This change goes on more rapidly when it is diluted with water, and agitated in contact with the air.

† *Fourcroy, Connaiss. Chim.* ii. 76.

492 With sulphuric acid. 12. Sulphuric acid separates the sulphurous acid in the gaseous form from its combinations, and even from water. Concentrated sulphuric acid absorbs this gas, which imparts to it a yellowish brown colour, and renders it pungent and fuming. The two acids strongly attract each other, so that when they are exposed to the action of heat, the first vapour which rises crystallizes in long, white, needle-shaped prisms. This is a compound of the two acids. It smokes in the air, dissolves with effervescence in it, and when thrown into water produces a hissing noise, like a red-hot iron. It has the strong smell of sulphurous acid. This substance was formerly called *glacial sulphuric acid* *.

493 Glacial sulphuric acid.

* *Ibid.* ii. p. 78.

494 Uses. 13. Sulphurous acid is very much employed in the arts, and sometimes in medicine. In the state of gas it is used for the bleaching of silk and wool, by extracting the colouring matter. It removes also the stains arising from vegetable juices, and spots of iron, from linen.

495 Composition. 14. According to the analysis of Dr Thomson, 100 parts of this acid are composed of

68 sulphur,
32 oxygen.

100

496 Affinities. 15. The compound salts formed by this acid are denominated *sulphites*.

16. The following is the order of its affinities:

Barytes,
Lime,
Potash,
Soda,
Strontites,
Magnesia,
Ammonia,
Glucina,
Alumina,
Zirconia.

SECT. III. *Of Nitric Acid.*

1. This acid was formerly known by the name of aquafortis, and spirit of nitre. Raymond Lully, who lived in the 13th century, seems to have been acquainted with it; and Basil Valentine, who lived in the 15th, describes the process for preparing it. He calls it *water of nitre*. But till the discoveries of modern chemistry, little was known of the nature, properties, and composition of this acid. It is to the experiments and researches of Cavendish and Priestley, of Lavoisier and Berthollet, that we are indebted for the knowledge we possess of it. 497 Names. 498 History.

2. Nitric acid exists in great abundance in nature. It is formed by the union of its constituent parts which are evolved during the putrefactive process of animal and vegetable matters; but it is never found, except in combination with some base, from which it must be extracted by art. The component parts of nitric acid are azote and oxygen. The name in this case is not derived from the base, which is azote, but from nitre, from which it is generally obtained. This acid cannot be formed merely by bringing in contact the two gases which are its constituent parts; but if they are mixed together in certain proportions, and electric sparks sent through the mixture, the gases disappear, and are converted into a liquid. This is *nitric acid*. By a similar experiment Mr Cavendish discovered the composition of the acid. 499 Abundant in nature.

3. This acid may be obtained by putting three parts of nitre with one of sulphuric acid into a glass retort, and distilling with a strong heat. The gas which comes over is condensed in a glass receiver, to which the retort is to be luted. The gas which is condensed is nitric acid. Nitre is composed of this acid and potash: but potash has a stronger affinity for sulphuric acid than for nitric acid; it therefore combines with the sulphuric acid in the retort, and the nitric acid is disengaged, and passes over in the gaseous form. 500 Method of procuring it.

4. The acid thus obtained is contaminated with muriatic, and sometimes with sulphurous acid. It is purified by distillation with a gentle heat. At first too it is of a yellow colour, which is owing to the fumes of nitric oxide gas with which it is combined. These fumes are driven off by heat, after which the acid remains pure, and is transparent and colourless. 501 Of purifying it.

5. Thus prepared, it has a strong acid taste; a disagreeable pungent odour, and gives a yellow colour to the skin. The specific gravity of strong nitric acid is 1.583, or, according to Mr Kirwan, at temperature 60°, 1.554. 502 Properties.

6. Nitric acid and one of its compounds, nitre, have long been the subject of the experiments and researches of 503 Discovery of its composition.

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of chemical philosophers. In investigating the nature of nitre, Mayow found that it possessed a common property with atmospheric air; namely, the property of giving a red colour to the blood. And, from observing that air was deprived of this property by the process of combustion and respiration, he drew the curious conclusion, that nitre contained that part of the air which is necessary for respiration and combustion.

7. When nitric acid dissolves metallic substances, a great quantity of a peculiar gas makes its escape, and the metal acquires considerable weight during this process. According to the phlogistic theory, it was supposed that the metal was deprived of its phlogiston, and that this phlogiston had combined with the nitrous gas which had escaped. This was Dr Priestley's explanation. But it was differently explained by Lavoisier. He took 1104 grs. of mercury, and added to it 945 grs. of nitric acid. Nitrous gas was emitted during the solution, and when he exposed the mercury which had been converted into an oxide, to a red heat, oxygen gas was given out, and the mercury appeared in the metallic state. He therefore concluded, that the nitric acid in this case was decomposed, and that it consisted of oxygen which combined with the metal, and of nitrous gas which was driven off. The proportions, he supposed, were, 64 parts of nitrous gas by weight, and 36 of oxygen gas. He found, however, that the quantity of oxygen obtained in this process, was sometimes greater than what was necessary to saturate the nitrous gas; and he was at a loss to account for this quantity. His own experiments, as well as some of Dr Priestley's, proved, that azote is a component part of nitre.

Mr Cavendish, who discovered the composition of water, in his experiments and researches on that subject, found, that nitric acid was produced during the explosion of oxygen and hydrogen gases; and that he could increase this quantity by adding azotic gas to the mixture before combustion. From this he concluded, that the formation of the acid depended on the azotic gas. He proved this by passing electrical sparks through common air in a glass tube. The air diminished in bulk, and nitric acid was formed. Repeating a similar experiment with oxygen and azotic gases in certain proportions, he found that the whole could be converted into nitric acid †. Mr Cavendish repeated the same experiments, with a view to remove some objections which had been made to his conclusions. They were followed by the same result, and the fact of the composition of nitric acid was thus fully established ‡.

† *Phil. Trans.* 1784.

‡ *Ibid.* 1788, p. 261.

To perform this experiment, take a glass tube of about one sixth of an inch in diameter. Close one end with a cork, through which let a metallic conductor with a ball at each extremity be passed. Fill the tube with mercury; immerse the open end into the mercurial trough; introduce a mixture of .13 parts of azotic gas, and .87 of oxygen gas, occupying three inches of the tube, and a solution of potash filling one-half inch more. Let electrical explosions be sent through the tube till the air ceases to be diminished in bulk. If the experiment succeed, the potash will be found converted into nitre, which shews that the nitric acid, which is a component part of nitre, has been formed during the process.

8. Nitric acid, having a strong affinity for water, is never found entirely deprived of this liquid. When exposed to the air, it attracts moisture from it, and heat is given out when it is mixed with water. Mr Kirwan has endeavoured to ascertain the relative strength of nitric acid of different densities or specific gravities; and the method which he adopted was the following. He saturated 36 grs. of carbonate of soda with 147 grs. of nitric acid, of specific gravity 1.2754, which contained 45.7 per cent. of standard acid, of specific gravity 1.5543. The carbonic acid which escaped amounted to 14 grs.; and by adding 939 grs. of water, the specific gravity of the solution, at the temperature of 58.5°, was 1.0401. By a similar test with that employed in ascertaining the strength of sulphuric acid, namely, by comparing this solution with one of nitrate of soda of the same density, he found the quantity of salt amounted to $1.\frac{16}{901}$ parts. There was an excess of acid of about 2 grs. The whole weight was 1439 grains. The quantity of salt, therefore, was $\frac{1439}{16.901}=85.142$ grs. The quantity of pure alkali was .50—14=36.05 grs. The quantity of standard acid was 66.7; the sum of both =102.75. Of this quantity only 85.142 entered into combination with the salt, the remaining 17.608 were mere water, given out by the standard acid. If then 66.7 parts standard acid lose 17.608 parts water combining with the alkali, 100 parts should lose 26.38. And, as Mr Kirwan has made it probable, that nitrate of soda contains very little water in its composition; 100 parts of standard nitric acid is composed of 73.62 of pure acid, and 26.38 of water §.

504 Absorbs water.

505 Method of determining the quantity.

§ *Irish Trans.* vol. iv. p. 34.

The following table, drawn up by Mr Kirwan, shews the quantity of pure acid in nitric acid of different specific gravities.

100 Parts. Sp. Gravity.	Real Acid.	100 Parts. Sp. Gravity.	Real Acid.
1.5543	73.54	1.4171	53.68
1.5295	69.86	1.4120	52.94
1.5183	67.12	1.4069	52.21
1.5070	68.39	1.4018	51.47
1.4957	67.65	1.3975	50.74
1.4844	66.92	1.3925	50.00
1.4731	66.18	1.3875	49.27
1.4719	65.45	1.3825	48.53
1.4707	64.71	1.3775	47.80
1.4695	63.98+	1.3721	47.06
1.4683	63.24	1.3671	46.33
1.4671	62.51	1.3621	45.59
1.4640	61.77	1.3571	44.86+
1.4611	61.03	1.3521	44.12
1.4582	60.30	1.3368	43.38
1.4553	59.56	1.3417	42.65
1.4524	58.83	1.3364	41.91
1.4471	58.09	1.3315	41.18
1.4422	57.36	1.3264	40.44
1.1373	56.62	1.3212	39.71
1.4324	55.89	1.3160	38.97
1.4275	55.15	1.3108	38.34
1.4222	54.12+	1.3056	37.50

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100 Parts. Sp. Gravity.	Real Acid.	100 Parts. Sp. Gravity.	Real Acid.
1.3004	36.77	1.2015	25.00
1.2911	36.03	1.1963	24.26
1.2812	35.30+	1.1911	23.53
1.2795	34.56	1.1845	22.79
1.2779	33.82	1.1779	22.06
1.2687	33.09	1.1704	21.32
1.2586	32.35	1.1639	20.59
1.2500	31.62	1.1581	19.85
1.2464	30.88	1.1524	19.12
1.2419	30.15	1.1421	18.48
1.2374	29.41	1.1319	17.65+
1.2291	29.68	1.1284	16.91
1.2209	27.94	1.1241	16.17
1.2180	27.21+	1.1165	15.44
1.2152	26.47	1.1111	14.70
1.2033	25.74+	2.1040	13.27

Sir H. Davy has, from his own experiments, deduced the real quantities of nitric acid in solutions of different specific gravities, and has assigned the following proportions *.

* Davy's Researches, p. 41.

Table of the quantities of True Nitric Acid in solutions of different Specific Gravities.

100 Parts Nitric Acid, of specific gravity.	True Acid (M).	Water.
1,5040	91,55	8,45
1,4475	80,39	19,61
1,4285	71,65	28,35
1,3906	62,96	37,04
1,3551	56,88	43,12
1,3186	52,03	47,97
1,3042	49,04	50,96
1,2831	46,03	53,97
1,2090	45,07	54,73

506 Action of light.

9. When colourless nitric acid is exposed to the light, it undergoes a partial decomposition. Some oxygen gas is separated, the acid assumes an orange yellow colour, and part of it passes into the state of nitrous acid.

10. It boils at the temperature of 248°, and is entirely dissipated without alteration, if the heat be continued. When it is made to pass through a red-hot porcelain tube, it is decomposed, and converted into its constituent parts, oxygen and azotic gases †. When nitric acid is cooled down to the temperature of —55°, it begins to crystallize in a few minutes, assumes a deep-red colour, and congeals into a thick mass resembling butter, by agitating the vessel which contains it †.

† Fourcroy Connais. Chim. tom. ii. p. 81.

† Annal. de Chim. vol. xxix. p. 282.

11. There is no action between nitric acid and oxygen or azotic gases; but when concentrated nitric acid is exposed to the air, the vapour which it exhales combines with the moisture of the atmosphere, forms white fumes, and is condensed into a liquid. 507 Of oxygen.

12. Hydrogen gas has no action on nitric acid at the ordinary temperature of the atmosphere; but, if they are made to pass through a red-hot porcelain tube, there is a violent combustion with detonation. Water is formed by the combination of the hydrogen with the oxygen of the acid; and azotic gas, its other constituent part, is evolved. 508 Hydrogen. Of combustible bodies.

13. Nitric acid is also decomposed by charcoal at a high temperature. Carbon combines with the oxygen, and forms carbonic acid, while the azotic gas is set at liberty.

14. It is also decomposed in the same way by phosphorus and sulphur. When the acid is poured upon these combustibles at a high temperature, inflammation takes place, and they are converted into phosphoric and sulphuric acids.

15. When nitric and sulphuric acids are mixed together, heat is evolved. The sulphuric acid attracts the water which existed in the nitric acid, and this water being more condensed in combination with sulphuric acid, the caloric with which it was combined along with the nitric acid, is given out. Thus, the nitric acid becomes more concentrated by the addition of the sulphuric acid. 509 Of sulphuric acid.

When nitric and sulphurous acids are mixed together, a very different action takes place. The nitric acid separates it from water and its other combinations; parts with its oxygen, and thus converts it into sulphuric acid, and passes itself into the state of nitric oxide gas. 510 Of sulphurous acid.

16. According to Lavoisier, the proportions of the component parts of nitric acid are, one part azote and four parts oxygen. This was the result of his experiments on the decomposition of nitre by charcoal. According to Mr Cavendish, the proportions of the azote and oxygen combined by electricity are one part azote and 2.346 of oxygen. The result of Sir H. Davy's experiments shews that 100 parts of pure nitric acid are composed of 511 Composition.

29.5 azote.
70.5 oxygen.

100.0

17. The combinations which are formed with the nitric acid, and the alkalies, earths, and oxides of metals, are denominated *nitrates*. 512 Combination.

(M) The quantities of oxygen and nitrogen in any solution, may be thus found: Let A = the true acid, X the oxygen, and Y the nitrogen,

$$\text{Then } X = \frac{238A}{239} \text{ and } Y = \frac{A}{239}.$$

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Acids.

513 Affinities. 18. The order of the affinities of nitric acid is the following.

Barytes,
Potash,
Soda,
Strontites,
Lime,
Magnesia,
Ammonia,
Glucina,
Alumina,
Zirconia,
Oxide of Zinc,
Iron,
Manganese,
Cobalt,
Nickel,
Lead,
Tin,
Copper,
Bismuth,
Antimony,
Arsenic,
Mercury,
Silver,
Gold,
Platinum.

514 Uses. 19. This is one of the most important of the acids, considered as an instrument of analysis in the hands of the chemist. It is employed in many arts. It is also used in medicine, for diseases of the skin; and sometimes as a cure in venereal affections. Perhaps it may be regarded as a useful auxiliary to the ordinary remedies.

Sect. IV. *Of Nitrous Acid.*

515 Method of procuring. 1. Nitrous acid bears the same relation to nitric acid that sulphurous acid bears to sulphuric; that is, the constituent parts of nitric acid are in different proportion from those of nitrous acid. Nitrous acid may be formed by combining nitric oxide gas with nitric acid: and it was at one time contended, that it is a mere mixture of these two substances. It is now, however, generally admitted, that the nitrous acid is as much a distinct compound, as any other of the compounds of azote.

516 Composition. 2. Sir H. Davy finds, that two measures of nitric oxide gas and 1 of oxygen (= 1 azote and 2 oxygen) are condensed into half their volume, forming nitrous acid gas. One hundred grains of this contain, by weight,

Azote	30.32
Oxygen	69.68.

517 Liquid acid. 3. When absorbed by water to saturation, it constitutes liquid nitrous acid; the water first becomes green, then blue, and then orange, depending on the quantities absorbed. This acid boils at 160, while the nitric boils at 236.

518 Action of light and heat. 4. Light has no action on nitrous acid; but when heat is applied, nitric oxide gas is driven off, and nitric acid remains behind. In the state of vapour, nitrous acid remains unchanged by the action of heat.

5. Neither oxygen gas, azotic gas, nor atmospheric air, produce any change on nitrous acid.

6. On combustible bodies the action of this acid is nearly similar to that of the nitric; but many substances are more rapidly inflamed by nitrous acid. This seems to depend on the nitrous acid being more easily decomposed, and giving up its oxygen, which is less strongly attracted by the azote, on account of the greater proportion of caloric united with it. It decomposes phosphureted and sulphureted hydrogen gases, and precipitates the phosphorus and the sulphur. 519 Combustibles.

7. Sulphuric acid combines with the vapour of nitrous acid, which communicates the property of disposing the sulphuric acid to crystallize. Nitrous acid converts sulphurous into sulphuric acid, and, at the same time, parts with its nitric oxide gas. 520 Sulphuric acid.

8. Nitrous acid enters into combination with the alkalies and earths. The compounds are distinguished by the name of *nitrites*. These compounds are not made by direct combination, and therefore the affinities of this acid are little known. 521 Compounds.

Sect V. *Of Muriatic Acid and Chlorine.*

1. The composition of this acid is at the present moment matter of controversy; but before entering on this, we shall state the facts known relative to it. The name of muriatic acid is derived from the Latin word *muria*, which signifies sea-salt, the substance from which the acid is usually extracted. It was formerly denominated *spirit of salt*, *acid of salt*, and *marine acid*. 522 Composition disputed. 523 Names.

2. Muriatic acid may be obtained by putting 100 parts of dry common salt, and 35 of sulphuric acid, into a retort or matrass with a bent tube. The beak of the retort at the end of the tube must communicate with a receiver containing water, that the muriatic acid may be condensed as it passes into the receiver. In this way liquid muriatic acid may be obtained. 524 Method of procuring.

3. But if the gas which comes over is received in a jar inverted in the mercurial apparatus, its properties may be examined in the state of gas. When it first passes over, it is in the form of white smoke. 525 In the state of gas.

4. Muriatic acid gas possesses the physical properties of common air. It is an invisible elastic fluid. It has a strong acid taste, and a very pungent smell. The specific gravity, according to Kirwan, is 0.002315. 526 Properties.

5. It is unfit for respiration, and equally so for supporting combustion.

6. This gas has a strong attraction for water. If a little water be introduced into a jar filled with this gas, standing over mercury, the whole of the gas will be absorbed, and the mercury will instantaneously rise to the top. Or if a jar filled with muriatic acid gas be inverted into a vessel of water, coloured with vegetable blue, the water suddenly rushes into the jar, which it completely fills, and the blue colour is changed to red, exhibiting the usual effects of acids on vegetable colours. 527 Action of water.

7. Light has no action whatever on this gas, nor does it undergo any change when it is made to pass through a red-hot porcelain tube. In the state of gas, it has no action upon oxygen gas. When this gas comes in contact with atmospheric air, thick white fumes are produced, with the extrication of caloric. This is a combination 528 Light and heat.

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Acids. combination of the gas with the water in the atmosphere, by which they are mutually condensed.

8. There is no action between muriatic acid gas and azote, hydrogen, charcoal, phosphorus, or sulphur.

529 Combines with water in great proportion. 9. The quantity of muriatic acid which water absorbs is very considerable. Ten grains of water combine with ten grains of the gas. The liquid acid thus formed occupies the space of 13.3 grains, and hence its specific gravity is 1.500; and the specific gravity of the purest muriatic acid in its condensed state is 3.300.

The specific gravity of the strongest muriatic acid that can easily be procured and preserved, is 1.196. One hundred parts of this, Mr Kirwan calculates, will contain about 49 of acid, whose specific gravity is 1.500, which he calls the standard acid.

530 Properties. 10. Liquid muriatic acid, in its ordinary state, is of a pale yellow colour; but when pure, it is transparent and colourless.

531 Action of light and heat. 11. Light has no action whatever on muriatic acid. When heat is applied, it readily assumes the gaseous form. Neither oxygen nor azotic gases are absorbed by muriatic acid, nor has this acid any action on hydrogen, charcoal, phosphorus, or sulphur.

532 Of sulphuric acid. 12. Sulphuric acid separates the muriatic acid from its compounds, and even from its combination with water; but the muriatic acid drives off the sulphurous acid from this liquid.

533 Of nitric acid. 13. One of the most remarkable characters of muriatic acid, is its combination with nitric acid. When these two acids are mixed together, they act upon each other, are strongly heated, and produce effervescence, with a change of colour to an orange red. A mixed acid is thus formed, which possesses properties which existed neither in the one acid nor the other when in a state of separation. It was formerly called *aqua regia*, from its property of dissolving gold, which was distinguished by the name of *king of the metals*.

534 Nitro-muriatic acid. It is now denominated *nitro-muriatic acid*. This acid is not to be considered as a simple mixture of the two acids. A double attraction takes place in their mutual action; the muriatic acid attracts part of the oxygen of the nitric acid, and the nitric combines with the nitrous gas. The muriatic acid thus combined with a portion of oxygen, is disengaged with effervescence in yellow fumes; the undecomposed nitric acid seizes the nitric oxide gas which is formed, and when it is saturated with it, the action ceases. Hence arises the colour of the mixed acid. The peculiar effect of the nitro-muriatic acid on metallic substances, will be described in treating of the metals.

535 Action of electricity. 14. The bulk of muriatic acid gas is greatly diminished by the action of electricity, and hydrogen gas is given out; but this action is limited. Dr Henry has shewn that it is not owing to the decomposition of the acid, as might at first sight be supposed, but to the decomposition of water which it holds in solution; so that the action continues as long as there is any moisture in the gas. The oxygen of the water combines with the acid, and forms oxymuriatic acid: while the hydrogen of the water is evolved.

536 Uses in destroying noxious vapours. 15. Muriatic acid gas has been successfully employed in destroying noxious, putrid exhalations. It was applied in this way in the year 1773 by Morveau, in purifying the cathedral of Dijon from these exhalations, on account of which it had been altogether deserted. Acids.

16. The compounds which are formed by muriatic acid, with alkalies, earths, and metallic oxides, are distinguished by the name of *muriates*. 537 Compounds

17. The following is the order of the affinities of this acid. 538 Affinities.

Barytes,
Potash,
Strontites,
Lime,
Ammonia,
Magnesia,
Glucina,
Alumina,
Metallic oxides.

1. Oxymuriatic acid, now called chlorine, was discovered by Scheele in the year 1774, and he gave it the name of *dephlogisticated marine acid*. On account of its singular properties, and the important uses to which it was soon applied, it has been much examined by chemical philosophers. 539 Oxymuriatic acid, or chlorine.

2. This substance is obtained by the following process: Take three parts of common salt, and one part of the black oxide of manganese reduced to powder. Introduce them into a tubulated retort; place the retort in a sand bath, and immerse its beak under the surface of warm water in the pneumatic trough. Pour upon it two parts of sulphuric acid a little diluted with water. An effervescence takes place, and a lemon-coloured gas is evolved, which may be received in jars, or preserved in large vessels with ground stoppers. 540 Method of procuring.

The nature of this process seemed till lately sufficiently obvious. Common salt is composed of muriatic acid and soda; the affinity of sulphuric acid for soda is stronger than that of muriatic acid; it therefore combines with the soda, and the muriatic acid is disengaged in the state of gas. The black oxide of manganese is composed of oxygen and the metallic substance. The sulphuric acid combines with the manganese at a lower stage of oxidation, and sets oxygen at liberty in the state of gas. But there is also an affinity between the muriatic acid and oxygen, so that in the moment of evolution they unite, and pass off in the state of oxymuriatic acid gas. This rationale of the process is now however disputed. We shall state the grounds of dispute, after we have detailed the properties of the substance obtained.

3. This gas is of a yellowish green colour, and is hence called chlorine; has a strong penetrating odour, and excites violent coughing, when a mixture of it with atmospheric air is respired. The pure gas is totally unfit for respiration. This gas supports combustion. It diminishes and reddens the flame of a taper; much smoke is evolved, and the taper consumes rapidly. 541 Properties.

4. Neither light nor heat have any action on the gas. When passed through red-hot porcelain tubes, it remains unchanged. 542 Unchanged by light and heat.

5. It has no action whatever on oxygen or azotic gases. 543 Action on inflammable substances.

6. In the cold no effect is produced from a mixture of this gas with hydrogen gas; but when they are passed

Acids.

passed through a red-hot tube, a violent detonation takes place.

7. In the cold there is no action between charcoal and this gas. When a mixture of equal bulks of this gas and carbureted hydrogen gas is inflamed, there is only a combustion of the hydrogen gas, with a deposition of charcoal. If two measures of oxymuriatic acid gas, and one measure of carbureted hydrogen gas, are mixed together in a close phial, and allowed to remain for 24 hours, they decompose each other. Water, muriatic acid, carbonic acid, and carbonic oxide, are the products. When water is admitted, the whole is nearly absorbed.

8. A bit of dried phosphorus introduced into this gas, is instantly inflamed, and converted into phosphoric acid. It also sets fire to phosphorated hydrogen gas, which has lost the property of spontaneous inflammation in the air.

9. Melted sulphur, plunged into this gas, is immediately inflamed, and converted into sulphuric acid. Sulphureted hydrogen gas is decomposed, but without inflammation, and sulphur is deposited.

544 Sulphurous acid.

10. There is no action between this gas and sulphuric acid; but, when sulphurous acid gas is mixed with it, a thick white vapour is formed, which is the sulphurous acid converted into sulphuric acid, by depriving the oxymuriatic gas of its oxygen. It has no effect on nitric acid; but nitric oxide gas brought into contact with it, is reddened, and converted into nitrous acid.

545 In the liquid state.

11. What is commonly known by the name of *oxymuriatic acid*, is water saturated with this gas. It has a pale green colour, and exhales the same odour as the gas. According to Berthollet, a cubic inch of water absorbs $1\frac{6}{10}$ grs. French of the gas. The quantity absorbed by the water is in proportion to the temperature and the pressure. When vessels containing water, and receiving this gas, are surrounded with ice, while the water is saturated, the gas crystallizes at the surface, and even at the bottom of the liquid, in the form of six-sided plates, of a greenish white colour; but the slightest heat dissolves them, and they rise through the liquor in the form of gas.

Water saturated with this gas at the temperature of 43° has the specific gravity of 1.003.

546 Destroys vegetable colours.

12. This substance does not redden vegetable blues, like the acids. It has the singular property of destroying vegetable colours, on account of which it has been much employed in the art of bleaching. The effect which takes place in this process, has been supposed to be the combination of the colouring matter with the oxygen of the chlorine; for the chlorine seems to be deprived of its oxygen, as it is converted into muriatic acid. For the full account of this process, see BLEACHING.

547 Action of light.

13. This substance, when exposed to the light, is decomposed; it gives out oxygen gas, becomes colourless, and passes into the state of muriatic acid. But, when heat is applied, the chlorine is disengaged in the state of gas, without any perceptible separation of its oxygen. Exposed to the air, it is gradually separated; exhaling at the same time, its pungent, disagreeable odour.

548 Composition.

14. The constituent parts of oxymuriatic acid, according to Berthollet, are of 89 muriatic acid, to 11 of oxygen. According to Mr Chenevix, it is composed of 84 of muriatic acid, and 16 of oxygen.

549 Views of Gay Lussac and Davy.

In consequence of some elegant experiments of Gay Lussac, however, very strong reasons have appeared for taking a totally different view of the nature of chlorine. Many eminent chemists, accordingly, as Sir H. Davy, Dr Thomson, Gay Lussac, Thenard, and perhaps the majority at the present moment, deny the compound nature of this substance, and maintain it to be a simple body, forming one of the constituents of muriatic acid, while hydrogen is the other. In every case in which oxygen has appeared to be yielded by chlorine, water was present; and when deprived of water, it is found much steadier in its constitution, not altered by light, and giving off no oxygen. The conclusion is, that the oxygen comes from the water, while the hydrogen of the water combines with the chlorine to form muriatic acid. Besides, it is incontrovertibly proved that, if chlorine gas differs from muriatic acid gas, by containing oxygen, this cannot be the only difference. In no case can we, by simply removing oxygen, convert chlorine into muriatic acid gas. When chlorine is made to act on hydrogen gas with detonation, muriatic acid is formed; but no oxygen is removed, for no water is produced capable of being separated from the gas. Muriatic acid gas is in fact the only product. It therefore contains whatever was contained in the chlorine, and the hydrogen besides. Those who adhere to the old opinion, therefore, say that water is an essential part of muriatic acid gas, but not of oxymuriatic; that the latter is dry acid in union with oxygen, while the former is the acid in union with water; and that the cause of the difficulty of obtaining muriatic acid gas, by removing oxygen without the aid of hydrogen, is the impossibility of the muriatic acid assuming a separate and gaseous state without the presence of a portion of water, which is necessary to it, in the same manner as it is to the sulphuric and the nitric acids. The question would be decided in favour of the old opinion, if it could be proved, either 1. That chlorine yields oxygen, or, 2. That muriatic acid gas, free from hygrometric vapour, contains combined water, and is capable, under any circumstances, of yielding it. The affirmative of these two last questions has been maintained by the late Dr Murray, who ably defends the old doctrine, both by arguments drawn from analogy, and by the results of his experiments. For these we refer to the last edition of the Elements of Chemistry of that author. We are certainly indebted to him for some careful and ingenious experiments directed to this object. Minute quantities of water were yielded by muriate of ammonia subjected to sublimation, after the muriatic acid and ammoniacal gases of which it was formed had been freed from hygrometric water, by passing over deliquescent salts. It also was apparently yielded by muriatic acid gas when made to act on metals. The only reply made to these results is, that the water was yielded by the glass vessels employed, a source which had never been before suspected of interfering in such cases. These rigid interrogations of nature are always useful, but we do not consider them in the present instance as completed. We wait for a repetition of them, with some variations. At all events, it is to be remarked, that, according to the old opinion, pure muriatic acid, uncombined

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uncombined with oxygen, or with water, has never been procured. It is also to be remarked, that where chlorine, called oxymuriatic gas, appears readily to part with oxygen, it is not its own oxygen that it yields; it is the oxygen of the water that is present, which is evolved in consequence of the mutual attraction subsisting between chlorine and the hydrogen of the water; for dry chlorine does not give off oxygenous gas, but dry chlorine readily combines with dry hydrogen when heat is applied. If chlorine is a compound, its compound nature is not easily demonstrated. Those eminent chemists of our cotemporaries, who regard it as a simple body, have introduced a new nomenclature, not only as applied to it, but to its compounds. The French chemists call it a combustible substance, and apply to its compounds a set of terms corresponding to this view. Its compounds with the metals are called by them *chlorurets*, as those of other inflammables are called *sulphurets*, *carburets*, &c. Its compound with oxygen being found to possess some qualities in common with the acids, is called *chloric* acid, and the salts which this acid form, *chlorates*. The muriatic acid being formed of chlorine and hydrogen, is called the *hydrochloric* acid, and its salts *hydrochlorates*. The British chemists, who maintain the simple nature of chlorine, regard it as a supporter of combustion, and therefore rank it in the same class with oxygen. They at first designated its compounds by the termination *ane*, as *sodane*, *cuprane*, &c. Now they call them *chlorides*, as a term analogous to the compounds of oxygen, the *oxides*. These chlorides of the British, and chlorurets of the French chemists, are, as we shall afterwards see, the muriates of the previously used and still prevalent nomenclature.

550 Of Dr Murray. More recently, however, a still different and very interesting view has been taken of these substances by Dr Murray, as contained in the Transactions of the Royal Society of Edinburgh, and in the last edition of his System of Chemistry. He supposes chlorine to be a compound of oxygen with an unknown simple body as its radical (which may be called *murion*), and muriatic acid as the same substance, acidified by the further addition of hydrogen. This last principle he regards as an acidifying principle like oxygen, and producing along with it more powerful acids than those formed by oxygen alone. Some combustible bodies form acids by uniting with hydrogen alone; such is sulphureted hydrogen, which is now known to possess acid properties. These are the weakest acids. Others are formed by the union of the radical with oxygen alone; such is sulphurous acid. These have stronger acid powers. Of this kind is chlorine or oxymuriatic acid; a substance the acid powers of which are feeble and scarcely recognizable, but which presents this strong analogy with the sulphurous acid, that they both have the property of destroying vegetable colours. Other acids are formed by the union of the radical both with oxygen and hydrogen; such is the case with the sulphuric acid, and such, he suggests, may be the nature of the muriatic. This doctrine is consistent with the results of his experiments, in which water was yielded by muriatic acid. It contains both oxygen and hydrogen, which may be obtained in the form of water, though existing in the acid not as water, but as two acidifying powers, heightening one another's efficiency. The author supports this view by many beautiful and striking analogies, and likewise by the application of the doctrine of definite proportions or fixed combining weights; and he maintains, by some ingenious calculations, that this view removes some of the anomalies which that doctrine, as applied to certain compounds, otherwise presents. This writer, therefore, still retains the old nomenclature, calling chlorine oxymuriatic acid, &c. which indeed may be done in sufficient consistency with all the facts. It is a suitable enough name for the compound formed of oxygen with the radical of the muriatic acid. It may even be used, though we should consider chlorine as a simple body, if we view it as a supporter of combustion. It is the oxygen or the acidifier to which muriatic acid owes its power.

Sect. VI. *Of the Compounds of* Chlorine *with* Oxygen.

1. When hyperoxymuriate or chlorate of potash, (a salt to be afterwards described,) is distilled at a gentle heat with weak muriatic acid, a gas is collected over mercury, differing from chlorine. It has a dense yellow colour, and a smell resembling that of burnt sugar. It has been called by Sir H. Davy, its discover, *euchlorine*. It explodes by a gentle heat with a further evolution of heat and light, and yet presents the remarkable phenomenon of an expansion rather than a condensation of its elements. Five volumes are expanded to six, being composed of two volumes of chlorine and one of oxygen; and the latter, being condensed to half its bulk. It does not act on mercury at ordinary temperatures as chlorine does. 551 Euchlorine.

2. Another compound is procured by distillation from hyperoxymuriate of potash, treated with a small quantity of concentrated sulphuric acid, and exposed to a moderate heat. This has a still livelier colour, and more bland odour than euchlorine. It explodes more violently than euchlorine when decomposed by heat, and the expansion produced is greater, amounting to an addition of nearly one half. It seems to consist of two volumes of oxygen to one of chlorine. 552 Peroxide of chlorine.

3. A compound is also obtained, consisting of a still larger proportion of oxygen with chlorine. It is in fact the same compound which, when united to potash, forms the hyperoxymuriate or chlorate of that alkali. It is obtained in a state of liquid or absorption by water, by detaching it from the chlorate of barytes by means of diluted sulphuric acid carefully introduced to avoid excess or deficiency. This compound, however, does not admit of being driven off by heat unchanged, and thus examined in the gaseous state. Such a distillation is always accompanied with a partial decomposition into chlorine and oxygen. 553 Hyperoxymuriatic or chloric acid.

The order of the affinities of hyper-oxymuriatic or chloric acid, is the following, as they have been ascertained by Mr Chenevix†. 554 Affinities.

Potash,
Soda,
Barytes,
Strontites,
Lime,
Ammonia,
Magnesia,
Alumina.

† *Philos. Trans.* 1802, p. 126.

Sect.

Acids.

Sect. VII. Of Iodine and its Acids.

555 History. 1. Iodine was discovered in 1813 by M. Courtois, a Parisian manufacturer of soda from kelp, whose attention was first directed to it by an unaccountable corrosion of his iron vessels, which he endeavoured to understand by experiment.

2. It is obtained from the lixivium of kelp. This lixivium, after repeated concentration and removal of the crystallizing salts, is treated with concentrated sulphuric acid under a gentle heat. Beautiful purple vapours now come over. These consist of iodine, and from that colour the substance derives its name. They condense in a brown crust or crystalline plates similar to plumbago. To purify it from the acid which comes over with it, the iodine may be redistilled from water containing a very little potash, and afterwards dried by blotting paper. It melts at 225, and is volatilized about 350. The volatilization which takes place in its first extrication under a moderate heat, arises from its affinity for aqueous vapour.

556 Hydriodic acid. 3. Iodine combines readily with hydrogen to form an acid, which is called the hydriodic. This acid may exist in the state of gas, but cannot be retained long pure, as it acts on liquid substances used for confining it; being absorbed by water and decomposed by mercury, which combines with the iodine, and sets the hydrogen gas at liberty.

This acid forms neutral salts with alkaline and other bases. These are called hydriodates. Hydriodate of soda exists in kelp, and from this the iodine is obtained.

557 Oxiodic acid. 4. Iodine is capable of combining with oxygen when presented to euchlorine. The compound formed, is a white semi-transparent solid, very soluble in water, capable of combining with alkalies and oxides. It is called oxiodic acid, and its salts oxiodates.

558 Nature of iodine, &c. 5. Iodine and its compounds present some striking analogies with chlorine and its compounds; and the same difference of opinion about its nature, whether simple or compound, exists regarding it.

Sect. VIII. Of Fluoric Acid.

559 History. 1. This acid was supposed to have been discovered by Scheele in 1771. But the substance then discovered is now found to consist of a compound of this acid with silex. In its uncombined state, or combined only with water, it was first obtained by Gay Lussac, and Thenard.

560 Method of Preparing. 2. It is obtained by distillation from fluate of lime, *i. e.* fluor spar (which must be pure and in a particular manner free from silex,) acted on by thrice its weight of concentrated sulphuric acid. This must be done in a leaden retort, to which a leaden or silver receiver is fitted, and the receiver must be surrounded with ice to ensure the condensation of the acid which comes over, as it possesses great volatility.

561 Properties. 3. The acid thus obtained is distinguished by some remarkable properties. It readily combines with water, emitting a strong heat even to boiling, and giving off dense and noxious fumes. When water is added to it slowly, its specific gravity is increased, and at last exceeds that of water itself; a property altogether unique as applied to fluids. It powerfully affects the skin. A small quantity of it instantly raises a painful blister; a larger quantity produces a deep ulcer, by exciting a morbid action which extends far beyond the seat of its corroding agency. It acts instantly and rapidly on glass, and therefore cannot be prepared nor preserved in glass vessels. It may be employed for removing the polish of glass surfaces, and for etching on glass.

3. This action arises from the strong affinity of the acid for silex, with which it forms a compound called silico-fluoric acid, which presents this singular property, as distinguished from pure fluoric acid, that it is readily obtained in the form of a gas, which the latter has never yet been. In the state of gas it does not attack glass. The gas is readily absorbed by water, to the extent of 263 times the bulk of the latter. It unites with ammonia, depositing its silex. 562 Silico-fluoric acid.

4. The fluoric acid has never been decomposed. But the great success of modern chemists in analysing bodies, has given rise to anticipations of its composition; some supposing it to consist of a peculiar body, a supporter of combustion, which, like chlorine, forms an acid by combining with hydrogen. This they have called fluorine: while others suppose it to consist of a peculiar radical combined with oxygen. 563 Nature.

5. The compounds with the alkalies, earths, and metallic oxides, are called *fluates*. 564 Compounds.

6. The order of its affinities is the following: 565 Affinities.

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Silica.

Sect. IX. Of Boracic Acid.

1. Boracic acid was first discovered by Homberg in 1702, who gave it the name of *narcotic* or *sedative salt*. The substance called borax of the shops is a compound of this acid and soda. 566 Discovery.

2. The process for obtaining this acid is the following: Dissolve a quantity of this substance in hot-water, and filter the solution. Gradually pour on it sulphuric acid, till the liquor acquires a slight degree of acidity. The sulphuric acid combines with the soda; and the boracic acid, as the solution cools, is precipitated in small shining white scales. To purify the acid thus obtained, it is to be washed with cold water; which removes the more soluble salts with which it is mixed. 567 Preparation.

3. Boracic acid is in the form of silvery white hexagonal scales, which have a greasy feel, and some resemblance to spermaceti. It has a sourish taste, which afterwards gives the sensation of coolness. It has no smell. It changes vegetable blues to red. In the scaly form, the specific gravity is 1.479; but when it is fused, it is 1.803. It has been decomposed by the agency of potassium (a substance afterwards to be described), by being heated along with an equal quantity of that substance 568 Composition and properties.

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stance in a green glass tube, and found to consist of a peculiar radical, termed *boron*, in union with oxygen. This radical is a greenish brown powder, the other chemical habitudes of which are little known. It seems to have little tendency to combine with other substances besides oxygen.

4. This acid, when exposed to heat, froths up, which is owing to the separation of the water of crystallization, and assumes the form of a viscid paste. In this state
569 Action of heat. it is known by the name of *calcined borax*. When it is exposed to a red heat, it is converted into a hard transparent glass, which, without attracting moisture from the air, becomes opaque when exposed to it, but undergoes no essential change: for when it is re-dissolved in warm water, it resumes its former properties, by cooling and crystallization *.

570 Of water. 5. Boracic acid has very little attraction for water: boiling water only dissolves about a 50th part of its weight, and cold water much less. When the solution in water is evaporated in close vessels, part of the acid rises in the state of vapour along with the water, and crystallizes in the receiver; but when the whole of the water is dissipated, the process stops; so that it is only by means of it that the acid is volatilized; otherwise it is perfectly fixed. The solution in water has little taste, but it reddens the tincture of turnsole.

6. Neither oxygen, azotic, nor hydrogen gases, produce any effect upon it; and with charcoal, phosphorus, and sulphur, it also remains unchanged. When burnt with phosphorus, indeed, a earthy yellow matter is left behind.

571 On acids. 7. At a red heat it drives off some of the acids from their combinations, even those acids which have a stronger affinity for the same substances in the cold. Boracic acid has some peculiar action with the sulphuric and nitric acids; for when it is heated with these acids, it deprives them of a portion of their oxygen.

572 Uses. 8. The boracic acid is employed in chemistry, not directly as an instrument of analysis, because its affinities and action have little energy compared with other acids, but to discover its peculiar combinations and compounds. It is also employed in the arts, as in soldering, to assist the fusion of metallic substances. It is of great importance to the mineralogist, in promoting the fusion of substances under the blow-pipe.

573 Compounds. 9. It forms an interesting compound with the fluoric acid. When one part of it, and two of fluate of lime, are subjected to strong heat in an iron tube, a gas is given off in great quantity. This gas, which is called *fluo-boric* acid, contains no water, but possesses a singularly powerful affinity for it. Hence it is used as a test of the presence of hygrometric vapour in any other gas on which it does not chemically act. When aqueous vapour is present, a cloudiness is shown on the introduction of fluo-boric acid gas; water takes up 700 times its bulk, and acquires a specific gravity of 1.77.

10. The compounds which boracic acid forms with the alkalies, earths, and metallic oxides, are distinguished by the name of *borates*.

574 Affinities. 11. The affinities of boracic acid are the following:

Lime,
Barytes, &c. as in Fluoric; then
Zirconia,
Water,
Alcohol.

* Fourcroy Connaiss. tom ii. p. 25.

Sect. X. Of Phosphoric Acid.

1. When phosphorus undergoes combustion in oxygen gas, a great quantity of white fumes are produced, which are deposited in white flakes. These are phosphoric acid; so that it is a compound of phosphorus and oxygen. 575 Formation.

2. The phosphoric acid was first shewn to be distinct from all other acids, in the year 1743, by Margraaff. He found that it existed in the salts which were taken from human urine, and that phosphorus could only be obtained from this acid, as well as that it could be converted into phosphoric acid. This acid was found to exist in some vegetable substances, although it was formerly supposed to be peculiar to animal matters. It was discovered by Scheele and Gahn in bones, in the year 1772. Bergman, Proust, and Tenant, detected it in several fossils; and Lavoisier proved, by a series of accurate and ingenious experiments, that it was composed of phosphorus and oxygen. 576 History.

3. Phosphoric acid may be obtained, not only by the method just mentioned, but also by transmitting a current of oxygen gas through phosphorus melted under water. The acid, as it is formed, combines with the water, from which it may be obtained in a state of purity by evaporation. It may be procured also by dropping small bits of phosphorus into nitric acid moderately heated. An effervescence takes place, and nitrous gas is evolved. Phosphorus combines with the oxygen, and forms phosphoric acid. The precaution of adding but a little phosphorus at a time, and of applying a moderate heat to the acid, should be carefully observed. The liquid is then evaporated, and the phosphoric acid remains behind in the solid state. The water that may be combined with it is driven off, by exposing it to a red heat. 577 Preparation.

4. In this state phosphoric acid is a transparent, colourless, solid substance, resembling glass, known under the name of *phosphoric glass*. 578 Properties.

The specific gravity of this acid varies, according to the different states in which it exists. In the liquid state it is 1.417; in the dry state it is 2.697; in the state of glass 2.8516. It changes the colour of vegetables blues to red; has no smell, but a very acid taste.

5. When it is exposed to the air, it attracts moisture, and is converted into a thick viscid fluid, like oil. It is very soluble in water. When in the form of dry flakes, it dissolves in a small quantity of this liquid, producing a hissing noise like that of a red-hot iron plunged into water, with the extrication of a great quantity of heat. In the state of glass it dissolves more slowly, but the concentrated liquid phosphoric acid unites with water with very little disengagement of caloric. 579 Attracts moisture.

6. Phosphoric acid being fully saturated with oxygen, has no action whatever on oxygen gas; nor is there any action between hydrogen or azotic gases, or sulphur, with the phosphoric acid. Charcoal has no effect on phosphoric acid in the cold; but when they are exposed together to a red heat, the phosphoric acid is decomposed; the oxygen combines with the carbon of the charcoal, forming carbonic acid, and the phosphorus is set at liberty. This is the process already described in treating of phosphorus, which is generally employed for obtaining that substance. 580 Action of charcoal.

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Acids.

581 Of acids. 7. Sulphuric acid has no action on phosphoric acid; but when the two acids are mixed together in the liquid state, the sulphuric acid, on account of its strong affinity for water, combines with the water in the phosphoric acid; and if heat be applied, the sulphuric acid is dissipated, and the phosphoric acid remains behind in the state of a transparent viscid matter, or in that of glass. Sulphurous acid is separated from its combinations by the phosphoric acid. Nitric acid separates the phosphoric from its combinations. Muriatic acid has the same effect.

582 Composition. 8. The component parts of this acid have been accurately ascertained by Lavoisier, and it consists of,

60 oxygen,
40 phosphorus.

100

583 Importance. 9. The accuracy of our information with regard to the component parts and properties of phosphoric acid, renders it of great importance in many chemical operations; and if it could be obtained with less difficulty and expence, its uses might be extended to medicine and the arts.

584 Compounds. 10. It combines with the alkalies, earths, and metallic oxides, and forms salts which are denominated *phosphates*.

585 Affinities. 11. The following is the order of its affinities.

Barytes,
Strontites,
Lime,
Potash,
Soda,
Ammonia,
Magnesia,
Glucina,
Alumina,
Zirconia,
Metallic oxides,
Silica.

Sect. XI. *Phosphorous and Hypophosphorous Acid.*

1. Phosphorous acid bears the same relation to phosphoric as sulphurous acid does to sulphuric. It is combined with oxygen in the smaller proportion. This was
586 Formation. demonstrated by Lavoisier in 1777, when he pointed out the difference between the product from the slow or rapid combustion of phosphorus. This acid is obtained by the slow combustion of phosphorus at the common temperature of the air. If phosphorus, in small pieces, be exposed to the air in a glass funnel placed in a bottle, it attracts the oxygen and moisture from the atmosphere, and the phosphorous acid runs down into the bottle. By this process, about three times the weight of the phosphorus is obtained. It is mixed, however, with phosphoric acid; and, according to some, the two acids are chemically combined, or rather we have in this instance a separate definite compound, to which the name of *phosphatic* acid has been given. When alkaline bases are presented to it, we have always a mixture of phosphates and phosphites.

A pure phosphorous acid is obtained by the agency of a chloride of phosphorus on water. That chloride is formed by subliming phosphorus through corrosive muriate of mercury (considered as a compound of that metal with chlorine). The chlorine combines with the phosphorus, and when the compound thus formed (the chloride) is moistened, water is decomposed, the hydrogen unites with the chlorine to form muriatic acid, and the oxygen unites with the phosphorus in that exact proportion which forms the pure phosphorous acid. For this process we are indebted to Sir H. Davy.

2. It is then in the form of a white thick liquid, adhering to the sides of the vessel. It varies in consistence according to the state of the air. Its specific gravity is not known. It has an acid, pungent taste, not different from phosphoric acid. It also reddens vegetable blue colours. 587 Properties.

3. Phosphorous acid is not altered by light. When exposed to heat in a retort, part of the water combined with it is first driven off; and when it is concentrated, bubbles of air suddenly rise to the surface, and collect in the form of white smoke, and sometimes inflame, if there be any air in the apparatus. If the experiment be made in an open vessel, each bubble of air, when it comes to the surface, produces a vivid deflagration, and diffuses the odour of phosphorated hydrogen gas. This inflammable gas continues to be evolved for a long time, and when the action ceases, phosphoric acid only remains behind. It ought to be observed, that the phosphorated hydrogen gas is not disengaged till the phosphorous acid is concentrated and brought to a high temperature, which seems to prove that the phosphorus which is not saturated with oxygen, strongly adheres to it. 588 Action of heat.

4. There is little attraction between oxygen and phosphorous acid, which seems to be owing to the great affinity between phosphorus and phosphoric acid. It absorbs, however, very slowly, a small quantity of oxygen; and even after long boiling, it is not completely converted into phosphoric acid. 589 Oxygen.

5. Hydrogen gas has no action on phosphorous acid; but this acid is decomposed at a red heat, by means of charcoal, which separates from it a greater quantity of phosphorus than from phosphoric acid. There is no action between these bodies in the cold. Sulphur has no action on this acid at the ordinary temperature of the atmosphere, and they cannot be combined by means of heat, because the phosphorus is dissipated before it unites with the sulphur. 590 Hydrogen.

6. There is no action between phosphorous acid and sulphuric acid in the cold; but when they are heated together to the boiling temperature, the phosphorous acid deprives the sulphuric of part of its oxygen, and is converted into phosphoric acid, while part of the sulphuric acid, thus decomposed, is disengaged in the state of sulphurous acid gas. Phosphorous acid produces a similar effect on nitric acid. The phosphorous is converted into phosphoric acid, and part of the nitric acid is converted into nitrous gas. 591 Of acids.

7. Phosphorous acid forms compounds with alkalies, earths, and metallic oxides, which are known under the name of *phosphites*. 592 Compounds.

8. The order of its affinities is the following. 593 Affinities.

Lime,
Barytes,
Strontites,

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Acids.

Strontites,
Potash,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia,
Metallic oxides.

594 Hypophosphorous acid. 9. Another acid, with a still smaller proportion of oxygen, and therefore called hypophosphorous acid, is formed when a phosphuret of an alkali or an earth is made to act on water by heat. The water is decomposed, the hydrogen is evolved, and carries with it a portion of phosphorus. The oxygen combines with another portion of phosphorus, forming two distinct acids, the phosphoric and the hypophosphorous, which both form at the same time neutral salts, a phosphate and a hypophosphite of the base employed. The hypophosphite is the most soluble of the two. When a phosphuret of barytes has been employed, the hypophosphite is obtained pure in solution, the phosphate of that earth being entirely precipitated; and now the earth may be separated from this acid by the sulphuric acid, which thus gives us the hypophosphorous acid uncombined.

Sect. XII. *Of Carbonic Acid.*

1. When a piece of charcoal, in a state of ignition, is plunged into a jar of oxygen gas, it burns with great brilliancy; and after the combustion has ceased, the
599 Formation. air in the vessel is totally changed. If a little water is introduced into the jar, and agitated, the air combines with it; and this water, when examined, exhibits acid properties. This is *carbonic acid*. It is formed by the combination of carbon and oxygen. This is one of the most important acids, both on account of its numerous combinations, and also on account of the discovery of it having occasioned a total revolution in chemical science.

2. It was regarded by the ancients, on account of the noxious effects which it produced, as a pestilential vapour, and they gave it the name of *spiritus lethalis*.
596 Names. Paracelsus and Van Helmont considered it as a peculiar matter, to which they gave the name, *spiritus sylvestris*, or *gas*. Hales, although he considered it merely as contaminated air, distinguished it by the name of *fixed air*, because it entered into the composition of many bodies. Dr Black demonstrated, that it is a peculiar substance, different from the air; that lime, magnesia, and the alkalies, were deprived of their causticity, by being combined with this air, and therefore he gave it the name of *fixed air*. It was afterwards found, by the experiments of Keir and Bergman, to be an acid, and hence Bergman gave it the name of *aërial acid*. The nature and properties of this acid were investigated by many chemical philosophers, and from them it received various names, as *mephitic acid*, *calcareous* or *cretaceous acid*, thus distinguished from its effects, or from the substances from which it was obtained. In the present chemical nomenclature it has the name of *carbonic acid*, from its base *carbon*.

597 At first supposed simple. 3. For some time after the discovery of the difference between carbonic acid and common air, and its properties as an acid, it was considered by many as a simple elementary substance, and was even regarded as the acidifying principle. In the progress of investigation it was found to be a compound substance, containing oxygen as one of its constituent parts, and it was generally believed that phlogiston constituted the other. When hydrogen was considered as the same with phlogiston, it was supposed that oxygen and hydrogen constituted carbonic acid. The discovery of Mr Cavendish proved that water, not carbonic acid, was the product of the combination of oxygen and hydrogen. The experiments of Lavoisier established the fact of its real composition, and placed it beyond dispute. He demonstrated that the weight of the carbonic acid which was obtained, was exactly equal to the quantity of the oxygen and charcoal which had disappeared.

4. Carbonic acid may be obtained by taking a quantity of chalk, limestone, or marble, and reducing them to a coarse powder. Introduce it into a matrass, pour over it a quantity of diluted sulphuric or nitric acids; a violent effervescence takes place, carbonic acid gas is disengaged, which passes over, and may be received in vessels in the usual way. The chemical action that takes place in this change is obvious. The affinity of the sulphuric acid for the lime is stronger than that of the carbonic acid, which is previously in combination with it; the sulphuric acid, therefore, seizes the lime, and the carbonic acid is disengaged in the state of gas. 598 Method of obtaining.

5. Carbonic acid thus obtained in the state of gas, is an invisible, elastic fluid. Its specific gravity is 0.0018. One hundred cubic inches of it weigh 46.5 grs. It is nearly double the weight of common air. It has no smell; it is totally unfit for respiration, and equally so for supporting combustion. It reddens the tincture of turnsole, which has its blue colour restored on being exposed to the air, by the separation of the acid. 599 Properties.

6. Water absorbs a considerable proportion of this acid, which is increased by agitation. At the temperature of 41° water absorbs its own bulk. When artificial pressure is employed, the quantity of gas absorbed may be greatly increased. It is in this way that what are called the aërated alkaline waters are prepared, some of which, it is said, contain no less than three times their bulk of the gas. Water impregnated with this gas, acquires an acidulous taste, and when poured from one vessel to another, has a sparkling appearance. When water impregnated with this acid is exposed to the air, it soon disappears. The air of the atmosphere attracts it from the water, having a stronger affinity for it than the water. 600 Absorbed by water.

When water containing this gas is raised to the boiling temperature, the whole is driven off; and if water impregnated with it be exposed to the temperature of 32°, the whole of the gas separates during the freezing.

7. Carbonic acid undergoes no change by the action of light. It is not changed by the action of heat in close vessels, nor by passing it through a red-hot tube. 601 Not altered by light or heat.

8. There is no action between this gas and oxygen. Exposed to the air of the atmosphere, it is gradually dissipated. The air of the atmosphere generally contains from .01 to .02 parts of this gas. 602 Attracted by the air.

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9. There is no action between this acid and azote.

603 Absorbed by charcoal. Charcoal has no chemical action on carbonic acid; but when it is heated, it has the property of absorbing and condensing within its pores the carbonic acid; but the acid is again separated by plunging the charcoal under water.

10. Phosphorus has no action on carbonic acid; but can decompose it by the aid of compound affinity.

11. Sulphur has still less action on carbonic acid than phosphorus. It is said, indeed, that a small quantity of sulphur is dissolved by this gas by means of heat, which gives it partly the fetid odour of sulphureted hydrogen gas.

604 Diminishes combustibility. 12. Carbonic acid gas mixed with carbureted, phosphoreted, and sulphureted hydrogen gases, diminishes the combustibility of these inflammable gases.

605 Compounds. 13. The carbonic acid combines with the alkalies, some of the earths, and metallic oxides, forming compounds known by the name of *carbonates*.

606 Affinities. 14. The following is the order of the affinities of this acid:

Barytes,
Strontites,
Lime,
Potash,
Soda,
Magnesia,
Ammonia,
Glucina,
Zirconia,
Metallic oxides.

607 Very abundant. 15. Carbonic acid exists in great abundance in nature. It is produced during the processes of combustion, respiration, and the fermentation of vegetable matters. Hence it is found in pits and caverns, where there is a stagnation of the air, and being specifically heavier than common air, it remains at the bottom. This is the reason why small quadrupeds, as dogs, are instantly suffocated, because they respire only this gas, when they enter places where it is accumulated. This has been long observed in the celebrated Grotto del Cani in Italy, where dogs are instantly suffocated; while men, whose heads are in the stratum of common air near the top of the cavern, receive no injury. Men

608 Fatal effects produced by it. have been suddenly killed by going down into large vats, in which the process of fermentation had been carried on. In consequence of the greater specific gravity of the carbonic acid gas, and the great quantity generated during the process, when the fermented liquor is drawn off, it sinks to the bottom of the vessel, and there remains till it is displaced by a denser fluid, or slowly attracted by the air. Similar accidents have happened to persons going down into pits or wells which have been long shut up, and where the air has been long stagnant. It is by respiring this gas that persons are suffocated who have been exposed to the fumes of burning charcoal in close places. During the combustion of the charcoal, the carbon combines with the oxygen of the atmosphere; and carbonic acid is

609 Mode of recovery. formed, which soon fills the apartment. In these cases, where life is not totally extinguished, the best method of recovery is said to be, to dash cold water on the head and body; a practice which is commonly followed in accidents of this kind, in northern countries, where charcoal is burnt in close apartments.

Sect. XIII. *Of Arsenic Acid.*

1. This acid, and the four following, have metallic substances for their radical. Most metallic substances combine with oxygen in different proportions, and the compounds formed with these substances and oxygen, are denominated *oxides*, because they possess no acid properties; but some of the metals combine with oxygen in such a proportion as gives them the characteristic properties of acid substances. 610 Five metallic acids.

2. The metallic substance arsenic, combines with oxygen in two proportions; the first, which is usually called the *white oxide of arsenic*, has been denominated by Fourcroy, the *arsenious acid*. Macquer discovered some of the combinations of arsenic acid, previous to the year 1746; for he shews that a mixture of white oxide of arsenic and nitre, subjected to the action of a strong fire, yields a neutral salt, to which he gave the name of the neutral salt of arsenic. But it was by the investigation of Scheele in 1775 that its properties were fully known.

3. The process for obtaining it which was pointed out by Scheele, is the following. Take three parts of the white oxide of arsenic, and dissolve it in seven parts of muriatic acid. Add five parts of nitric acid to the solution, and distil it to dryness. The arsenic acid remains behind. It may also be procured by dissolving the white oxide in liquid oxymuriatic acid, or by making a stream of oxymuriatic acid gas pass through a solution of the white oxide of arsenic. The chemical action which takes place in these processes, is the union of the arsenic with an additional portion of oxygen, which it derives from the nitric acid, the liquid oxymuriatic, or the oxymuriatic acid gas. 611 Process for obtaining it.

4. By whatever process it is obtained, the arsenic which is not crystallized has an acid, caustic, and metallic taste. It reddens the syrup of violets, and its specific gravity is 3.91. When it is exposed to a strong heat in a retort or crucible, it fuses, attacks the glass of the retort, or the earth of the crucible; it remains transparent and pure at a high temperature, gives out a little oxygen, and is partly converted into white oxide. 612 Properties.

5. Exposed to the air, it attracts the moisture from it, and absorbs two thirds of its own weight of water from the atmosphere, which is sufficient to hold it in solution.

6. The arsenic acid is much more soluble in water than the white oxide. Three or four parts of water are sufficient to dissolve it. When it is evaporated, it assumes a thick consistence like honey. 613 Action of water.

7. Combustible substances decompose arsenic acid, by depriving it of part of its oxygen, and converting it into the white oxide. Hydrogen gas, mixed with a solution of this acid, has the property of precipitating it. Charcoal, phosphorus, and sulphur, produce a similar effect. Exposed in a retort to heat with charcoal; the charcoal is inflamed, and the arsenic acid is reduced to the metallic state. Sulphur heated with arsenic acid, is partly converted into sulphurous acid gas, and partly sublimed into the red sulphuret of arsenic. When heated 614 Of combustibles.

Acids. heated with phosphorus, part of the phosphorus is converted into phosphoric acid, and the arsenic reduced to the metallic state, unites with another part of the phosphorus, with which it forms a phosphuret of arsenic, which sublimes.

615 Composition. 8. The arsenic acid is composed of the white oxide of arsenic and oxygen. The proportion of its constituent parts, according to the experiments of Proust, are

65 arsenic,
35 oxygen,

100

616 Compounds. 9. The compounds which arsenic acid forms with alkalies, earths, and some metallic oxides, are known by the name of *arseniates*.

617 Affinities. 10. The order of its affinities is the following:

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia.

Sect. XIV. *Of Tungstic Acid.*

618 History. 1. In the year 1781, Scheele and Bergman, in investigating the nature of a heavy stone (called tungsten by the Swedes), discovered that it is composed of lime combined with a peculiar acid. Their discovery was afterwards confirmed by several chemists, and particularly by the experiments of the D'Elhuyarts, who detected the same acid in the mineral wolfram.

619 Methods of obtaining. 2. This acid always exists in combination with lime and iron. It may be obtained by reducing the former to a fine powder, and treating it with nitric or muriatic acids, which unite with the lime, and then by alkalies, which dissolve the acid. The alkaline solution is to be precipitated by the nitric or muriatic acid; the precipitate is to be carefully washed and dried, which is the tungstic acid in the solid state.

620 Properties. 3. Tungstic acid, thus prepared, is in the form of a white powder, which has an acid and metallic taste; changes the colour of vegetable blues into red; and has a specific gravity according to Bergman, equal to 3.600.

621 Actions of heat. Heated under the blow pipe, this tungstic acid becomes first yellow, then brown, and at last black; it affords no smoke, and gives no sign of fusion. When it is calcined for some time in a crucible, it is deprived of the property of dissolving in water.

622 Of water. 4. Exposed to the air, it suffers no change. It is soluble in 20 parts of boiling water, but it is partially separated on cooling. This solution has an acid taste, and reddens the tincture of turnsole. Heated with charcoal, it is reduced, but with difficulty, to the metallic state. With sulphur and phosphorus it becomes of a gray colour, but without reduction.

623 Of acids. 5. The acids do not dissolve the tungstic acid in the form of white powder, but they change completely its properties. The sulphuric acid changes it to a blue, and the nitric and muriatic acids convert it into a fine yellow colour. In this state it has lost its taste and solubility, has become specifically heavier, and has acquired the property of forming salts with the same bases distinctly different from those formed with what was called the white acid. The Spanish chemists D'Elhuyarts, consider the latter as an acidulous triple salt, and yellow oxides as real tungstic acid.

6. Vauquelin and Hecht, who instituted a set of experiments on these oxides, as they propose to denominate them, obtained the same results. They consider the tungstic acid of Scheele as a triple salt, which has retained a portion of the acid by which it was precipitated in its composition, and when the oxide of tungsten is pure, it possesses none of the properties which are admitted and acknowledged as the characteristics of the acids, but that it has a strong tendency to form triple combinations, in which only it exhibits acid properties. The compounds which it forms with the alkalies, earths, and metallic oxides, are a species of neutral salts; but the chemical combination is not fully completed to hide the alkaline properties of the former †. In forming these compounds, it is the only property in which it agrees with the acids. The compounds are denominated tungstates. 624 Only an oxide. 625 Tungstates.

† *Jour. de Mines*, No. xix. p. 26.

626 Affinities. 7. The order of its affinities is the following:

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Glucina,
Alumina,
Zirconia.

Sect. XV. *Of Molybdic Acid.*

1. This acid was discovered by Scheele in the year 1778. It is a compound of the metallic substance molybdena and oxygen. Scheele supposed that it existed in the mineral from which he obtained it, and that this mineral was a compound of the acid, sulphur, and iron. The experiments of later chemists have shown that the acid is formed in the process of preparing it, by the metal combining with oxygen. 627 History.

2. There are various processes for the preparation of this acid.

a. Scheele found that by treating a little of the sulphuret of molybdena (sulphur combined with the metal) on a silver plate, the white fumes which exhaled from it, adhered to the plate in form of a small scale of a brilliant yellowish white colour, which was the true molybdic acid. But a very small quantity can only be obtained in this way. 628 Processes for obtaining it.

b. Another process is by means of nitric acid. On one part of sulphuret of molybdena in powder, pour five parts of nitric acid, and distil it to dryness. The same process is repeated three or four times. The dry residuum is a white powder, which is the molybdic acid mixed with the sulphuric acid, which is also formed during the process with the nitric acid. The sulphuric acid

acid may be washed off with hot water, and the molybdic acid remains behind in a state of purity.

c. It may be also prepared by projecting into a red-hot crucible three parts of nitrate of potash, and one part of sulphuret of molybdena, reduced to fine powder and well mixed together. A red mass remains after the detonation, composed of the oxide of iron, of the sulphate of potash, and the molybdate of potash. By throwing the mass into water, the two salts are dissolved, and the oxide of iron is precipitated. Evaporate the solution to obtain the sulphate of potash, and drop into the liquid which refuses to crystallize, and which should be diluted with water, sulphuric acid, till there is no farther precipitation. The precipitate is molybdic acid, but not in a state of perfect purity; for it is combined with a certain portion of potash.

629 Properties. 3. Molybdic acid prepared in this manner, and sufficiently purified, is a white powder of a sharp metallic taste. According to Bergman, the specific gravity is 3.4.

630 Action of heat. 4. When heated in a large glass retort, it yields a little sulphurous acid. But when it is exposed to a strong heat in a close vessel, it fuses, attaches itself to the sides of the vessel, and crystallizes on cooling in rays going out from a centre. But if at the moment the acid is in fusion the vessel be uncovered, it rises into a white smoke by contact with air, and this vapour attaches itself to cold bodies in form of brilliant scales of a golden-yellow colour.

631 Of water. It is readily soluble in warm water. One part of the acid requires about 500 grs. The solution is of a yellow colour, has little smell, and reddens litmus paper.

632 Of charcoal and sulphur. 5. Molybdic acid is decomposed by charcoal, with the assistance of heat; it is also decomposed by sulphur, with the extrication of sulphurous acid, and the formation of sulphuret of molybdena.

633 Of acids. 6. The concentrated sulphuric acid dissolves a considerable quantity of molybdic acid, with the aid of heat. The solution on cooling becomes of a violet blue colour, which disappears when it is heated. The muriatic acid dissolves a considerable proportion by boiling. When this solution is distilled to dryness, one part of the acid is sublimed, of a blue and white colour. The nitric acid has no effect whatever *.

* Philos. Trans. 1789, p. 389.

634 Compounds. 7. Molybdic acid combines readily with the alkaline and earthy bases, which have the name of *molybdates*.

8. This acid has not been applied to any use.

Sect. XVI. *Of Chromic Acid.*

635 Discovery. 1. This acid was discovered by Vauquelin in the year 1797. It has only been found in small quantity, in combination with lead or iron.

636 Preparation. 2. Chromic acid may be obtained by boiling the red lead ore of Siberia in a solution of carbonate of potash, and precipitating it by means of another acid, which has a stronger attraction for the potash. A red or yellow orange powder falls to the bottom, which is chromic acid.

3. It has an acrid and peculiar metallic taste, more perceptible than any other metallic acid.

4. When exposed to the action of light and caloric, in open vessels, it assumes a green colour; but in close vessels, it gives out pure oxygen gas, and losing its acid properties it returns to the state of green oxide. This is the only metallic acid, which by the action of caloric, easily parts with its oxygen.

5. Strongly heated with charcoal, chromic acid becomes black, and is easily reduced to the metallic state without fusion. It is probable also, that it may be decomposed with equal facility by hydrogen, phosphorus, and sulphur. 637 Action of charcoal.

6. Chronic acid is soluble in water, and crystallizes by cooling and evaporation, in prisms of a ruby red colour. 638 Water.

7. The muriatic acid by distillation with a moderate heat with the chromic acid, passes to the state of oxymuriatic acid, and the mixture acquires the property of dissolving gold. In this respect it resembles the nitric acid, and it is the only metallic acid which is distinguished by this property. 639 Muriatic acid.

8. The chromic acid combines readily with the alkalies, and has the peculiar property of giving an orange colour to the crystals: from this it derived its name. The compounds are called *chromates*. 640 Compounds.

9. The chromic acid, from its peculiar colour, and the beautiful colours which it communicates to other bodies, promises to be useful in painting on porcelain and glass, or even in dyeing. 641 Uses.

Sect. XVII. *Of Columbic Acid.*

1. The last of the metallic acids is the columbic, which was discovered by Mr Hatchet in 1801. In the ore from which it was extracted, it is combined with oxide of iron, from which it was separated, by exposing it to a strong red heat, with five times its weight of carbonate of potash. The alkali combined with part of the acid, and from this it was separated by water. By repeatedly fusing the residuum with potash, he separated the whole of the acid from the iron, which latter combined with muriatic acid that was added to it. By treating the alkaline solution with nitric acid, a precipitate of a white, flaky, insoluble substance was obtained. This is the columbic acid. 642 Discovery. 643 Preparation.

2. It is of a pure white colour, but not very heavy, and has scarcely any perceptible taste; it is not soluble in boiling water. When some of the powder is placed upon litmus paper, moistened with distilled water, the paper in a few minutes becomes red. When exposed to the blow-pipe, it is not fusible, but only becomes of a less brilliant white. 644 Properties. 645 Action of heat.

3. It is dissolved in boiling sulphuric acid, and forms a transparent colourless solution, which is only permanent while the acid is in a concentrated state; for if it be diluted with water, it assumes a milky appearance; a white precipitate is deposited, which, as it dries on the filter, changes when completely dry to a brownish gray. It is then insoluble in water, has no taste, is semitransparent, and breaks with a glossy, vitreous fracture. This compound appears to be formed of the sulphuric and columbic acids. Nitric acid has no effect on the columbic acid *. 646 Of acids.

* Phil. Trans. 1802, p. 44.

Sect. XVIII. *Of Acetic Acid.*

1. Acetic acid, or vinegar, was one of the earliest known. This indeed was to be expected, from the 647 History.

manner

manner and the abundance in which it is produced, as it is the first change to which wine and similar liquids are subject. The sourness which exists in these liquids, is owing to the production of this acid. It has different names, according to the state in which it is found.

648 **Names.** When it is first prepared, it is known under the name of *vinegar;* when purified by distillation, it is called *distilled* vinegar; and when it is strongly concentrated, it is called *radical* vinegar, or *acetic acid*.

649 **Preparation.** 2. The process by which vinegar is obtained is the fermenting process of many vegetable matters, what is usually denominated the acetous fermentation, or the second stage of the fermentative process of vegetable matter. The circumstances in which this fermentation takes place are, a temperature between 70° and 80°, the addition of some fermenting substance, and exposure to the air.

The process which is recommended by Boerhaave is generally followed. Two large hogsheads are prepared, by fixing about a foot from the bottom, a grating of rods, on which vine branches are to be placed. The wine to be fermented is poured into the vessels; the one is to be filled to the top, and the other only one half. They are both left exposed to the air. Fermentation begins in the vessel which is half full; when it is completely begun, fill it up from the other vessel, which interrupts the fermentation in the full hogshead, and it commences in that which is half full. When this has continued for a little time, it is filled up from the other vessel, in which the fermentation again commences, and is interrupted in the other.

Thus, the process is carried on by alternately emptying and filling the vessels till vinegar is formed, which generally requires a period of from 12 to 15 days.

650 **Properties.** 3. Vinegar is generally of a yellowish colour, an acid taste, and agreeable smell. It reddens vegetable blues, and when exposed to heat, it is entirely dissipated. The specific gravity varies from 1.005 to 1.0251. It varies considerably in colour, specific gravity, and other properties, according to the substances from which it has been obtained. Vinegar in this state is extremely apt to be decomposed. Scheele has pointed out a very simple process, by which it may be preserved for a long time. Put the vinegar into bottles, and place them over the fire in a vessel filled with water. Let the water boil for a moment, and then take out the bottles, after which it may be kept for several years.

651 **Purified by distillation.** 4. To separate the impurities with which vinegar is contaminated, it is distilled with a moderate heat; the temperature must not exceed that of boiling water, and the process should be carried on only till about $\frac{2}{3}$ of the quantity have passed over. This is distilled vinegar, or the acetous acid of the chemists. It is then perfectly transparent and colourless, has an agreeable odour, and a strong acid taste. The vinegar in this state, when exposed to a sufficient degree of cold, is partly frozen. As the ice which is formed consists almost entirely of water, when it is separated the fluid which remains is the vinegar highly concentrated.

652 **Of radical vinegar.** 5. To prepare what has been denominated radical vinegar, a salt, of which this acid forms a component part, must be decomposed. The acetate of copper, or verdigris, is generally employed for this purpose. It is reduced to powder, and distilled in a retort with a strong heat. The liquid which first comes over is insipid and colourless, and must be kept separate from the remaining part of the product, which is the acetic acid in a highly concentrated state. It has generally a green colour, being contaminated with a little copper, but it may be purified by distillation with a moderate heat, by which it is rendered colourless.

6. The acid in this state was at first considered by chemists as different from the acetous acid in its properties, affinities, and in the compounds it forms with other bodies. This was the opinion of the celebrated Berthollet, and the same opinion was adopted by almost all chemists. It was supposed that it was the acetous acid in combination with another portion of oxygen, and hence it was denominated, according to the present nomenclature, *acetic acid*. 653 **Acetous and acetic acids supposed to be different.**

7. The nature and properties of these two supposed acids were at last investigated fully by Adet and Darracq, who proved that there was no difference in the proportion of oxygen in the acetous and acetic acids. This conclusion was controverted by Chaptal and Dabit, who endeavoured to support the opinion of Berthollet, that the two acids are distinguished from each other by different properties and different combinations with other bodies. It is now generally admitted, that what have been called the acetous and acetic acids, are essentially the same, their apparent difference depending on the quantity of water, mucilage, and other substances with which the acetous acid is combined. 654 **Found to be the same.**

8. This acid, when pure, is transparent and colourless. In the state of acetous acid, it has an agreeable, aromatic odour. In the state of acetic acid, or when it is highly concentrated, it acquires a sharp, penetrating odour, different from that of the vinegar, and in this state it is extremely acrid. Applied to the skin it reddens and destroys it. It is highly volatile; and when exposed to the open air, it is soon dissipated. When heated in contact with the air, it inflames. 655 **Properties.**

9. This acid may be obtained in crystals, by forming distilled vinegar into a paste with charcoal, and subjecting the mixture to a temperature which does not exceed 212°. By this heat the watery part is dissipated, and the acid remains behind; but when a stronger heat is applied, the acid itself is driven off. By repeating the process the acid may be obtained crystallized. 656 **Crystallises.** 657 **Action of heat.**

10. Acetic acid undergoes no perceptible change by the action of oxygen, hydrogen, or azotic gases; and it is not altered by charcoal, phosphorus, or sulphur.

11. Acetic acid is decomposed by the sulphuric acid. It absorbs carbonic acid, and dissolves boracic acid. It is also decomposed by nitric acid, and is converted into carbonic acid and water. Dr Higgins analyzed the acetic acid by decomposing it in combination with an alkali. He distilled in a glass retort 7680 grs. of acetate of potash, that is, potash combined with acetic acid, and he obtained the following products. 658 **Of acids.** 659 **Analysis.**

Potash, - -	3862.9940
Carbonic acid gas, -	1473.5640
Carbonated hydrogen gas,	1047.6018
Charcoal, - -	0078.0000
Oil, - -	0180.0000
Water, - -	0340.0000
Deficiency, - -	0726.9402

Dr

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Acids.

Dr Higgins was at a loss to account for this deficiency, till by repeated experiments he found that it is always owing to the water and oil, and chiefly to the water which is carried off by the elastic fluids. He states the quantity of water carried off in vapour at 700 grs. and the quantity of oil carried off in the same way at 26.9402, which together make up the whole deficiency †. The potash remained behind unaltered; the acetic acid, therefore, has been decomposed, and has yielded the products which were obtained by distillation. But the constituent principles of these products are oxygen, hydrogen, and carbon; and from the proportions of oxygen and carbon which enter into the composition of carbonic acid, the proportions of carbon and hydrogen in carbonated hydrogen gas, and of oxygen and hydrogen in the composition of water, 100 parts of acetic acid are composed of about,

† *Experiments and observations*, p. 27.

660 Composition.

50 oxygen.
36 carbon,
14 hydrogen.

100

661 Compounds.

12. The compounds which acetic acid forms with alkalies, earths, and metallic oxides, are denominated *acetates*.

662 Affinities.

13. The order of its affinities is the following:

Barytes,
Potash,
Soda,
Strontites,
Lime,
Ammonia,
Magnesia,
Metallic oxides,
Glucina,
Alumina,
Zirconia.

Sect. XIX. *Of Oxalic Acid.*

663 Found in plants.

1. This acid exists ready formed in the *oxalis acetosella* or wood-sorrel, and some other species belonging to the same genus of plants. From this it derives the name of *oxalic acid*. It was originally denominated the *saccharine acid*, or the acid of sugar, because it was obtained from that substance. Its properties were first particularly investigated by Bergman and Scheele, and the method of preparing it is given by the former.

664 Method of obtaining.

2. An ounce of white sugar in powder is put into a retort, with three ounces of strong nitric acid. During the solution, a great quantity of fumes of the nitrous acid escapes. Apply heat till the liquor boils, and nitrous gas is then driven off. When the liquor in the retort acquires a reddish brown colour, add three ounces more of nitric acid, continue the boiling till the fumes cease, and the colour of the liquor vanishes. Pour out the liquor into a wide shallow vessel; and, when it cools, crystals will be formed in slender four-sided prisms, which may be collected and dried in blotting paper. The crystals thus obtained may be again dissolved in distilled water, and evaporated to obtain new crystals. Oxalic acid may be obtained by a similar process from other vegetables, and from some animal substances, as gum arabic, alcohol and honey.

665 Properties.

3. Prepared in this way, oxalic acid is in the concrete state, crystallized in four-sided prisms, terminating in two-sided summits. They are white and transparent, and have a considerable lustre. They have a strong sharp taste, change vegetable blues into a red colour, and produce the same effect on all vegetables except the indigo.

The acid properties of this substance are so strong, that one part of concrete oxalic acid gives to 3600 parts of water, the property of reddening paper stained with turnsole.

666 Action of heat.

4. When oxalic acid is exposed to heat, it is volatilized, partly in a liquid, and also in a solid and crystalline form. It is not decomposed, but at a high temperature; but, when it is exposed to a moderate heat, it dries, is covered with a white crust, and is soon reduced to powder. It loses $\frac{1}{10}$ of its weight when put upon burning charcoal; it exhales a pungent, irritating smoke, and there remains behind a white alkaline residue.

667 Of water.

5. This acid is deliquescent in the air, when it is loaded with moisture. Cold water dissolves about $\frac{1}{2}$ its weight of the acid; boiling water dissolves a quantity equal to its own weight.

665 Composition.

6. Oxalic acid is decomposed by the sulphuric acid with the assistance of heat, and charcoal is deposited; at the boiling temperature it is decomposed by the nitric acid, and converted into water and carbonic acid. According to Fourcroy, the component parts of oxalic acid, as they have been ascertained by him and Vauquelin, are

77 oxygen,
13 carbon,
10 hydrogen.

100 *

* *Connais. Chim.* tom. vii. p. 225.

668 Compounds.

7. Oxalic acid combines with the alkalies, earths, and metallic oxides, and the salts thus formed are distinguished by the name of *oxalates*.

669 Affinities.

8. The affinities of this acid are in the following order:

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Alumina.

Sect. XX. *Of Tartaric Acid.*

670 History.

1. This acid was procured by Scheele in a separate state, in the year 1770, the process for which he communicated to M. Retzius, who published the account of it in the Swedish Memoirs for that year. It was the first discovery in the bright career of that distinguished chemist.

671 Preparation.

2. The process which he followed was by boiling a quantity of the substance called *tartar*, or *cream of tartar*,

Acids. *tartar*, in water, and adding powdered chalk till effervescence ceases, and the liquid no longer reddens vegetable blues. It is then allowed to cool; the liquor is filtered; and a white insoluble powder remains on the filter, which is carefully removed and well washed. This is put into a matrass, and a quantity of sulphuric acid, equal in weight to the chalk employed, diluted with water, is poured upon it. The mixture is allowed to digest for 12 hours on a sand bath, stirring it occasionally with a glass rod. The sulphuric acid combines with the lime, and forms a sulphate of lime, which falls to the bottom. The liquid contains the tartaric acid dissolved in it. This is decanted off, and a little acetate of lead is dropt into it, as a test to detect the sulphuric acid, should any remain. With it it forms an insoluble precipitate; and if this be the case, it must be digested again with more *tartrate of lime*, to carry off what remains of the sulphuric acid. It is then evaporated, and about $\frac{1}{3}$ of the weight of tartar employed is obtained, of concrete tartaric acid. To purify this, the crystals may be dissolved in distilled water, and again evaporated and crystallized. It seems probable, Fourcroy observes, that this acid exists in a state of purity in some vegetables. Vauquelin has found a 64th part in the pulp of the tamarind.

672 Crystals. 3. Tartaric (or tartarous) acid, thus obtained, is in the form of very fine needle-shaped crystals; but they have been differently described by different chemists. According to Bergman, they are in the form of small plates attached by one extremity, and diverging at the other. They have been found by others grouped together in the shape of needles, pyramids, regular six-sided prisms, and square and small rhomboidal plates. The specific gravity is 1.5962.

673 Properties. 4. This acid has a very sharp, pungent taste; diluted with water, it resembles the taste of lemon juice; and it reddens strongly blue vegetable colours.

674 Action of heat. 5. When it is exposed to heat on burning coals, it melts, blackens, emits fumes, froths up, and exhales a sharp, pungent vapour. It then burns with a blue flame, and leaves behind a spongy mass of charcoal, in which some traces of lime have been detected. Four ounces of the concrete crystallized acid, carefully distilled, gave the following products *:

Cub. In.	
431	carbonic acid gas,
120	carbureted hydrogen gas.

675 Action of heat. 6. In the decomposition of tartaric acid by heat, one of the most remarkable products which particularly characterizes it, is an acid liquid of a reddish colour, which amounts to one-fourth part of the weight of the former. This was formerly known by the name of pyrotartarous acid. It has a slightly acid taste, produces a disagreeable sensation on the tongue, is strongly empyreumatic, and reddens the tincture of turnsole. But it has been found by the experiments of Fourcroy and Vauquelin, to be the acetic acid impregnated with an oil † (Q).

* Fourcroy Connais. Chim. tom. vii. p. 255.

7. Tartaric acid is very soluble in water. The specific gravity of a solution formed by Bergman, was found to be 1.230. This solution in water is not soluble to spontaneous decomposition, unless it is diluted. While it is concentrated, it loses nothing of its acid nature or its other properties. 676 Water.

† Ann. de Chim. tom. xxxv. p. 161.

677 Converted into oxalic. 8. Bergman supposed that tartarous acid could not be changed by the strongest mineral acids, and more especially by the nitric; but Hermstadt has succeeded in converting it into oxalic acid by several successive distillations, with six times its weight of nitric acid. Three hundred and sixty parts of tartaric acid yielded 560 parts of oxalic acid, which shews that it had combined with a great additional proportion of oxygen ‡.

‡ Fourcroy Connais. Chim. tom. vii. p. 256.

678 Composition. 9. According to the analysis of Fourcroy and Vauquelin, 100 parts of this acid are composed of

70.5	oxygen,
19.0	carbon,
10.5	hydrogen.
100.0	

679 Affinities. 10. The affinities of this acid are in the following order:

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Alumina.

Sect. XXI. *Of Citric Acid.*

680 Found in fruits. 1. The sour acid or taste of the juice of lemons and oranges is well known. This is *nitric acid*, but it is mixed with water and mucilage; and various processes have been proposed to obtain it in a state of purity.

681 Preparation. 2. The first which succeeded was proposed by M. Georgius, an account of which was published in the Swedish Memoirs for the year 1774. His process was the following. It consisted in filling bottles with lemon juice, shutting them up close, and placing them for some time in a cellar to separate the mucilage. He afterwards exposed it to a temperature of about 24°; the watery part froze, and carried with it a portion of mucilage. This was removed, and the liquid part which remained was again frozen, till the solid part had a perceptible acid taste. The juice thus reduced to one-eighth part of its original bulk, is eight times stronger, and requires the same quantity of potash for saturation. In this state of concentration it was preserved.

682 Process of Scheele. 3. But in this state it is not pure. We are indebted to Scheele for the discovery of the process by which it is obtained in a state of purity, and for ascertaining the

(Q) The pyromucous and the pyroligneous acids are to be regarded in the same light. The peculiar properties which were supposed to distinguish them from other acids were found by the same philosophers to be owing to a similar impregnation.

the characters by which it is distinguished from tartaric acid, with which it was formerly confounded. Lemon juice which has been filtered, is saturated with powdered chalk. While the chalk is added, an effervescence takes place, which is owing to the combination of the citric acid with the lime, and the separation of the carbonic acid from it in the state of gas. When the effervescence ceases, a white powder falls to the bottom. This is the lime combined with the citric acid. Wash this powder with warm water till it passes off colourless, then put the salt which has been washed into a matrass with a little water. Take such a quantity of concentrated sulphuric acid, diluted with six or seven parts of water, as may be necessary to saturate the lime which has been employed; boil it for a few minutes, then let it cool, and filter the liquor. The sulphate of lime, formed by the decomposition of the calcareous citrate, remains upon the filtre. The filtered liquor contains the pure citric acid, which is to be evaporated to the consistence of a syrup,* and to be set by in a cool place to crystallize. The citric acid is thus obtained in small crystals.

683 Excess of acid to be added. Scheele thinks that is necessary to add a small excess of sulphuric acid, to take up the whole of the lime from the citric acid. But Dizè is of opinion that this excess of sulphuric acid is only necessary, to destroy the remaining portion of mucilage which adheres to the citric acid, and thus to separate from it every extraneous substance *.

* Fourcroy, Connaiss. Chim. tom. vii. p. 204.

684 Supposed to be unnecessary. But it has been observed, that when an excess of sulphuric acid is employed, it may act upon the citric acid itself, decompose it, and produce the black matter which was supposed to be owing to the mucilage which adhered to it. And it appears, from an investigation by Proust on the preparation of this acid, that when too much sulphuric acid is employed, it decomposes the citric acid, and prevents it from crystallizing. To prevent this, a small quantity of chalk is added. He found that four ounces of chalk were necessary for the saturation of 94 ounces of lemon juice, and that the product which he obtained amounted to $7\frac{1}{2}$ ounces of citrate of lime; and to decompose this, he added 20 ounces of diluted sulphuric acid †.

† Journ. de Phys. iii.

685 Properties. 4. When citric acid is pure, it crystallizes in rhomboidal prisms, whose sides are inclined to each other at angles of 60° and 120°, terminating at each end in four trapezoidal faces, which include the solid angles. By slow cooling of large quantities of the solution of the pure acid, evaporated to the consistence of syrup, Dizè obtained very fine crystals.

5. Citric acid has a very strong acid taste, and even seems to be caustic; but when it is diluted with water, the taste is cooling and agreeable. It has a very slight odour of lemons, and it reddens blue vegetable colours.

686 Action of heat. 6. When exposed to heat, it melts rapidly in its own water of crystallization. When the solid acid is put upon burning coals, it quickly fuses, froths up, exhales a sharp penetrating vapour, and is reduced to the state of charcoal. Distilled in a retort, it is partly disengaged without decomposition, seems to be converted partly into vinegar, and then yields carbonic acid gas, carbonated hydrogen gas, and there remains in the retort a mass of light charcoal.

7. Exposed to the air, it effloresces in a dry, warm atmosphere; but when the air is moist, it absorbs water, and loses its crystalline form. It is very soluble in water. Seventy-five parts of water dissolve 100 of the acid. 687 Water.

8. Sulphuric acid, when concentrated, converts it into acetic acid. It is also decomposed by the nitric acid, which converts it partly into oxalic acid, but the greater proportion into acetic acid. 688 Acids.

9. From the experiments which have been made with this acid, by decomposing it by means of other acids, and the products which it affords, and its conversion into acids whose component parts are known, it seems to be pretty certain that oxygen, hydrogen, and carbon enter into the composition of citric acid. 689 Composition.

10. This acid enters into combination with alkalies, earths, and metallic oxides, and forms salts which are denominated *citrates*. 690 Compounds.

11. The affinities of citric acid are the following: 691 Affinities.

Lime,
Barytes,
Strontites,
Magnesia,
Potash,
Soda,
Ammonia,
Alumina,
Zirconia.

Sect. XXII. *Malic Acid.*

1. Malic acid is found in considerable proportion in the juices of a great number of fruits. In them it exists ready formed, and particularly in the juice of apples, from which it has derived its name. In some fruits it exists in small quantity, mixed with a great proportion of citric acid, as in two species of *vaccinium, oxycoccos* and *vitis idæa, prunus padus*, and *solanum dulcamara*. These acids are found in nearly equal proportions in some other fruits, as in the gooseberry, cherry, and strawberry; but it exists in greatest abundance, and in the greatest purity, in the juice of apples. 692 History.

2. It is prepared by the following process, which was discovered by Scheele. Bruise a quantity of sour apples, express the juice, and filter it through a linen cloth. Saturate this juice with potash, add to the solution acetate of lead (sugar of lead) dissolved in water, and continue the addition till there is no more precipitation. The acetic acid combines with the potash, and remains in the liquid, while the malic acid unites with the lead, and being insoluble, falls to the bottom. Wash the precipitate with water, and pour upon it diluted sulphuric acid. The sulphuric acid combines with the lead, and forms an insoluble salt, which falls to the bottom. The malic acid remains uncombined in the liquid. Care should be taken to add a sufficient quantity of the sulphuric acid to separate the whole of the malic acid from the lead, which may be known by the pure acid taste unmixed with the sweet taste of the salt of lead. 693 Method of preparing it.

3. When this acid is mixed with citric acid, as is the case in the juices of many fruits, Scheele contrived the 694 Of separating it from citric.

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Acids. the following process to separate them. The juice is first evaporated to the consistence of honey; alcohol is poured upon it, by which the two acids are dissolved, and a great quantity of mucilage is separated; the alcohol is then evaporated; the residue after evaporation is diluted with two parts of water, and saturated with chalk, which combines with both the acids. The citrate of lime, which is the least soluble, is separated by evaporation; the malate of lime, or the combination with the malic acid, may be also separated, by adding another portion of alcohol, which does not dissolve the salt, but a saccharine matter which had combined with the malate of lime. The malic acid may then be separated as before, with the solution of the sugar of lead.

695 Obtained from house-leek. 4. Vauquelin has extracted a very pure and nearly colourless malic acid from the juice of house-leek, (*sempervivum tectorum*, Lin.) It exists in this juice combined with lime. He extracted it by evaporating the juice, pouring alcohol upon the residue to separate a small quantity of sugar which it contained, and by adding to the remaining matter an equal weight of concentrated sulphuric acid, previously diluted with seven or eight times the quantity of water. But as some traces of sulphate of lime are always found in the malic acid prepared in this way, he prefers the following method.

Add to the juice a solution of sugar of lead; a precipitate is formed, which is to be decomposed by means of diluted sulphuric acid *.

* *Ann. de Chim.* xxxiv. p. 127.

696 Properties. 5. Malic acid, thus obtained, is a reddish brown liquid, of a pungent acid taste, leaving afterwards the sensation of sweetness. It reddens blue vegetable colours. It never assumes a crystalline form, but becomes thick and viscid like syrup; and when exposed to dry air, it dries in thin strata like a brilliant varnish, for which purpose it might be employed on polished surfaces †.

† *Fourcroy Connaiss. Chim.* tom. vii. p. 799.

697 Action of heat. 6. Malic acid is very readily decomposed by heat. It becomes of a dark colour, swells up, exhales a thick acrid vapour in the open air, and leaves behind a bulky mass of coal. When distilled in a retort, it yields an acid water, a great deal of carbonic acid gas, a little carbonated hydrogen gas, and a light spongy coal.

698 Decomposed spontaneously. 7. It is spontaneously decomposed in the vessels in which it is kept; undergoes a kind of vinous fermentation, and deposits a mucous, flaky substance. This decomposition is owing to the intimate re-action of its constituent parts.

699 by nitric acid. 8. All the strong acids decompose it. Concentrated sulphuric acid chars it; and it is converted into oxalic acid by nitric acid. Scheele discovered, that mucous matters treated with nitric acid, passed to the state of malic acid, or were converted into this acid, and into oxalic acid.

700 Proportion of its constituents unknown. 9. The proportions of the constituent parts of this acid have not been ascertained; but from its decomposition, and the products which are thus obtained, it is obvious that it is composed of oxygen, hydrogen, and carbon, of which the latter is supposed to be in great proportion.

701 and also its affinities. 10. The affinities of this acid are not determined. The compounds which it forms with alkalies, earths, and metallic oxides, are denominated *malates*.

11. It is very soluble in water.

Sect. XXIII. *Of Gallic Acid.*

Acids.

1. This acid exists most abundantly in a well known 702 History.
substance, *nut galls*, and hence it has obtained the name of gallic acid. It is also found in the bark and wood of many other plants. It was first examined by the academicians of Dijon in 1772, and its acid properties clearly ascertained; but it is to Scheele that we are indebted for the discovery of the process by which it may be obtained pure and crystallized. The account of this process was published in 1780, which is the following.

2. To one part of nut galls, reduced to a coarse 703 Preparation.
powder, add six parts of pure water. Let the infusion macerate for 15 days at the temperature of between 70° and 80°; filter it, and put the liquid into a large glass or earthen vessel, expose it to the air, and allow it to evaporate slowly. A thick glutinous pellicle forms on the top; a great quantity of mucous flakes are precipitated, and the solution has no longer an astringent, but a perceptibly acid taste. At the end of two or three months, Scheele had observed on the sides of the vessels in which the solution was contained, a brown crust covered with shining crystals of a yellowish gray colour. He found also a great quantity of these crystals under the thick pellicle which covered the liquid. He then decanted it, and added alcohol to the precipitate, the pellicle and the crystalline crust, and applied heat. The alcohol dissolved the crystallized acid, without touching the mucilage. The solution was now evaporated, and the gallic acid was obtained pure, in small shining crystals of a yellowish gray colour.

3. Deyeux has pointed out another method, by which, 704 Another process.
with proper precautions, gallic acid may be more readily obtained. He introduces into a large glass retort, a quantity of nut galls reduced to powder, and applies heat slowly and cautiously, by which he obtains a large quantity of laminated, brilliant, silvery crystals, sufficiently large, and which have all the properties of gallic acid. But in following this process, it is necessary to observe, that the heat must be very moderate, and not continued till an oil is disengaged, which instantly disolves all the crystals sublimed before its appearance *.

* *Connaiss. Chim.* viii. p. 181.

4. Sir H. Davy prepares it by boiling together for some 705 Davy's.
time carbonate of barytes, and a solution of gall nuts. This affords a bluish green liquor. When diluted sulphuric acid is dropt into it, it becomes turbid; sulphate of barytes is deposited, and after filtration, if the saturation of the earth be complete, a colourless solution of gallic acid, apparently pure, is obtained †.

† *Journ. Roy. Inst.* vol. i. p. 274.

5. Gallic acid is crystallized in transparent octahe- 706 Properties.
drons, or brilliant plates; it has a sharp, pungent, and austere taste, but less strong and astringent than that of the gall nut.

6. This acid is not sensibly affected by exposure to 707 Action of water.
the air. It requires 24 parts of cold water, and about two-thirds of its weight in boiling water, to dissolve it, from which it can only be crystallized by a very slow evaporation.

7. With a moderate heat, it rises into vapour, which 708 Of heat.
on cooling is condensed and crystallized. In the state of vapour, it has a sharp, aromatic odour, resembling that

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Acids. that of the benzoic acid. Every time that it is sublimed, even with a moderate heat, it is partially decomposed; water is formed, an acid liquid, carbonic acid gas, carbonated hydrogen gas, and some drops of a brown coloured oil; and there remains behind, a great quantity of coaly matter.

709 Of acids. 8. Concentrated sulphuric acid decomposes and chars the gallic acid. Nitric acid converts it into the malic and oxalic acids. Oxymuriatic acid produces peculiar changes on the gallic acid, but these have not been distinctly ascertained †.

† *Fourcroy, Connaiss. Chim.* tom. vii. p. 183.

710 Of metallic oxides. 9. Although we have not yet treated of metallic substances, it may be necessary to anticipate a little, and mention the effects of gallic acid on metallic oxides. This indeed is its chief characteristic. On this account, it is much employed by chemists, to discover metallic substances, which are held in solution along with other bodies. Its effects on the metallic oxides are extremely various, and with different metals it affords different coloured precipitates. The more readily the metallic oxides give up their oxygen, the greater is the change produced by the gallic acid. On some metallic solutions it has no effect; such are, solutions of platina, of zinc, of tin, of cobalt, and of manganese. The precipitates of the different metals produced by means of gallic acid, exhibit the following colours:

Gold,	Brown.
Silver,	Brown.
Mercury,	Orange-yellow.
Copper,	Brown.
Bismuth,	Citron-yellow.
Iron,	Black.
Lead,	White.
Nickel,	Gray.
Antimony,	White.
Tellurium,	Yellow.
Uranium,	Chocolate.
Titanium,	Reddish-brown.
Chromium,	Brown.
Columbium,	Orange.

711 Composition. 10. The component parts of gallic acid are the same as those of the other vegetable acids, but having a greater proportion of carbon; but these proportions have not been ascertained.

712 Compounds. 11. The compounds which the gallic acid forms with alkalies, earths, and metallic oxides, are denominated *gallates*.

713 Affinities. 12. The affinities of this acid have not been ascertained.

Sect. XXXIV. *Of Benzoic Acid.*

714 History. 1. Benzoic acid is obtained from several plants, and particularly from the *styrax benzoë*, a tree which grows in Sumatra; from the balsam of Peru and Tolu; from vanilla, and liquid amber. It also exists in the urine of children, and sometimes in that of adults, but constantly in the urine of quadrupeds which live on grass and hay, especially in that of the horse and cow. It is suspected also that it exists in many of the grasses, and that it is derived from them by means of the aliment to the urine of the animals in which it is found. Fourcroy and Vauquelin suspect that it exists in the sweet-scented grass, (*anthoxanthum odoratum*, Lin.) which gives the fine flavour to hay ‡.

‡ *Fourcroy, Connaiss. Chim.* tom. vii. p. 187.

The first mention of benzoic acid is made by Blaise de Vigenere, who wrote about the commencement of the 17th century (R). He says, that he obtained by distilling benzoin, an acid salt which crystallized in needles, of a penetrating odour. It was then called *flowers of benzoin*, but at present *benzoic acid*.

2. To obtain this acid by the most common process, put into an earthen pot a quantity of benzoin grossly powdered. Cover the vessel with a cone of paper, and apply a very gentle heat. The benzoic acid is sublimed, and attaches itself to the sides of the cone, which may be renewed every two hours. Continue the process till the acid sublimed begins to be coloured by the oil which is disengaged. By a process proposed by Geoffroy, the benzoin reduced to a powder is digested in warm water, and this being filtrated, yields on cooling needle-shaped crystals of benzoic acid; but the quantity obtained in this way is very small, which led Scheele to adopt the following process. He took 1 part of quicklime, to which were added 3 parts of water, and afterwards about 30 parts more, which is then to be gradually mixed with 4 parts of powdered benzoin. Heat the whole on a moderate fire for half an hour, continually agitating the mixture; then remove it from the fire, and let it remain at rest for several hours. Decant the clear supernatant liquor, and add 8 parts more water to the residuum. Boil it for half an hour, and mix it with the former. Reduce the liquor by evaporation to two parts; add drop by drop, to a slight excess, muriatic acid, which causes the benzoic acid to precipitate, by separating it from the lime. Wash the precipitate well on a filter; and to obtain it in crystals, dissolve it in 5 or 6 times its own weight of boiling water, which, on cooling, yields crystals in the form of long compressed prisms. 715 Preparation.

3. Pure benzoic acid is either in the form of a light powder, perceptibly crystallized, or in the form of very small needles, of which it is extremely difficult to determine the shape. It is white and brilliant, and has some degree of ductility and elasticity. It has an acrid, pungent, acidulous, and very bitter taste. In the cold the odour is slight, but is aromatic, and this is sufficient to characterize it. It reddens the tincture of turnsole, but has no effect on the syrup of violets. The specific gravity of benzoic acid is 0.667. 716 Properties.

4. Exposed to a moderate heat, it melts, forms a soft brown and spongy body, which cools into a solid crust, exhibiting on the surface some appearance of crystallization. With a stronger heat it is sublimed, and exhales a white acrid vapour, which affects the eyes. It burns when brought into contact with flame, and the whole is consumed without any residuum. When it is distilled in close vessels, great part sublimes unchanged, but part is decomposed and yields a viscid liquid, a considerable quantity of oil, and a much greater quantity of carbonated hydrogen gas than any other 717 Action of heat.

(R) *Traité du feu et du sel*, which was printed at Paris in 1608.

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Acids other body of this nature. A very small portion of coaly matter remains in the retort.

718 Of water. 5. It is not sensibly changed by exposure to the air. It is scarcely soluble in cold water. Four hundred parts of boiling water dissolve 20 parts of the acid, 19 of which are separated on cooling.

719 Of acids. 6. Concentrated sulphuric acid readily dissolves this acid, and one part of the sulphuric acid passes into the state of sulphurous acid. Benzoic acid may be separated from this solution without having undergone any change, by adding water. The nitric acid dissolves it in the same way, and it is also separated by means of water. Guyton found, by distilling nitric acid on the concrete benzoic acid, that nitrous gas was disengaged, only towards the end of the process, and that the acid itself then sublimed without alteration.

720 Composition. 7. As this acid yields by distillation oil and carbonated hydrogen gas, it is obvious that it must be composed of carbon and hydrogen, and probably also oxygen, although this latter has not been discovered in any experiments that have been made on this substance.

721 Compounds. 8. Benzoic acid unites very readily with alkalies, earths, and metallic oxides, and the compounds which are thus formed are denominated *benzoates*.

722 Affinities. 9. The order of the affinities of benzoic acid is the following:

White oxide of arsenic,
Potash,
Soda,
Ammonia,
Barytes,
Lime,
Magnesia,
Alumina.

Sect. XXV. *Of Succinic Acid.*

723 History. 1. Succinic acid, formerly called volatile salt of amber, was long regarded as an alkaline salt. It was not till towards the end of the 17th century, that its acid properties were discovered. As amber, the substance from which the acid is obtained, is found in considerable quantity under strata of substances which contained pyrites, it was thought that this acid was formed by sulphuric acid. This was the opinion of Hoffman and Neuman. Amber is found on the sea-coast of different countries, especially in the Prussian territory on the shores of the Baltic. The name of the acid is derived from *succinum*, the Latin name for this substance.

724 Preparation. 2. Succinic acid may be obtained by the following process. Introduce a quantity of amber in powder into a retort, and let it be covered with dry sand. Adapt a receiver, and distil with a moderate heat in a sand bath. There passes over first a liquid which is of a reddish colour, and afterwards a volatile acid salt, which crystallizes in small, white, or yellowish needles in the neck of the retort; and if the distillation be continued, a white light oil succeeds, which becomes brown, thick, and viscid. The acid which is obtained in this way is contaminated with the oil; and therefore to separate this oil, it may be dissolved in hot water, and passed through a filter on which has been placed a little cotton moistened with oil of amber, which retains the oil, and prevents it from passing through along with the acid. The acid may then be evaporated and crystallized. Guyton has observed, that the acid may be rendered quite pure, by distilling off it a sufficient quantity of nitric acid, but with this precaution, that the heat employed is not strong enough to sublime the succinic acid *.

* Ann. de Chim. tom. xxx. p. 162.

3. The acid thus obtained is in the form of white, Properties. 725
shining, transparent crystals, which are foliated, triangular, and prismatic. The taste is acid, but not corrosive. It reddens the tincture of turnsole, but has no effect on the infusion of violets.

4. With the heat of a sand bath, the crystals of succinic acid first melt, and are then sublimed and condensed in the upper part of the vessel. There is, however, a partial decomposition, for there is a coaly matter left behind in the vessel. Action of heat. 726

5. At the temperature of 212°, two parts of water dissolve one of this acid, which crystallizes on cooling. When the water is cold at the temperature of 50°, it requires 96 parts of water to dissolve one of the acid. Of water. 727

6. This acid, like other vegetable acids, is composed of oxygen, hydrogen, and carbon; for when it is distilled in a retort with a strong heat, carbonic acid gas and carbonated hydrogen gas are evolved, and charcoal remains behind in the retort. The proportions of the component parts have not been ascertained. Composition. 728

7. This acid enters into combination with alkalies, earths, and metallic oxides, and forms with them compounds, which are denominated *succinates*. Compounds. 729

8. The affinities of this acid are in the following order: Affinities. 730

Barytes,
Lime,
Potash,
Soda,
Ammonia,
Magnesia,
Alumina,
Metallic oxides.

Sect. XXVI. *Of Saclactic Acid.*

1. To this acid Fourcroy has given the name of *Mucous acid*, because it is obtained from gum arabic and other mucilaginous substances; and it was formerly called *acid of sugar of milk*. This latter name it received from Scheele, who discovered it in the year 1780, while he was employed in making experiments on the sugar of milk, in order to obtain from it oxalic acid, which he procured from sugar. History. 731

2. This acid may be obtained by the following process. To 1 part of gum arabic, or other mucilaginous substance, add 2 parts of nitric acid in a retort, and apply a gentle heat. There is at first disengaged a little nitrous gas and carbonic acid gas, after which let the mixture cool. There is then precipitated a white powder which is slightly acid. This powder is the saclactic acid. Preparation. 732

3. Thus obtained, saclactic acid is in the form of a white powder, a little gritty, and with a weak acid taste. Properties. 733

4. It is readily decomposed by heat, and yields an acid liquor which crystallizes by rest in the shape of needles, Action of heat. 734

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Acids. needles, a small quantity of an acrid caustic oil, of a blood-red colour, carbonic acid gas, and carbonated hydrogen gas; and there is left behind a considerable quantity of coaly matter. It is partly sublimed in needles or brown plates, with an odour similar to that of benzoic acid †.

† Fourcroy Connaiss. Chim. tom. vii. p. 147.

735 Of water. 5. Saclatic acid in the state of powder is not very soluble in water. Cold water does not take up more than 200 or 300 parts of its weight; boiling water does not take up above one half more. On cooling, the acid is deposited in brilliant scales, which become white in the air. The solution has an acid taste. It reddens the tincture of turnsole. Its specific gravity at the temperature of 59° is 1.0015‡.

‡ Encyc. Method. i. p. 290.

736 Compounds. 6. This acid enters into combination with earths, alkalies, and metallic oxides; and the salts which it forms are known by the name of *saccolates*.

737 Affinities. 7. The order of its affinities, according to Bergman, is the following:

Lime,
Barytes,
Magnesia,
Potash,
Soda,
Ammonia,
Alumina,
Metallic oxides.

Sect. XXVII. *Of Camphoric Acid.*

738 History. 1. This acid is obtained, as the name imports, from *camphor*, a concrete substance procured from a species of laurel (*Laurus camphora*, Lin.) which is a native of the East Indies.

739 Preparation. 2. Camphoric acid was first obtained by Kosegarten, by distilling nitric acid 8 times successively off camphor. This experiment was repeated by Bouillon Lagrange with the same result. He introduced into a glass retort, 1 part of camphor, and he poured over it 4 parts of nitric acid. A receiver was adapted to the retort, and the joinings were well luted. The retort was placed on a sand-bath, and a gradual heat was applied. A great deal of nitrous gas and carbonic acid gas was disengaged. One part of the camphor is sublimed, and another part seizes on the oxygen of the nitric acid. The same process must be repeated till the whole of the camphor is acidified, which is known by its crystallizing when the liquor cools which remains in the retort. These crystals are camphoric acid. To purify it, it must be dissolved in distilled warm water, and the liquor is then to be filtered and evaporated to nearly half its volume, or till a thin pellicle is formed on it. When it cools, crystals of pure camphoric acid will be obtained.

740 Properties. 3. Camphoric acid has a slightly acid, bitter taste. It reddens the tincture of turnsole. The crystals resemble, when, in a mass, those of the muriate of ammonia. Exposed to the air the mass effloresces.

741 Action of water. 4. Cold water dissolves this acid with great difficulty. An ounce of water at the temperature of between 50° and 60°, cannot dissolve more than 6 grs. while water at the boiling temperature will hold in solution eight times that quantity.

742 Of heat. 5. When this acid is put upon burning coals, it exhales a dense, aromatic vapour; with a less degree of heat, it melts, and is sublimed. When put into a heated porcelain tube, and if a stream of oxygen gas be passed through it, the acid remains unchanged, but it is sublimed from the sides of the tube. When distilled alone, it first melts and then sublimes. This sublimation produces some change in its properties. It no longer reddens the tincture of turnsole, and acquires a strong aromatic odour, and a less pungent taste; becomes insoluble in water, and in the sulphuric and muriatic acids. The nitric acid heated, makes it yellow, and dissolves it *.

* Annal. de Chim. tom. xiii. p. 173.

743 Compounds. 6. Camphoric acid enters into combination with the alkalies, earths, and metallic oxides, and the compounds thus formed are denominated *camphorates*.

744 Affinities. 7. The affinities of this acid are the following †:

† Ibid. xxvii. p. 42.

Lime,
Potash,
Soda,
Barytes,
Ammonia,
Alumina,
Magnesia.

Sect. XXVIII. *Of Suberic Acid.*

745 History. 1. This acid is obtained from cork, a well-known substance, which is the bark of a tree (the *quercus suber* Lin. or cork-tree). From the Latin name of this substance, *suber*, the name of the acid is derived, and hence it is called *suberic acid*. The acid which is obtained from cork, by treating it with nitric acid, was supposed to be the oxalic acid, on account of possessing some common properties, and particularly that of forming with lime an insoluble salt. But the experiments of Bouillon Lagrange have shewn, that this is a peculiar acid.

746 Preparation. 2. This acid is obtained by the following process. Take a quantity of clean cork, grated down. Introduce it into a retort, and pour on it six times its weight of nitric acid; the acid ought not to be too concentrated. It is then to be distilled with a moderate heat. The cork swells up and becomes yellow, and there is disengaged a quantity of red vapours; and as the distillation goes on, the cork is dissolved, and swims on the surface like foam. If this scum is not formed, the cork has not been acted upon by the acid. In this case, when the distillation begins to stop, return into the retort the acid which had passed over into the receiver, and distil as long as any red vapours appear, and then immediately remove the retort from the sand bath, and pour out the contents while yet hot into a glass or porcelain vessel; put it into a sand bath and apply a gentle heat, stirring it constantly with a glass rod. The matter gradually thickens, and as soon as white vapours are disengaged, which excite a tickling in the throat, it is to be removed from the sand bath, and constantly stirred till the mass is nearly cold. In this way a substance is obtained of the consistence of honey, of an orange-yellow colour, of a sharp penetrating odour while it is warm, but which gives out a peculiar aromatic smell when it is cold.

To procure the acid which is contained in this substance, put it into a matrass, and pour upon it double its

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its weight of distilled water. Apply heat till the mass becomes liquid, and separate by filtration that part which is insoluble in water. The liquor which is obtained is of a clear amber colour, and of a peculiar odour. The filtered liquor on cooling becomes muddy, is covered with a thin pellicle, and deposits a powdery sediment. The precipitate is to be separated from the liquid by filtration, and it is to be dried with a gentle heat. This precipitate is the suberic acid. The remaining liquor is then to be evaporated to dryness with a moderate heat, to obtain the whole of the acid which it holds in solution.

The acid which is prepared by this process is a little coloured, and may be purified, either by saturating the suberic acid with potash, and precipitating with an acid, or by boiling it with charcoal powder.

747 Properties.

3. Suberic acid is in the solid form, but it is not crystallized. When it is obtained by precipitation, it is in the state of a powder, and by evaporation it is in the form of thin irregular pellicles.

4. It has a slightly bitter and acid taste. Dissolved in a small quantity of boiling water, it tickles the throat, and excites coughing. It reddens vegetable blues.

748 Action of light.

5. Exposed to the light, it becomes brown after a certain time; but this effect is more speedily produced when it is exposed to the sun's rays.

749 Of heat.

Heated in a matrass, the suberic acid is sublimed, and the glass remains marked with zones of different colours. If the sublimation be stopped in time, the acid is obtained on the sides of the vessel, in small points formed of concentric circles. When exposed to the heat of the blow-pipe on a spoon of platina, it first melts, then falls down into a powder, and at last is totally dissipated by sublimation.

750 Of acids.

6. It undergoes no change from the action of oxygen gas. The action of the acids on suberic acid is very weak. The solution is not complete, especially when it is impure.

751 Of water.

7. Water at the temperature of 60° or 70° dissolves the concrete acid only in the proportion of 10 grs. to the ounce. When the acid is very pure, the water will not dissolve more than 4 grs. Boiling water dissolves half its weight; but as the liquor cools, it becomes muddy, and the acid is deposited*.

* *Annal. de Chim.* tom. xxiii. p. 42.

752 Compounds.

8. This acid combines with the alkalies, earths, and metallic oxides, and forms with them compounds which are known by the name of *suberates*.

753 Affinities.

9. The order of its affinities is the following †:

Barytes,
Potash,
Soda,
Lime,
Ammonia,
Magnesia,
Alumina,
Metallic oxides.

† *Ibid.* p. 57.

Sect. XXIX. *Of Mellitic Acid.*

754 Discovery.

1. The acid is procured from a mineral substance which was discovered about the year 1790. Werner gave it the name of *honigstein*, (honeystone) from its colour. By other mineralogists it has been denominated mellite, from the Latin name of honey, and hence the acid which it affords has been called *mellitic* acid. The mineral from which this acid is obtained seems to be of vegetable origin. It is found in small crystals among the layers of wood coal at Arten in Thuringia. In the first analysis to which this mineral was subjected, no new acid was detected. But in the year 1799 the acute and accurate Klaproth examined its nature and component parts, and found that it is a compound of a peculiar acid and alumina. His experiments have been since repeated by Vauquelin, and the result of his analysis has been fully confirmed.

755 Process for obtaining.

2. It is procured from mellite by the following process. The mineral is to be reduced to powder, and boiled with about 72 times its weight of water. The alumina is precipitated in the form of flakes, and the acid combines with the water. By filtration and evaporation, crystals are deposited, which are the crystals of mellitic acid.

756 Properties.

3. This acid crystallizes in the form of fine needles, or in small short prisms with shining faces. They are considerably hard. It has a slightly acid taste, accompanied with some degree of bitterness.

757 Action of water.

4. This acid has very little solubility in water, but it has not been ascertained to what degree; or what proportion of water it requires for its solution.

758 Of heat.

5. A small quantity of this acid, exposed to the flame of the blow-pipe, at first gave out sparks like nitre; and then swelled up, and left a matter which penetrated the charcoal. Heated in a crucible of platinum, it swells up at first, is then charred, without the production of any oily vapour, and leaves behind a light coaly alkaline matter*.

* *Annal. de Chim.* vol. xxxvi. 210.

759 Of acids.

6. When the nitric acid is added to this acid, it produces no other change than giving it a yellowish colour. It has not yet converted it into any of the vegetable acids, to which it is nearly allied in its properties and constituent parts.

760 Composition.

7. According to Klaproth's analysis the mineral from which the acid is obtained consists of

46	metallic acid,
16	alumina,
38	water.
100	

When it was distilled in a retort the acid was completely decomposed; and the products obtained by Klaproth in this way from 100 grains of mellite were the following:

54	cubic inches of carbonic acid gas,
13	hydrogen gas,
38	grs. of acidulous water,
1	aromatic oil,
9	charcoal,
16	alumina.

The constituent parts of mellitic acid are obviously carbon, hydrogen, and oxygen. But the proportions have not been ascertained.

761 Compounds.

8. Mellitic acid enters into combination with the earths, alkalies, and metallic oxides, and forms compounds with them which are called *mellates*.

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Sect. XXX. *Of Lactic Acid.*

762 Discovery. 1. In investigating the changes which spontaneously take place in milk, the celebrated Scheele discovered that it contains a peculiar acid. To this has been given the name of *lactic acid*. The formation of this acid depends on the change of the sugar of milk or of the saccharine mucous matter; for after the acid is once well formed, when the serous part of the milk being very sour reddens vegetable blues, no more is obtained by evaporation and crystallization.

763 Preparation. 2. Scheele did not succeed in separating the acid from the serous part of the milk by distillation. He therefore contrived the following process. He evaporated a quantity of sour whey to $\frac{1}{8}$th of its bulk, and then filtered it to separate the whole of the coagulated cheesy matter. He then added lime-water to precipitate the phosphate of lime, and diluted the liquid with three times its weight of pure water. He then precipitated the excess of lime by means of the oxalic acid, adding no more of the latter than what is necessary. He evaporated the solution to the consistency of honey, poured on a quantity of alcohol, which separates the portion of sugar of milk and of other extraneous matter, and dissolves the lactic acid; and distilled the clear filtered liquor till the whole of the alcohol employed be driven off; what remains in the retort is the lactic acid.

764 Properties. 3. This acid is never crystallized; but always appears in the form of a viscid mucilaginous substance. It has a strong sharp taste, which is far from being agreeable. It reddens the tincture of turnsole, and gives a reddish violet shade to the syrup of violets.

765 Composition. 4. When it is distilled in a retort it yields an empyreumatic acid which is very strong and analogous to the tartaric, very little oil, carbonic acid gas, and carbonated hydrogen gas, and a small quantity of coaly matter which adheres to the glass. This shews what are the constituent parts of this acid, but the proportions of these have not been determined.

766 Compounds. 5. The compounds with alkalies, earths, and metallic oxides which are formed with the lactic acid, are denominated *lactates*.

767 Affinities. 6. The affinities of this acid are in the following order:

Barytes,
Potash,
Soda,
Strontites,
Lime,
Ammonia,
Magnesia,
Metallic oxides,
Glucina,
Alumina,
Zirconia.

Sect. XXXI. *Of Laccic Acid.*

768 History. 1. The substance from which this acid is obtained, is collected in the neighbourhood of Madras. It was first described by Dr Anderson, who says that nests of insects resembling small cowry shells were brought to him from the woods by the natives, who eat them with avidity. These supposed nests he shortly afterwards discovered to be the coverings of the females of an undescribed species of coccus; and having noticed in Abbé Grosier's account of China, that the Chinese called a kind of wax, much esteemed by them, under the name of *pela*, from a coccus deposited for the purpose of breeding on certain shrubs, and managed exactly in the same manner as the Mexicans manage the cochineal insects, he followed the same process with his new insects, and found means to propagate them with great facility on trees and shrubs in the neighbourhood.

This substance, which he called white lac, was found on examination to have a considerable resemblance to bees wax. Dr Anderson supposes, that the animal which secretes it provides itself, by some means or other, with a small quantity of honey, resembling that produced by our bees. The sweetness of it tempted the children who were employed to collect it, to eat so much of it as very much to diminish his crop. A small quantity of this matter was sent to Europe in 1789. It was examined by Dr Pearson, who published an account of his analysis in the Philosophical Transactions for 1794, from which we have extracted the information which we now lay before our readers. 769 and nature of the substances from which it is obtained.

A piece of white lac, which weighs from three to fifteen grains, is supposed to be produced by each insect. These pieces are about the size of a pea, of a gray colour, opaque and roundish, but with a flat side, by which they adhere to the bark. In its dry state, white lac is soft and tough, and has a saltish and bitterish taste. A watery liquid, which has a slight salt taste, oozes out on pressing a piece of this substance. White lac has no smell, unless it be pressed or rubbed, when it becomes soft, and then it emits a peculiar odour. When it is gathered from the tree, the pieces of lac are lighter than bees-wax; but after being melted and purified, it sinks in water. It melts in alcohol and in water at the temperature of 145°, and very readily in boiling water.

2. Dr Pearson exposed 2000 grains of white lac to such a degree of heat as was sufficient to melt them. They became soft and fluid, and there oozed out 550 grains of a reddish watery liquid, which emitted the smell of newly baked bread. The liquid was filtered and purified from extraneous matter. This liquid is *laccic acid*. 770 Preparation.

3. It has a slightly saltish taste, with some degree of bitterness. It smells when heated like newly baked hot bread. It reddens the tincture of turnsole. Its specific gravity, at the temperature of 60°, is 1.025. When this liquid remains for some time at rest, it becomes turbid, and deposits a sediment. When it is evaporated, it becomes more turbid; and, allowed to remain at rest, it affords small needle-like crystals in mucilaginous matter. 771 Properties.

4. Two hundred and fifty grains of this liquid were exposed to heat in a small retort. As the liquor grew warm, mucilage-like clouds appeared, but when it grew hot, they disappeared. At the temperature of 200° it distilled over very fast. On distillation to dryness, a small quantity of extractive matter remained. The distilled liquid was transparent and yellowish, and while hot, had the smell of newly baked bread. Paper stained with turnsole, which had been put into the receiver, was 772 Action of heat.

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Acids. was not reddened. One hundred grains of yellowish transparent liquid being evaporated till it became turbid, afforded in the course of a night, acicular crystals which had a bitterish taste. Under a lens they appeared in a group, somewhat resembling the umbel of parsley. One hundred grains of yellowish transparent liquid being evaporated in a low temperature to dryness, a blackish matter remained behind, which did not entirely disappear when exposed to pretty strong heat; but on heating oxalic acid to a less degree, it evaporated and left no trace behind.

From these properties, and from its peculiar action with alkaline, earthy, and metallic salts, Dr Pearson concludes, that this acid is different from any of the acids already known.

773 Composition. 5. The experiments which have been made on white lac, and on the acid obtained from it, show that it is closely allied to the vegetable acids. Its component parts, therefore, probably are, carbon, hydrogen, and oxygen; but experiments are still wanting fully to ascertain its nature and properties *.

* Phil. Trans. 1794. p. 383.

Sect. XXXII. *Of Prussic Acid.*

774 History. 1. This is one of the most important acids, both to the chemist and to the manufacturer. It has been alledged, that the ancients were acquainted with Prussian blue, which they employed in painting; but Landriani has shown, in his dissertation on this substance, from the evidence of Theophrastus and Pliny, and from the analysis of an Egyptian mummy, that the ancients employed ultramarine blue and the smalt or azure of cobalt; and that Prussian blue, which is readily acted on by the substances to which it must have been exposed in these countries, could not have resisted their influence for so many ages, and retain the beautiful colours which are admired in the paintings of Herculaneum.

775 The discovery. 2. Stahl relates, in his 300 experiments, that the discovery of Prussian blue was owing to an accident. About the beginning of the 18th century, Diesbach, a chemist of Berlin, wishing to precipitate a decoction of cochineal with an alkali, borrowed from Dippel some potash, on which he had distilled several times his animal oil; but as there was some sulphate of iron in the decoction of cochineal, the liquor instantly exhibited a beautiful blue in place of a red precipitate. Reflecting on the circumstances which had taken place, he found that it was easy to produce at pleasure the same substance, which afterwards became an object of commerce. It obtained the name of *Prussian blue*, from the place where it was discovered.

776 First announced. 3. This discovery was announced in the Memoirs of the Academy of Berlin, for the year 1710; but the process by which it was obtained was kept secret, that those who were in possession of it might derive the whole advantage from the manufacture. It was published for the first time by Woodward in the Philosophical Transactions for the year 1724, who declared, that it had been sent to him from Germany, by one of his friends. This is all that is known of the manner by which this process was made public. It is not certain whether it came originally from the first inventors, or was owing to the researches of some other chemist.

4. The method which is described by Woodward succeeds very well. It is by preparing an extemporaneous alkali, by detonating four ounces of nitre, with an equal quantity of tartar; then to add four ounces of bullock's blood, well dried, and to calcine the whole with a moderate heat, till the blood be reduced to a coal, or emit no smoke capable of blackening any white body that is exposed to it. Towards the end of the process the fire is to be increased, till the crucible which contains the materials shall be moderately red. Throw the red-hot matter into water, and boil it for half an hour; and having poured off the first water, add another quantity, and boil it again. Repeat this operation till the last water comes off insipid, then add all the quantities of water together, and evaporate to the quantity of two pints. To this liquid the Germans have given the name of *blood ley*. By others it has been denominated *phlogisticated alkaline ley*. Acids. 777 Process.

5. A solution of 2 ounces of sulphate of iron, and 8 ounces of alum, in two pints of boiling water, is to be mixed with the former solution while both are hot. A great effervescence takes place; the liquor becomes muddy, assumes a greenish colour, inclining more or less to blue; and a precipitate is formed of the same colour. Separate this precipitate, and to heighten the colour, pour upon it carefully muriatic acid till it no longer increases the intensity of the blue colour; then wash it with water, and dry it slowly.

6. Such was the process by which Prussian blue was obtained, before the theory was discovered, to account for the different changes and effects which it presented. The same year in which Woodward published an account of the process, Brown instituted a set of experiments to discover the nature of this substance, and the circumstances which attended its formation. He found that flesh, as well as bullock's blood, possessed a similar property. He thought that Prussian blue was the bituminous part of iron, developed by the alkaline ley, and fixed in the aluminous earth. Geoffroy adopted the same explanation. He found that, in the animal kingdom, oils, wool, hartshorn, sponge, had the same effect as blood with the alkali, in precipitating iron of a blue colour; and that some vegetable charcoal treated with the alkali, in some measure communicated to it a similar property. Neuman discovered that the animal empyreumatic oils might be employed for the same purpose. The abbé Menon was of opinion, that the colour of iron is blue; and that this colour, usually disguised by same saline matter, reappears, when it is separated by the phlogisticated alkaline ley, and thus Prussian blue was only iron precipitated in its natural state. The aluminous earth, he saw, served only to diminish the intensity of the colour, and to give it a more agreeable shade. 778 Nature of it investigated by several chemists.

7. It is to the celebrated Macquer that we are indebted for the first correct views in developing the theory of this process. He observed, 1. That pure alkalies precipitated iron from its solution of a yellow colour. 2. That this precipitate is soluble in acids. 3. That the blue fecula obtained from the blue phlogisticated ley after the addition of muriatic acid, was not acted on by acids. He therefore concluded that the first green precipitate was not a homogeneous substance, but 779 By Macquer,

but a mixture of two precipitates, the one yellow and the other blue; and that it was sufficient to remove the first by any acid, to give to the second its full intensity of colour. Hence he supposed, that the acid of the alum employed in this process was useful in saturating, in a great measure, the pure alkaline portion of the ley, and diminishing proportionally the yellow precipitate of iron. Having found that it was impossible to saturate the alkali with a colouring matter by means of calcination; and, having discovered that the pure alkali deprived iron (which was converted into Prussian blue) of its characteristic properties; and finally, having ascertained that the alkali which was employed in the process became exactly similar to that which was calcined with combustible matters, to prepare it for the precipitation of iron of a blue colour, and that alkaline properties disappeared as it was more or less saturated with the colouring matter, he attempted to saturate it fully. He therefore saturated an alkali so completely with the colouring matter, that it underwent no change by boiling, and exhibited none of its alkaline properties by chemical tests. By this discovery we are now in possession of this valuable substance which had been hitherto known under the name of the *saturated ley of the colouring matter of Prussian blue*.

Macquer found, in the course of his experiments, that the saturated ley could not be decomposed by sulphuric acid, or by the solution of alum; but, on the contrary, that every metallic substance dissolved in an acid, separated the phlogistic matter from all the fixed and volatile alkalies. Hence he concluded, that in the process of the formation of Prussian blue, it is necessary that the affinity of the iron should co-operate with that of the acid with the alkali, to form a sum of affinities capable of effecting the separation. This luminous explanation of so striking a process, has not a little contributed to establish the theory of compound affinities.

780 and others. 8. After the publication of Macquer's dissertation, almost all chemists were occupied in researches into the nature of Prussian blue, either to discover the nature of its principles, or to improve the process for preparing the colouring matter: but they were chiefly occupied in examining those bodies which were capable of phlogisticating the alkali, as it was called; and this property was found to exist in a great number of substances. Till the year 1775, no change or modification was proposed on the theory of Macquer.

781 By Bergman. 9. About this time Bergman, in his dissertation on elective attractions, threw new light on this subject, by considering the colouring matter of Prussian blue as a distinct acid, and possessed of peculiar attractions. According to Sage, the alkali which precipitated Prussian blue was nothing but an alkali saturated with phosphoric acid; but Lavoisier justly remarked, that according to this theory, the salt formed of phosphoric acid and an alkali ought to precipitate a solution of sulphate of iron, of a blue colour, which was not the case.

Many chemists examined the nature of this substance by means of heat; and among others Delius and Scopoli, Deyeux and Parmentier, Bergman and Erxleben, subjected it to distillation, the product of which was a quantity of ammonia. By others an oil was obtained in this process, and sometimes a peculiar acid, which had the properties of sulphuric acid. The difference of these results probably arose from the different states of purity of the Prussian blue which was employed in the experiment.

Fontana discovered that the sulphuric acid distilled on Prussian blue passed to the state of sulphurous acid, and that the colouring matter produced detonation with nitre. Landriani found that it yielded by distillation, besides ammonia, a small portion of liquid perceptibly acid, and some oil, and a great quantity of elastic fluids, which consisted of azotic and hydrogen gases, the latter burning with a blue flame, and detonating strongly with oxygen gas. 782 By Fontana.

10. But the most important step in the progress of the discovery of the nature and properties of this singular substance, was made by Scheele, an account of which he published in two dissertations in the Stockholm transactions for 1782 and 1783. He began by examining the blood ley, and he found by exposing it for some time to the air, that it lost the property of precipitating iron of a blue colour, and that the precipitate which it then yields is soluble in acids. To discover what change had taken place on the air, he put some of the ley fresh prepared into a large glass globe close shut up, and he found some time after, that neither the air nor the ley had undergone any change. He concluded, therefore, that the colouring matter was not pure phlogiston. He suspected that carbonic acid might have some effect in changing the nature of the alkali when exposed to the open air. He filled a globe with carbonic acid gas, and having introduced a quantity of Prussian alkali, he kept it close shut up for 24 hours, after which, on examining the alkali, it gave a precipitate which was soluble in acids; the change then must have been occasioned by the carbonic acid gas. He repeated this experiment by adding to the colouring matter a small quantity of sulphate of iron. This matter was not changed by the action of the carbonic acid gas. The same result was observed when he boiled the colouring matter in an oxide of iron precipitated by an alkali. It suffered no change in the carbonic acid gas, but precipitated the iron as before. The iron then has the property of fixing the colouring principle, of defending it against the action of carbonic acid gas; and hence it happens that the neutral colouring salt formed with an alkali boiled on Prussian blue, does not so easily lose its properties. But if the colouring ley be digested on an oxide of iron, as that which is obtained from the sulphate of iron boiled in nitric acid, and afterwards precipitated by an alkali, no effect is produced. By this digestion the action of the gas is not prevented, and if the sulphate of iron be added, even with an excess of acid, there is no longer a production of Prussian blue. 783 By Scheele. 784 He examines the ley. 785 Effect of carbonic acid. 786 Iron fixes the colouring principle.

To discover what happened to the colouring principle, when it was charged with carbonic acid gas, Scheele introduced into a globe filled with this gas, some of the Prussian alkali, and suspended in it a bit of paper, previously dipped in a solution of sulphate of iron, and on which he had let fall two drops of alkaline liquor to precipitate the iron. The paper was removed at the end of two hours, and, with the addition of a little muriatic acid, was covered with a fine blue colour. The same experiments repeated with alkali saturated

saturated with excess of sulphuric acid, gave the same result; that is to say, the paper charged with oxide of iron and suspended as above, acquired a blue colour on adding muriatic acid. Hence it follows, that the colouring principle is disengaged by acids, without decomposition, for it still has the property of being fixed with oxide of iron with which it comes in contact. Thus he found that the colouring matter might be separated from the substances with which it was generally in combination, and without undergoing decomposition.

787 It is disengaged by acids.

788 To separate the colouring matter.

11. To obtain it, therefore, in a separate state, he contrived the following process. He put into a glass vessel two parts of Prussian blue reduced to powder, one part of red oxide of mercury, and six parts of water. He boiled the mixture for some minutes, continually stirring it. It then assumes a yellowish green colour. He put the whole on a filter, and poured upon the residuum two parts more of boiling water, to wash it completely. This liquid is a solution of mercury combined with the colouring matter, which has the metallic taste, and is neither precipitated by acids nor alkalies. Pour this liquid into a glass vessel upon one half part of clean iron filings, and a smaller quantity of concentrated sulphuric acid. Shake the mixture well for some minutes, when it becomes black by the reduction of the mercury. The liquid then loses its metallic taste, and gives out the odour which is peculiar to the colouring matter. Having allowed it to remain at rest for some time, it is poured off, put into a retort to which a receiver is adapted, and distilled with a gentle heat. One-fourth part of the liquid only should be allowed to pass over, for the colouring matter is much more volatile than water, and consequently rises first. The liquid in the receiver is commonly mixed with a little sulphuric acid, from which it may be separated by distilling again off a little powdered chalk, which takes up the sulphuric acid. The liquid then passes over in a state of purity; and this liquid is *prussic acid*.

789 Prussic acid obtained.

790 Nature of this process.

12. In this process the oxide of mercury which was mixed with the colouring matter, takes it from the iron with which it is combined in the state of Prussian blue, and is then a crystallizable prussiate of mercury. The iron which is added in the metallic state, reduces the oxide of mercury; and at the moment it combines with the sulphuric acid, which has also been added, the heat applied sublimes the prussic acid which has been disengaged from the mercury, which is now reduced to the metallic state. The prussic acid thus obtained, partly in the liquid, and partly in the gaseous state, combined with alkalies, produces the same effects as the blood ley, and the colourless Prussian blue.

791 Composition.

13. Having obtained the prussic acid in a separate state, it was his next object to discover its component parts. He had observed in the process for procuring it, that the air in the receiver was inflammable; and in decomposing the prussiates, he obtained ammonia and carbonic acid, and found that some metals were reduced by distillation with the metallic prussiates. He concluded from this, that prussic acid was composed of ammonia and oil, and he endeavoured to prove this by the test of experiment; but he soon found that he could not succeed in forming the colouring compound, by combining ammonia and the different oils heated together. Seeing that water was an obstacle to the formation of the prussic acid, he conducted his experiments in a different way, by combining the ammonia with the dry combustible principle, which he supposed existed in oils, and with the carbonic acid, equally in the dry state. He saw that charcoal alone, strongly heated with fixed alkalies, gave them the property of colouring iron blue. Having heated these two substances in crucibles, he added to the one muriate of ammonia, at the moment when the first mixture had acquired a white heat, and he continued the heat till no more vapour was disengaged. This process furnished him with a pure Prussian alkali, whilst the combination of the alkali and the charcoal, without the addition of the muriate of ammonia, afforded none.

14. Such was the state of our knowledge with regard to the colouring matter of Prussian blue, when Berthollet, at the end of 1787, communicated to the Academy of Sciences, the result of his investigations into the nature and properties of this substance. He repeated the experiments of Scheele, improved and extended his views, and confirmed his conclusions. The result of his researches on this substance was closely connected with the light which he had thrown on the nature and composition of ammonia some years before. He proved that the alkaline prussiate is a triple salt, which is composed of prussic acid, the alkali and iron; that when it is evaporated and re-dissolved, it affords crystals in the form of octahedrons; and mixed with sulphuric acid, and exposed to the sun, there is precipitated Prussian blue, which does not happen in the dark. After these preliminary experiments, he proceeded to the examination of prussic acid, by the action of oxymuriatic acid. This acid, in proportion as it is dissolved in the prussic acid, is deprived of its oxygen, and is converted into the state of muriatic acid. The prussic acid becomes more odorous and volatile, and less susceptible of combination with the alkalies, precipitating iron from its solutions, of a green colour. This green precipitate recovers its blue colour when exposed to the light, by contact with sulphurous acid, by iron. It is the oxy-prussic acid. When the oxymuriatic acid is still continued to be added in the state of gas, and is exposed to the light, the new acid separates from the water, and is precipitated to the bottom in the form of an aromatic oil, which is converted by heat to an insoluble vapour, which is no longer capable of combining with iron. Thus superoxygenated, this acid can no longer return to its original state. It is totally different in its properties.

792 Berthollet's experiments.

793 Oxy-prussic, or chloro-cyanic acid.

When the oxyprussiate of iron, which is prepared by treating Prussian blue with the oxymuriatic acid, and which is distinguished by its green colour, is deprived of its acid, by being brought into contact with a caustic fixed alkali, it is instantly decomposed, and is converted into carbonate of ammonia. It is now, however, found that this oxy-prussic acid consists of prussic acid combined with chlorine. Hence the French chemists call it the chloro-cyanic acid, and its salts chloro-cyanates.

15. Scheele and Bergman were of opinion, that prussic acid contained ammonia ready formed. Berthollet, however, concludes from his experiments, that it only contains the elements, namely, the azote and

 hydrogen,

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Acids. hydrogen, both in combination with carbon; and thus he considers prussic acid to be a triple compound of
794 Prussic acid a triple compound. hydrogen, carbon, and azote, but he has not been able to ascertain the proportions. He thinks, however, that the hydrogen and azote come near to the proportions which exist in ammonia *.

*Fourcroy. Connaiss. Chim. tom. ix. p. 89.

16. In some experiments by M. Clouet, on the colouring matter of Prussian blue, he attempted to combine the elements of ammonia with charcoal, with the view of producing prussic acid; but in whatever proportion he employed them, no colouring matter was obtained. He therefore concluded, that it was necessary to combine directly the ammonia with the charcoal, for the production of this substance. He took $2\frac{1}{2}$ parts of quicklime in powder, and mixed them with one part of sal ammoniac dried, and also in the state of powder. He put the mixture into a porcelain retort, which he placed upon a sand-bath. To the beak of the retort was adapted a porcelain tube filled
795 Prussian blue formed of carbon and ammonia. with dry powdered charcoal. The porcelain tube passed across a furnace, in which it might be strongly heated. It was then made red hot, and heat being afterwards applied to the retort, the ammonia was disengaged in the state of gas, which passed through the red-hot porcelain tube containing the charcoal. The product was received in proper vessels, and when examined, was found to be the colouring matter of Prussian blue †.

† Ann. de Chim. tom. xi. p. 30.

It is obtained in a purer state by decomposing the prussiate of mercury, by means of the muriatic acid, under the application of heat. It passes over in vapour, and is condensed by cold.

796 Properties of prussic acid. 17. It is a colourless liquid, of the specific gravity of 0.705, has the odour of peach blossom, or bitter almond, substances which actually contain it, and owe to it their peculiar smell and their narcotic power. The acid is extremely baneful to animal life. A single drop applied to the tongue of a small animal is fatal, and we are even told that it has proved destructive by mere external application.

Its freezing point is 5°. It boils at 80°, and is so volatile as to freeze by the cold of its own evaporation in the open air. From this cause a drop held on the end of a glass rod instantly freezes; a fact of which it furnishes an unique example. This acid has scarcely any effect on vegetable blues.

797 Composition. The composition of it, as consisting of carbon, azote, and hydrogen, has been demonstrated by analysis, by passing it in the state of vapour through an ignited tube containing iron. The products are hydrogen, and azote in the state of gas, charcoal deposited on the iron, but without any oxidation of this metal, showing that it contained no oxygen.

It is further found that the carbon and azote which it contains can be obtained in a state of mutual combination, free from the hydrogen, and then form a well-marked and definite compound. This is effected by subjecting the prussiate of mercury to a powerful heat. The oxygen of the mercurial oxide, and the hydrogen of the acid, combine, and the carbon and azote of the latter assume the state of a separate compound, which passes over in the gaseous form, and has received the name of *cyanogen*; and the French chemists now call the prussic acid, formed by the union of it with hydrogen, the *hydro-cyanic*.

This acid combines with difficulty with alkalies and earths, and without destroying their alkaline properties. Acids.

19. The carbonic acid drives it off from these combinations. It deprives oxymuriatic acid gas of its oxygen, and by this addition changes its properties. It has no action on the metals; but it combines with their oxides, changing the colour, and forming salts which are in general insoluble. 798 Action of carbonic acid, &c.

20. This acid has the greatest tendency to form triple salts with the alkaline and metallic bases. These complex combinations are more permanent and fixed than the simple alkaline prussiates. They are not decomposed by carbonic acid, light, air, or the other acids. 799 Triple compounds 800 not easily decomposed.

21. The affinities of prussic acid are the following: 801 Affinities.

Barytes,
Strontites,
Potash,
Soda,
Lime,
Magnesia,
Ammonia.

SECT. XXXIII. *Of Sebacic Acid.*

1. The penetrating fumes which are exhaled from melted tallow, and which affect the eyes, the nostrils, and even the lungs, had been long ago observed, and Olaus Borrichius has thrown out some hints, warning against the danger of being exposed to these fumes. But little attention was paid to their nature and properties. Grutzmacher was the first who demonstrated the existence of this acid, in a dissertation *de ossium medulla*, printed at Leipsic in the year 1748. Rhodes published a small work in 1753 at Gottingen, in which he makes particular mention of this acid. The following year appeared a dissertation by M. Segner, *on the acid of animal fat*, which contained a number of well-conducted experiments. Crell endeavoured to improve the process for the separation and purification of this acid, and to ascertain the properties of its combinations. These were published in the Philosophical Transactions for the years 1780 and 1782. 802 History.

But it appears, as Thenard, who made experiments on this acid, observes, that the acid obtained by those who first treated of the subject, was either the acetic acid, or some acid different from the sebacic, the properties of which are quite distinct from those which had been formerly described.

2. The process by which this chemist obtained the sebacic acid is the following. He distilled a quantity of hogs lard, and washed the product several times with hot water. He then dropt into it acetate of lead; there was formed a flaky precipitate, which was collected and dried, put into a retort with sulphuric acid, and heated. The liquor in the receiver had no acid character; but there appeared in the retort a melted matter analogous to fat. This is carefully separated; and after being washed, is boiled with water. By the action of heat the whole is dissolved by the water, and when it cools, crystals in the shape of needles are deposited. These are sebacic acid. To be certain that these were not 803 Preparation.

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 not produced by means of the sulphuric acid, he washed the fat which had been distilled with water, which was filtered and evaporated, and needles were formed, exhibiting exactly the same properties. Or, after having washed with water the distilled fat, he saturated the filtered liquor with potash, evaporated it, and dropt into it a solution of lead. There was instantly formed a salt composed of the sebacic acid and lead. This is to be decomposed as before with sulphuric acid. This acid has the following properties.

804 Properties. 3. It has no smell, a slight acid taste, and reddens strongly the tincture of turnsole. When heated, it melts like tallow.

4. It is much more soluble in warm than in cold water. Boiling water saturated with this acid forms a solid mass on cooling. It crystallizes in small needles, but with certain precautions may be obtained in the form of long, large, and very brilliant plates *.

* *Ann. de Chim.* tom. xxxix. p. 192.

Sect. XXXIV. *Of Uric Acid.*

805 History and names. 1. This acid was discovered by Scheele in the year 1776. It was at first called *lithic acid.* It constitutes one of the component parts of urinary calculi, and is also found in human urine. There is one species of calculus which is almost entirely composed of this substance. It is that species which resembles wood in appearance and colour.

806 Properties. 2. This acid, as its properties have been described by Scheele, is thus characterized. It is insipid, inodorous, almost insoluble in cold water, and soluble only in about 360 parts of boiling water. It separates from this when it cools, into small yellow crystals. The solution in water reddens the tincture of turnsole.

807 Action of water.

808 Of acids. 3. There is scarcely any action between uric acid and sulphuric and muriatic acids. It is soluble in the concentrated nitric acid, to which it communicates a red colour. It would appear that in this change of colour the nature of the acid is also changed, for part of it is converted into oxalic acid. Oxymuriatic acid very readily acts upon uric acid, either by suspending a calculus in the liquid acid, or, which is easier, by passing a stream of oxymuriatic acid gas through water, at the bottom of which is placed the uric acid in powder. Its colour becomes pale, the surface swells up, it softens, and is at last converted into a jelly. This part disappears, and is soon dissolved, giving a milky colour to the liquid. There is extricated by slow effervescence small bubbles of carbonic acid gas. The liquid by evaporation gives muriate of ammonia, acidulous oxalate of ammonia, both crystallized; muriatic acid, and malic acid. Thus the oxymuriatic acid decomposes the uric acid, and converts it into ammonia, carbonic, oxalic, and malic acids.

809 Of heat. 4. When uric acid is distilled, there is a little of it sublimed without decomposition. It yields also a very small quantity of oil and water, crystallized carbonate of ammonia, carbonic acid gas; and there remains behind a very black coal without any alkali, and without any lime.

810 Combination. 5. All these facts shew that uric acid is a compound of a very peculiar kind, formed of azote, of carbon, of hydrogen and oxygen, and susceptible of a great number of different changes by chemical agents.

Sect. XXXV. *Of Rosacic Acid.*

1. During certain diseases, the urine, when it cools, deposits a peculiar substance, which has been denominated from its colour, which resembles bricks, *lateritious sediment.* During fevers, this appearance of the urine takes place; and in gouty persons, at the termination of the paroxysms, it is very abundant. And when this suddenly disappears, and the urine at the same time continues to deposit this substance, a relapse may be dreaded. It appears in the form of red flakes, and adheres strongly to the sides of the vessel. If the urine be heated, this sediment is again dissolved. 811 Origin.

2. This substance was formerly considered by chemists as uric acid. If into fresh urine a little nitric acid is dropt, it becomes muddy, and a precipitate is formed. The nitric acid, and the substance to which the name of *rosacic acid* has been given, combine together, and are deposited. The uric acid being much less soluble than the rosacic acid, it is very easy to separate them. All that is necessary is to pour boiling water on the sediments, and to wash them on the same filter, in which case the uric acid remains behind. 812 Preparation. 813 Properties.

Proust, who made experiments on this substance, considers it as another characteristic of rosacic acid, that it produces with a solution of gold, a cloudy precipitate of a violet colour *.

* *Ann. de Chim.* tom. xxxvi. p. 265.

Sect. XXXVI. *Of Amniotic Acid.*

1. A peculiar acid has been detected in the liquor of the amnios of the cow. This was discovered by Buniva and Vauquelin. This acid is concrete, white, and brilliant, has a very slight acid taste, and reddens the tincture of turnsole. It is little soluble in cold water, but dissolves more readily in boiling water, from whence it is deposited, by cooling, in long needle-shaped crystals. When this acid is exposed to heat, it swells up, and exhales an odour of ammonia sensibly mixed with prussic acid. It leaves behind a voluminous coal. 814 Properties.

2. It seems at first to have some analogy with the saclactic and uric acids, but this is not really the case. The saclactic acid does not furnish ammonia by distillation; the uric acid yields ammonia and prussic acid by heat, but it is not equally soluble in warm water, and does not crystallize in long, white, brilliant needles, nor is it soluble in boiling alcohol, as the amniotic acid is †. 815 And distinctive characters.

† *Annal. de Chim.* tom. xxxiii. p. 279.

Chap. XI. Of INFLAMMABLE SUBSTANCES.

The class of bodies which we are to examine in this chapter, under the title of inflammable substances, are *alcohol*, *ether*, and *oils*. These substances are closely allied to many of the bodies which were treated of in the last chapter. Their constituent parts are the same with those of many of the vegetable acids, arranged, however in different proportions, and totally different in their properties and effects. The elements of these inflammable substances are chiefly carbon and hydrogen, but 816 Introduction.

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but in some there is a triple compound of carbon, hydrogen and oxygen; the last does not exist in such a quantity as to exhibit acid properties, or these properties are concealed by the proportions of the other constituent parts. It was therefore thought necessary to treat of these substances in this place, that we might be early acquainted with their properties, some of which are of great importance in chemical researches, particularly their effects on many saline bodies. They are valuable instruments of chemical analysis. We shall consider the inflammable substances in the four following sections, namely; 1. Alcohol, 2. Ether, 3. Fixed oils, and 4. Volatile oils.

Sect. I. *Of Alcohol.*

817 Preparation.

1. When vegetable matters have been subjected to the vinous fermentation, the fluid is totally changed. It is converted into a substance called *wine* or *beer*, according to the nature of the materials from which it has been prepared. When this product, the wine or beer, is subjected to another process, a very different product is obtained. By distillation a fluid is obtained of very different properties from the beer or wine from which it is extracted. This liquid, when is perfectly pure, is known in chemistry by the name of *alcohol*, or *spirit of wine*, because it is produced from wine. It is sometimes denominated also *ardent spirit*, from its effects. Ardent spirit, as it is first obtained by distillation, is to be considered as a mixture of alcohol and water, because the alcohol in the process of distillation is condensed by water. In this state, ardent spirit is different in flavour, in colour, and in strength, according to the nature of the materials from which it is obtained,

818 Different names.

and hence in common language it is distinguished by different names. When it is obtained from the fermented juice of the grape, it is known by the name of *brandy;* from that of the sugar-cane, by that of *rum;* and from that of farinaceous substances, by that of *whisky*. All these substances, therefore, are to be considered as composed of alcohol, or pure spirit of wine, water, and a peculiar oil, to which the flavour is owing.

819 History.

Ardent spirit, it is supposed, was known in the dark ages. It does not appear, from any of the writings of the Greeks or Romans, that they were acquainted with such a liquor. The preparation of it from wine, and even the discovery of alcohol, or pure spirit itself, is ascribed to Arnold de Villa Nova, who lived in the 13th century.

820 Purification.

2. To purify the alcohol or pure spirit, from water and colouring matter, it is again distilled; and, to have it perfectly pure, this process must be repeated several times. When ardent spirit is distilled for the first time, after it is extracted from the fermented liquors, it is distinguished by the name of rectified spirits. The process which is recommended by some is the following. Distil it in a water bath, till one fourth of the quantity has passed over; then distil it again for several times, taking only the first half of the product. Mix all these products together, and distil them with a very gentle heat; the first half of the liquor which passes over, is the purest alcohol that can be obtained; the remainder may be reserved for ordinary purposes†.

† Fourcroy Connaiss. Chim. tom. viii. p. 143.

Even in this state, the alcohol, thus obtained, contains a certain proportion of water, to separate which, Boerhaave has given a very good process, by means of an alkali. Take a quantity of carbonate of potash which has been exposed to a red heat, to separate the moisture; reduce it to powder, and put it into the spirit. This salt, on account of its strong attraction for water, combines with the water of the alcohol; and this solution of the alkali having the greater specific gravity, falls to the bottom. The alcohol which remains at the top may be easily separated. To purify this alcohol from a small quantity of potash which it holds in solution, it may be redistilled in a water bath. It ought to be observed, however, that the distillation should not be carried on till the whole of the alcohol is driven off, because, towards the end of the process, it carries part of the potash along with it. The salt called muriate of lime, may be employed for the same purpose.

821 Properties.

3. Alcohol, thus prepared and purified, is a light, transparent, and colourless liquor, of a sharp, penetrating, agreeable smell, and of a warm, stimulating, acrid taste. It has the property, in a much greater degree than wine, of producing intoxication. The specific gravity of alcohol, when perfectly pure, is 0.800, but the strongest spirit which is afforded by mere distillation, according to Mr Nicholson, is 0.820 at the temperature of 71°. The alcohol or rectified spirit of commerce, has rarely a specific gravity below 0.8371.

822 Volatile.

4. When alcohol is exposed to the air at a temperature between 50° and 60°, it evaporates, and when it is pure, leaves no residuum. By this rapid evaporation it produces great cold, which is very sensibly felt by dipping the fingers in alcohol, and exposing them to the air. It boils at the temperature of 176°, and is then converted into an elastic fluid. In the vacuum of an air-pump it boils at 56°. It has never yet been frozen by the greatest degree of cold to which it has been exposed. It remains fluid when the thermometer stands at —69°. When passed through a red-hot porcelain tube, it is decomposed, and converted into carbonic acid gas, carbureted hydrogen gas, and water.

823 Action of heat.

824 Phosphorus.

5. With the aid of heat, alcohol dissolves a small quantity of phosphorus. When this solution, which has a fetid odour, is precipitated, by dropping a little of it into water, it becomes luminous in the dark. Jets of flame arise from the surface of the water; and an oxide of phosphorus is formed in the state of white powder. Alcohol seems also capable of dissolving phosphureted hydrogen gas.

825 Sulphur.

6. There is no action between alcohol and sulphur at ordinary temperatures, nor even when they are boiled together; but when the two bodies are brought in contact with each other in the state of vapour, they combine readily, and a fetid sulphureted alcohol is formed, which deposits a small quantity of white sulphur, and becomes muddy in cooling. The sulphur is precipitated by water, and gives about $\frac{1}{60}$th part. Alcohol combines still more readily with sulphureted hydrogen gas, which communicates to the alcohol a little colour, and in this combination is decomposed with more facility by oxygen gas, and all other oxygenated bodies, than when it is in the state

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Inflammable Substances. state of gas. Alcohol combines with sulphureted hydrogen gas, which is contained in mineral waters, and deprives them of this gas by distillation.

826 Of acids, 7. The strong acids have a very powerful effect on alcohol. It is decomposed by the sulphuric, the nitric, the oxymuriatic, and the acetic acids: and the product of this decomposition varies according to the nature of the acid, its strength, and the proportions in which it is employed. Some of the acids are soluble in alcohol. With the aid of heat, it dissolves the boracic acid, which communicates to it the property of burning with a green flame. It also holds in solution carbonic acid gas in greater proportion than its own bulk. It precipitates from water, on the contrary, the phosphoric acid, almost in the concrete state, and also the metallic acids which are soluble in this liquid.

827 Of water, 8. Alcohol combines with water in all proportions. The affinity between the two fluids is so strong that water is capable of separating from alcohol many bodies with which it is combined, while the alcohol decomposes many aqueous saline solutions, and precipitates the salt. When water and alcohol are combined together, there is an increase of temperature, which shews that there is a condensation of the two liquids. Accordingly it is found, that the density or specific gravity of the mixture is greater than the mean of the uncombined liquids. The density varies according to the different proportions of the alcohol and water which are employed. In consequence of this variation, it becomes an object of considerable importance, both in a political and commercial view, to be able to ascertain the strength of spirits; that is, the proportions of alcohol and water of different degrees of density or specific gravity. For the purposes of commerce, various instruments have been contrived, and tables constructed, for the convenience of those who are concerned in the purchase and sale of spirituous liquors. For the purposes of revenue, a most elaborate and minute set of experiments was instituted by Sir Charles Blagden, who was expressly employed by the British government to ascertain the relative value or strength of ardent spirit at different temperatures and different specific gravities. An account of these experiments was published in the Philosophical Transactions for the year 1790. Tables which shew the result of the experiments were published by Mr Gilpin in 1793; but as these are not immediately connected with the elements of chemistry, we refer our readers to the original papers, to the article *Spirituous Liquors*, in this work, and to a long note in the present article, under the head of sulphuric acid, p. 508—510.

828 Alkalies and salts. 9. Alcohol dissolves the fixed alkalies in the pure state, and forms with them an acrid solution of a reddish colour. The solution of potash in alcohol was formerly denominated *the acrid tincture of tartar.* It is in this way that the fixed alkalies are obtained in their purest state. Alcohol, therefore, becomes a valuable instrument of analysis for separating the fixed alkalies from a great number of extraneous substances. Ammonia also combines with alcohol by the assistance of heat. The ammonia with a higher temperature is driven off, and carries with it part of the alcohol. Many of the saline bodies may be dissolved in alcohol, and on this account also it is valuable to the chemist in his researches. Tables have been constructed, shewing the quantities of different salts which may be dissolved at different temperatures. The following tables were drawn up from the experiments of M. Guyton *.

I. *Table of Salts which are readily Dissolved.*

	Temperature.	Grains.	
240 grains of alcohol dissolve at	54.5°	240	Nitrate of cobalt:
	54.5	240	copper.
	54.5	240	Muriate of zinc.
	54.5	240	alumina.
	54.5	240	Nitrate of alumina.
	113.	240	Acetate of lead.
	180.5	694	Nitrate of magnesia.
	180.5	1313	Muriate
	180.5	240	of iron.
	180.5	240	of copper.
			Nitrate of zinc decomposed.
			Nitrate of iron partly decomposed.
			Nitrate of bismuth.

II. *Table of Salts that are little Soluble.*

	Grains.	
240 grains of alcohol at the boiling temperature dissolve	240	Muriate of lime.
	214	Nitrate of ammonia.
	212	Oxymuriate of mercury.
	112	Acetate of soda.
	100	Nitrate of silver.
	23	Nitrate of soda.
	18	Acetate of copper.
	17	Muriate of ammonia.
	9	Arseniate of potash.
	7	Superoxalate of potash.
	5	Nitrate of potash.
	5	Muriate of potash.
	4	Arseniate of soda.
	1	Tartrate of potash.

III. *Salts that are Insoluble.*

Borax,
Tartar,
Alum,
Sulphate of ammonia,
iron,
copper,
zinc,
soda,
potash,
lime,
silver,
mercury,
Tartrate of soda,
Nitrate of lead,
mercury,
Muriate of lead,
Carbonate of potash,
soda.

* Journ. de Physique, 1785, p 65.

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The following table, drawn up by Mr Kirwan, shews the quantity of salts that are soluble in 100 parts of alcohol of different densities. The temperature in which the solutions were made was from 50° to 80° †.

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† Min. Wat. p. 274.

Salts.	Alcohol of				
	0.900	0.872	0.848	0.834	0.817
Sulphate of soda.	0.	0.	0.	0.	0.
Sulphate of magnesia.	1.	1.	0.	0.	0.
Nitrate of potash.	2.76	1.		0.	0.
Nitrate of soda.	10.5	6.		0.38	0.
Muriate of potash.	4.62	1.66	0.	0.38	0.
Muriate of soda.	5.8	3.67	0.	0.5	0.
Muriate of ammonia.	6.5	4.75	0.	1.5	0.
Muriate of magnesia dried at 120°	21.25	0.	23.75	36.25	50.
Muriate of barytes.	1.	0.	0.29	0.185	0.09
Do. crystallized.	1.56	0.	0.43	0.32	0.06
Acetate of lime.	2.4	0.	4.12	4.75	4.88

829 Composition.

10. A great variety of different opinions have been proposed with regard to the composition of alcohol. It had been observed, in burning this combustible substance, in close vessels, that water was formed. Some philosophers had even observed that the quantity of water obtained by the combustion of alcohol was greater than the whole weight of the alcohol consumed. From observing this circumstance, it was supposed to consist of water, combined with an acid, an oil, or phlogiston, according to the views and theories of different philosophers.

830 According to Lavoisier.

It is to the experiments of Lavoisier that we are indebted for ascertaining the real constituent parts of this substance. He burnt in a proper apparatus, with a known quantity of oxygen gas, 76.7083 grs. troy of alcohol, and, after the combustion, carbonic acid gas and water were found to be the only products; and by estimating the oxygen gas consumed, the quantity of carbonic acid and of water which were formed, it appeared that the quantity of alcohol consumed was composed of

22.840 carbone,
6.030 hydrogen,
47.830 water.

76.700

831 To Fourcroy.

But it has been since proved, by the experiments of Fourcroy and Vauquelin, that oxygen is a component part of alcohol; for when they mixed together equal parts of alcohol and concentrated sulphuric acid, and while ether was formed from it, there was also at the same time a production of water; the alcohol in this case was decomposed, but the sulphuric acid suffered no change. The oxygen, therefore, which combined with the hydrogen in the formation of water, must have come from the alcohol *.

* Nichol. Jour. i. p. 191.

Sect. II. *Of Ether.*

832 Formation.

By the action of different acids with alcohol, the latter is decomposed, and different products are obtained, according to the proportions of the acid employed, and the heat which is applied. When the acid and the alkali are in a certain proportion, and are exposed to a moderate temperature, the product is a peculiar substance, which has received the name of *ether*. Ether has been obtained by the action of different acids on alcohol, and hence it has received different names, as *sulphuric ether*, *nitric ether*, *muriatic ether*. The first, namely, sulphuric ether, which seems to have been longest known, and is most easily obtained, has excited the greatest attention among chemists. We shall therefore consider it first. 833 Names.

1. Of Sulphuric Ether.

834 History.

1. It appears from different passages in the writings of the earlier chemists, that the knowledge of sulphuric ether was in the number of their secrets. It was then called *oleum vitrioli dulce*. The method of preparing it is described in a book published at Nuremberg about the year 1540. But the nature of this substance was not much attended to till the year 1730, when a quantity was presented to the Royal Society by Dr Frobenius, with a paper which was published in their Transactions for that year, containing an account of a number of experiments which were made upon it.

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it. It was long known among the German chemists under the name of *naphtha*.

834 Preparation. 2. The following is the process by which sulphuric ether may be obtained. Equal parts of concentrated sulphuric acid and alcohol are put into a retort, to which a receiver is to be adapted and luted. Or perhaps it is better to add the acid by small portions at a time, that the action may not be too violent, and the heat produced too great. The receiver should be immersed in cold water, or surrounded with ice, or it may be kept cool by the application of wet cloths, over which a small stream of water is directed. Heat is then applied, and the first product which comes over is a fragrant spirit of wine; but as soon as the mixture begins to boil, the ether comes over, is condensed by the cold, and runs in streams down the sides of the receiver. When the quantity obtained amounts to about one half of the alcohol employed, the process should be stopped, and the receiver unluted and removed; but if it be continued, white fumes begin to come off, which are known to be the fumes of sulphurous acid. After this there rises a light yellowish coloured oil, which has been called *the sweet oil of wine*. The heat should now be moderated after the ether has passed over, because the matter contained in the retort becomes black, thick, and swells considerably. When the whole of the sweet oil has come over, there is still an evolution of sulphurous acid, which becomes constantly thicker, till at last there is nothing but a dark coloured sulphuric acid.

835 Purification. 3. The ether obtained by this process is impure, being generally contaminated with sulphurous acid. To purify it, it has been usual to mix a quantity of potash with the fluid, and to distil it over again. The acid in this case combines with the potash, and the ether being separated, passes over into the receiver. Dizè, however, considering this process as tedious and uncertain, has proposed other substances in the room of potash, and he has tried several metallic oxides, such as the red oxide of lead, the yellow oxide of iron, the red oxide of mercury, and the black oxide of manganese. After a variety of experiments, he is of opinion that the black oxide of manganese is the most convenient for the purification of ether. It is mixed with ether, allowed to remain some time, and is to be frequently agitated. The oxygen of the manganese combines with the sulphurous acid, and converts it into sulphuric acid, which is a more fixed body than the sulphurous acid *.

* Journ de Phys. xlvi p. 298.

To separate the liquid from the sulphurous acid, Proust recommends the following method, which he says is employed in the large way, as by far the most preferable. Introduce into a bottle which is ¼ths filled with impure ether, some water, and a portion of slaked lime. Agitate the bottle strongly, and do not open it to examine its odour, till after it has remained for some minutes in cold water, and when the vapour within the bottle has ceased to exert its elastic force against the cork; if the sulphurous smell is not entirely removed, the process is to be repeated till it is completely destroyed. This method, which was employed by Woulfe, Proust prefers on account of its economy, particularly as it affords at the same time a sulphite of lime, which is formed by the combination of the sulphurous acid with the lime. When the liquids have separated, the ether which swims on the top, may be drawn off by means of a syphon, and it may be introduced into a retort to be rectified by distillation †.

† Ann. de Chim xlii. p. 257.

4. The ether which is thus obtained, is a transparent colourless fluid, of a very fragrant smell, and a hot pungent taste. The specific gravity is only 0.7581, so that it is considerably lighter than alcohol. It is extremely volatile, so that when it is agitated, or poured from one vessel to another, it is instantly dissipated. It produces so great a degree of cold, that water may be frozen by means of it. It rises in the state of gas which burns with great rapidity, and the air which holds ether in solution may be passed through water without being deprived of its combustibility or fragrance. 836 Properties.

5. It boils in the open air at the temperature of 98°, and in the vacuum of an air-pump at —20°, so that it would constantly remain in the state of gas if the pressure of the air were removed. 837 Action of heat.

When ether is kindled in the open air, it burns very readily. The electric spark also inflames it. It burns with a copious white flame, and leaves behind it a black trace on the surface of any body exposed to the flame. Lavoisier has observed that an acid is always formed during the combustion of this liquid; and Scheele says that the residuum of ether burnt over a little water, contains sulphuric acid. When the ether is exposed to a cold of —46°, it freezes and crystallizes. It is decomposed when the vapour is passed through a red-hot porcelain tube, and the product is carbonated hydrogen gas.

6. Dr Priestley discovered that ether agitated with any kind of gas, greatly increased its volume, and in most cases doubled it. Mr Cruickshank made a similar experiment, by agitating some oxygen gas with a little ether. The bulk was exactly doubled. In this state the gas did not explode, but when one part of this mixture was added to three parts of oxygen, an ignited body or the electric spark produced a dreadful explosion. The products were water, with 2⅓d carbonic acid gas. Hence it would appear, Mr Cruickshank observes, that one part of this vapour requires about seven of oxygen to saturate it; and according to this experiment, the proportion of carbon to hydrogen in the vapour of ether or ether itself, should be as five to one ‡. 838 Increases the volume of gases.

‡ Nich. Journ. v. p. 205.

7. Phosphorus is dissolved in small quantity in ether, and produces a transparent solution; but when alcohol is added to the solution, it becomes milky. 839 Action of phosphorus.

8. Sulphuric acid has a peculiar action on ether, by converting it into a kind of oil, which is called *the sweet oil of wine*. This is one of the products in the preparation of sulphuric ether. When a small quantity of ether is introduced into a bottle filled with oxymuriatic acid gas, it explodes, and inflames; or if paper moistened with ether be introduced, the same effect follows. Carbonic acid gas is produced, and charcoal is deposited on the sides of the bottle. 840 Of Acids.

9. Various theories have been proposed, to account for the production of ether. From the manner of its production by means of sulphuric acid, it was natural to suppose that this acid formed one of its component parts. This accordingly became a general opinion, till it was found that the sulphuric acid suffered no change in the process, but merely assisted or disposed the alcohol to that 841 Composition.

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that change which it undergoes when it is converted into ether. According to Macquer, the alcohol has not been changed, but merely deprived of the whole of its water. Scheele supposed, that ether was alcohol deprived of its phlogiston; and when the new theories were introduced, ether was considered as a combination of alcohol and oxygen.

10. The experiments and researches of Fourcroy and Vauquelin have thrown new light on this subject, and have led to different views of the nature and composition of ether. According to the result of these experiments, ether contains a smaller proportion of carbon, but a greater proportion of hydrogen and oxygen. From their experiments, and from those of others, it appears that the changes induced by the action of sulphuric acid on alcohol, depend on the quantity and strength of the acid, and the temperature.

A. Equal parts of concentrated sulphuric acid and alcohol mixed together raise the temperature to 189°. Bubbles of gas are emitted; the liquid becomes turbid, and at the end of some hours assumes a deep red colour.

B. A mixture of two parts sulphuric acid, and one part alcohol, produces a temperature of 200°. The mixture becomes instantly of a deep red colour, passes to black a few days after, and diffuses an odour which is perceptibly that of ether.

C. When equal parts of sulphuric acid and alcohol are exposed to the action of heat, in a proper apparatus, such as is employed for the preparation of ether, the following phenomena are observed.

a. When the temperature is raised to 207°, the liquid boils; there is produced a fluid which is condensed by cold, into a light, colourless, and fragrant liquor, which from its properties has received the name of ether. If the process be properly conducted, no permanent gas is evolved, till about $\frac{1}{2}$ of the alcohol is converted into ether.

b. If, as soon as the sulphurous acid appears, the receiver be changed, there is no longer any production of ether; but the sweet oil of wine, water, and acetic acid are formed, without a single particle of carbonic acid. When the sulphuric acid makes about $\frac{4}{5}$ths of the mass which remains in the retort, there is evolved an inflammable gas, which has the odour of ether, and which burns with a white oily flame. This is the gas which the Dutch chemists have called *carbureted hydrogen gas*, or *olefiant gas*, because when it is mixed with oxymuriatic acid it forms oil. At this period, the temperature of the matter contained in the retort is elevated to 230° or 234°.

c. When the sweet oil of wine ceases to flow, if the receiver be again changed, there is only sulphurous acid emitted, water which was previously formed, carbonic acid gas; and there remains only in the retort, a mass which consists chiefly of sulphuric acid thickened with charcoal.

842 Inferences.

The operation of ether, then, may be divided into three periods; the first, in which a small quantity of ether and water is formed, without the assistance of heat; the second period, in which the greatest quantity of ether which can be obtained without the evolution of sulphurous acid at a temperature of 207°; and the third, in which the sweet oil of wine, olefiant gas, acetic acid, sulphurous and carbonic acid, are produced while the temperature of the mixture is raised to 230° and 234°. To all these three periods there is only one circumstance in common, and this is, the continual formation of water from the beginning to the end of the operation.

843 Theory.

On these observations, Fourcroy and Vauquelin have established their theory of the formation of ether. In the case in which ether is formed by the simple mixture of alcohol and sulphuric acid, without the aid of heat, the formation which appears by heat as well as by the black precipitate, the charcoal which is separated without the production of sulphurous acid, proves that the sulphuric acid acts in a different manner on alcohol from what was supposed. This acid is not decomposed by charcoal at that temperature. There is no action between these two bodies in the cold, nor is there any action between this acid and alcohol; for in that case, sulphurous acid would be formed, of which not the smallest trace can be perceived at the beginning of the operation. Recourse then must be had to a different action, namely, the strong affinity which exists between sulphuric acid and water. It is this which determines the union of the constituent principles of water existing in the alcohol, and with which this acid comes in contact: but this action must be very limited. A balance of affinities is soon established, and no farther change takes place.

If then it be proved that ether is formed by the mixture of certain quantities of sulphuric acid and alcohol, it must obviously follow, that a mass of alcohol may be completely converted into ether, water, and acetic acid, by increasing the quantity of sulphuric acid; and it is equally obvious, that this acid would undergo no change but that of being diluted with water.

It is not necessary to suppose, according to this theory, that ether is alcohol deprived of a certain portion of oxygen and hydrogen, for there is separated at the same time a quantity of charcoal proportionally greater than that of the hydrogen; and it may be conceived, that the oxygen which is combined in this case with the hydrogen, to form water, would not only saturate this hydrogen in the alcohol, but that it would saturate at the same time the carbon which has been precipitated. Thus, then, instead of considering ether as alcohol with a smaller proportion of hydrogen and oxygen, if we take into account the carbon which is precipitated, and the small quantity of hydrogen contained in the water that is formed, it must be considered as alcohol with a greater proportion of hydrogen and oxygen. Such seems to be the nature of the spontaneous action between sulphuric acid and alcohol without the aid of heat.

But when the mixture is subjected to heat, the production of ether is more complicated, and the products more numerous.

It ought to be observed, that the mixture of sulphuric acid and alcohol in equal proportions, boils only at the temperature of 207°, whilst alcohol alone boils at 176°; whence we must conclude, that the alcohol is retained by the affinity of the sulphuric acid, which fixes it. Now, if we compare what happens in this case to the change produced on all other vegetable matter

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matter exposed to the action of heat, in which the principles are volatilized, according to the order of their affinity for caloric, carrying with them a small quantity of the more fixed elements, in proportion as the sulphuric acid attracts the alcohol and the water, of which it favours the formation, the ether which is evolved attracts caloric, and is sublimed; and when the greatest part of the alcohol has been changed into ether, the mixture becomes denser, the heat more considerable, and the affinity of the sulphuric acid for the undecomposed alcohol being increased, the acid is decomposed, so that on one hand its oxygen combines with the hydrogen of the alcohol, and forms water, which rises gradually into vapour, whilst, on the other, the ether retaining a greater quantity of carbon, with which it rises in vapours at this temperature, affords the sweet oil of wine, which ought to be considered as an ether with a greater proportion of carbon. This seems to be proved by its greater specific gravity, less volatility, and its citron colour.

11. From this theory the ingenious authors have deduced the following practical conclusions.

a. The formation of ether is not owing, as was supposed, to the immediate action of the principles of the sulphuric acid on those of alcohol, but to the reaction of the principles of the latter on each other, and particularly of its oxygen and hydrogen, occasioned by the sulphuric acid.

b. A portion of alcohol may be converted into ether without the aid of heat, by increasing sufficiently the proportion of sulphuric acid.

c. With regard to the change which takes place on alcohol in the production of ether, the process may be divided into two periods. In the one, ether and water are only produced; in the other, sweet oil of wine, water, and sulphuric acid.

d. During the formation of ether, the sulphuric acid is not decomposed, and there is no production of the sweet oil of wine. When the latter makes its appearance, there is given out no more, or at least very little, ether; and at the same time the sulphuric acid is decomposed by hydrogen solely; whence sulphurous acid is formed.

e. The formation of the sweet oil of wine may be avoided, by keeping the temperature of the mixture between 200° and 207°. This is managed by introducing a few drops of water into the retort.

f. And lastly, alcohol differs from ether, in containing more carbon, less hydrogen and oxygen; and the sweet oil of wine is to ether very nearly what alcohol is to the former *.

* *Fourcroy Connaiss. Chim.* tom. viii. p. 161—166.

II. Of Nitric Ether.

1. Nitric acid, or rather nitrous acid, acts with much greater violence on alcohol than sulphuric acid. In this case the action must be moderated, either by diluting the two liquids, or by cooling the mixture. The first easy process which was proposed for the preparation of nitric ether, was given by Navier, a physician of Chalons.

2. The process of Navier is the following. He put into a strong bottle 12 parts of pure alcohol, and plunged it into cold water, or rather surrounded it with ice. To this he added, in different portions, eight parts of concentrated nitric acid, agitating the mixture, after every addition. The bottle is then stopped with a cork, which is secured with leather, and the mixture is set in a convenient place, to avoid the danger of accidents from the bursting of the bottle, which sometimes happens. At the end of some hours, bubbles rise from the bottom of the vessel, and drops are collected on the surface of the liquid, which gradually form a stratum of ether. This action continues for the space of six days. When it ceases, the cork is to be pierced with a needle, to permit the escape of a quantity of nitric oxide gas, which, without this precaution, would rush out rapidly on uncorking the bottle, and would carry along with it the ether, which would be lost. When the gas is dissipated, the cork is to be drawn out, and the whole liquid in the bottle is to be poured into a funnel. The ether swims on the top, and the remaining liquor being heavier, is allowed to pass off, and the ether is retained.

844 Preparation by Navier.

3. This process was improved by Beaumè. He found that the greatest produce of ether was from two parts of acid to three of alcohol. He directed both ingredients to be used in the coldest state, by keeping each in melting ice, and the bottle in which the mixture is made, to be kept equally cold. In this proportion of ingredients, the danger of explosion is avoided, and the low temperature greatly moderates the violent action. The mixture in the bottle is always to be well agitated before any new addition of acid is made, and by this means the accumulation in any particular spot is prevented. The ether begins to form, as in the former process, in the course of a few hours; and if the bottle is allowed to remain undisturbed for eight or ten days, a quantity of ether equal to one half the weight of the alcohol is obtained, after which no more is produced.

845 Beaume.

4. Dr Black's process is described by himself in the following words. "Into a strong phial, having a ground stopper, I first pour four ounces of strong hale nitric acid. I then add three ounces of water, pouring it in so gently, that it swims on the surface of the acid. I then pour in after the same manner six ounces of alcohol. I put in the stopper slightly, and I set the phial in a tub of water or ice. The acid mixes slowly with the water, and in a diluted state comes in contact with the alcohol, on which it immediately acts, and ether is produced slowly and quietly. The liquor gets a dim appearance, because imperceptible bubbles are formed, which get to the top, and having collected to a certain degree, they lift the stopper, and escape (s). After eight or ten days, I find upwards of three ounces of nitric ether, though I am certain by the smell, that much escapes with the vapour. This is, however, a certain, easy, and safe process, though it is slow and imperfect *."

846 Black's process.

* *Black's Lect.* ii. 324.

6. Many other processes have been proposed for the preparation

847 Laplanche's.

(s) Dr Black, we believe, contrived a spring for the stopper which kept down the cork till it was pushed up by the elastic vapours; and when they had escaped, it returned to its place by the force of the spring.

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preparation of nitric ether. Laplanche, a Parisian apothecary, has employed nitre, which he introduced into a tubulated stone-ware retort, and first pouring the concentrated sulphuric acid, and then the alcohol upon it, there is an immediate production of ether; but by this process it is suspected that the nitric ether may be mixed with sulphuric ether. He has therefore proposed another process, which is more complicated †.

† Fourcroy Connais. Chim. tom. viii. p. 170.

848 Chaptal's.

6. The process which has been proposed by Chaptal, is, according to Proust, the best that can be adopted. This process, with some additions and alterations, which he has found it necessary to make from his own experience, is the following. The proportions which he employs are, 32 ounces of alcohol, and 24 of nitric acid. These are introduced into a large retort, which is to be luted to a globular glass vessel, furnished with a tube of safety. A tube passes from this globe to a second, which is also furnished with a tube of safety. One or two ounces of water should be introduced into the second globe to shut up its tube of safety. Three bottles of Woulfe's apparatus, containing from 64 to 80 ounces of liquid, are then to be connected with the second globe. These bottles are half filled with alcohol. The alcohol and the acid are poured into the retort, and are mixed by agitation. The retort is luted to the glass globe, and heat is applied, with this precaution, that it must be removed as soon as there is any effervescence. The process now goes on, and requires no farther attention than occasionally cooling the globes and the bottles with cloths moistened with snow-water. The greatest part of the ether which is formed, condenses in the first bottle, and gives the alcohol a yellow colour. It then passes to the second, in which the colour is lighter, and at last to the third, where there is little perceptible change. To separate the ether of the first bottle, the mixture is to be saturated with an alkali, and distilled ‡.

‡ Annal. de Chim. tom. xlii. p. 261.

849 Purification.

7. But by whatever process nitric ether is obtained, it requires to be purified, to separate the acid and alcohol, which are generally mixed with it. This is done by distilling it from potash, which reduces its quantity; for the distillation must not be continued longer than when two-thirds or one-half of the first ether has come over. To purify this still more, it is directed to be mixed with one-fifth of nitrous acid, and distilled again, taking two-thirds of the product set apart, and rectify it from an alkali. The remainder which comes over is a less pure ether, which has been known under the name of *Hoffman's mineral anodyne liquor*. What remains in the retort has been called *dulcified spirit of nitre*.

850 Properties.

8. Nitric ether, thus obtained, is a yellowish coloured liquid, equally volatile as sulphuric ether. Its odour, though stronger and less sweet, is analogous to the sulphuric ether. The taste is hot and more disagreeable. It is often of a deeper yellow colour, and always contains a small excess of acid and nitrous gas. The stopper is frequently driven out of the bottle in which it is kept, for there is a constant evolution of a considerable quantity of gas.

851 Burns with a brilliant flame.

9. When kindled, it gives out a more brilliant flame, and a denser smoke, than sulphuric ether, and deposits a greater quantity of charcoal. When it is long kept in a close vessel, some water is formed, holding a small quantity of oxalic acid in solution, which falls to the bottom of the vessel.

852 Analogous to sulphuric ether.

10. Nitric ether is not only analogous to sulphuric ether in its properties, but also in the nature of the process by which it is obtained, and in the other products which accompany this process. But in the production of nitric ether, there is no deposition of charcoal, and the acid itself is decomposed. This appears from the great quantity of nitric oxide gas evolved during the process; and the reason assigned for the disappearance of the charcoal is, that the oxygen of the acid combines with it, and forms carbonic acid, which escapes in the form of gas. The products which are generally obtained in the processes for the preparation of nitric ether are nitrous gas, ether, oil, acetic acid, oxalic acid, and carbonic acid gas.

If equal parts of nitric acid and alcohol are mixed together, a violent effervescence immediately takes place, which is owing to the evolution of a great quantity of gas, which being a compound of ether and nitric oxide gas, has been denominated *etherised nitrous gas*. The same gas is obtained by employing a diluted acid; but then the mixture requires the assistance of heat. This gas may be collected in vessels over water. It has a disagreeable ethereal odour, quite different from the odour of nitric ether, and exactly similar to that kind of ether which is furnished by the oily carbureted hydrogen gas, treated with oxymuriatic acid gas. If a candle be applied to this gas, it burns slowly with a yellow flame. This gas is soluble in water, and is wholly absorbed; but the absorption is slow. The water acquires the odour of the gas. Alcohol also dissolves it completely, and more rapidly. Oxygen gas mixed with this gas, provided it be pure, produces no change; but when the mixture is kindled, there is a violent detonation. When this gas was exposed to sulphuric, nitric, and muriatic acids, the ether was absorbed by the acids, and the nitrous gas remained behind. The sulphurous acid in the state of gas, combined with an equal bulk of the inflammable gas, also decomposed it; but this effect did not take place till after several days §.

§ Jour. de Phys. xlv. p. 245.

If the alcohol and nitric acid be mixed together in the proportion of one of the former to three of the latter, and a gentle heat applied, there is a copious evolution of gas, which is composed of the etherised nitrous gas and nitric oxide gas. If towards the end of the process, when a small part of the liquid remains in the retort, it is allowed to cool, crystals are formed; and these crystals are found to be oxalic acid. They were formerly called *crystals of Hierne*, from the name of a Swedish chemist, who first discovered them ||.

|| Ibid. p. 346.

If one part of nitric acid be added to its own weight of alcohol, and one part of sulphuric acid be added soon after, the mixture is suddenly inflamed, and burns with great violence. In this case, when the products are collected, they are found to be ether and oil.

From this statement of facts, therefore, it appears, that the mode of production of nitric and sulphuric ethers is nearly the same; that the differences which take place, are owing to the different nature of the acids; the violent action which follows in the formation

of

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of nitric ether, depending on the nitric acid itself being decomposed, and by the operation of new affinities, new actions having taken place.

III. Of Muriatic Ether.

853 Processes for obtaining it. 1. Muriatic acid has no sensible action on alcohol, either by simple mixture, or by distilling them together, as in the former case. Beaumé obtained a small quantity of muriatic ether, by combining together muriatic acid and alcohol in the state of vapour. But other means were thought of for this purpose, and particularly the oxymuriate of antimony, and the oxide of zinc dissolved in muriatic acid, and to distil this salt, concentrated by evaporation, in close vessels with alcohol. By this process muriatic ether has been obtained. But the most successful method of procuring this ether, was proposed by Courtanvaux. His process is the following.

854 From salts of tin. 2. One part of alcohol is mixed with three parts of oxymuriate of tin, or the fuming liquor of Libavius, in a glass retort. A strong heat is produced, with the production of a white suffocating vapour, which disappears when the mixture is agitated. There is then emitted an agreeable odour, and the liquor assumes a lemon colour. The retort is then to be placed on a sand bath; two receivers are to be attached, one of which is to be immersed in cold water. There passes over at first some pure alcohol, and soon after the ether, which is known by its fragrant odour, and the streams which run down the sides of the retort. When the odour changes, and becomes sharp and suffocating, the receiver must be changed; and if the distillation be continued, a clear acid liquor is procured, on the surface of which are observed some drops of sweet oil, which is succeeded by a yellow matter of the consistence of butter, which is a true muriate of tin, and at last a brown heavy liquid, which exhales very copious white vapours; and there remains in the retort a gray matter in the state of powder.

855 Purification. 3. To purify this ether, it is put into a retort over carbonate of potash. A brisk effervescence takes place, and a very copious precipitate is produced. This is owing to the oxide of tin which the acid had carried off during the distillation. A little water is to be added, and distilled with a gentle heat. About the one-half of the product of the ether is thus obtained. All the fluids which come over after the muriatic ether, are loaded with oxide of tin; they attract moisture from the air, and combine with the water without any precipitation.

856 Prepared from common salt, 4. Another method has been proposed for the preparation of muriatic ether by Laplanche. He pours into a tubulated retort sulphuric acid and alcohol on common salt which has been strongly dried. The muriatic acid gas, disengaged by the sulphuric acid, meeting the vapours of the alcohol in the retort, combines with them. In this way an ether is obtained, which may be purified in the usual way. But, in this process, Fourcroy thinks that the production of ether is owing to a small portion of oxymuriatic acid which is formed during the process.

857 and manganese, 5. Pelletier has succeeded in obtaining muriatic ether, by distilling in a large tubulated retort, a mixture of oxide of manganese, common salt, concentrated sulphuric acid, and alcohol. The quantity of ether obtained by this process is equal to one half the weight of the alcohol employed.

6. Another process has been proposed by Berthollet, by distilling with a gentle heat alcohol which has been saturated with oxymuriatic acid gas, and by distilling the oxide of manganese, a mixture of alcohol, and strongly concentrated muriatic acid. 858 and oxymuriatic acid gas.

7. Muriatic ether, thus obtained, is transparent and very volatile. It has nearly the same odour as sulphuric ether. It burns like it, and gives out a similar smoke; but it differs in two of its properties; the one is, that it exhales, while burning, an odour as pungent and acrid as sulphurous acid; and the other is, that the taste is astringent like that of alum. This difference in odour and taste is owing, it is supposed, to some extraneous substances with which it is contaminated; for in the whole process of its formation it appears to be exactly the same; a constant product of the decomposition of alcohol, by whatever re-agent this is effected. 859 Properties.

IV. Acetic Ether.

1. An ether has also been obtained by distilling a mixture of acetic acid and alcohol. This was the first process which was employed in the production of this ether. It was discovered by the count de Lauraguais in 1759. It has been improved by Pelletier, who distilled equal quantities of acetic acid, obtained from acetate of copper, and alcohol. It was then poured back into the retort, and distilled a second time. When this process is finished, it is distilled a third time, and the product of the third distillation is a mixture of acetic acid and ether. To separate the acid from the ether, it is saturated with potash, and distilled with a gentle heat. The acetic ether passes over in a state of purity. 860 Preparation.

2. Another process has been proposed to obtain the same ether. Take 16 parts of acetate of lead, six parts of concentrated sulphuric acid, and nine parts of alcohol. Let it be distilled till ten parts come over. Let this liquid be agitated with one third of its bulk of lime water; the ether separates and swims on the top. The quantity generally amounts to about six parts.

3. This ether is similar to the other ethers in its properties, excepting that it has a slight odour of acetic acid.

4. Ether has also been formed by several other acids, and it appears, that these acids possess one common property in their action on alcohol, for all the ethers produced by the different acids are nearly the same, and indeed it is supposed would be exactly the same, were it not that they are contaminated with extraneous matters derived from the acids, the alcohol, or other substances, which are employed in their formation.

Sect. III. *Of Fixed Oils.*

1. Oils, which are copious productions of nature, have been long known; and their extensive utility in domestic economy and the arts, has always rendered them objects of great importance. The general characters of oils are combustibility, insolubility in water, and fluidity. From the peculiar properties of different 861 Oils of two kinds.
oils,

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oils, they are naturally divided into two kinds; fixed or fat oils, and volatile or essential oils. The fixed or fat oils require a high temperature to raise them to the state of vapour, a temperature above that of boiling water; but the volatile or essential oils are volatilized at the temperature of boiling water, and even at a lower one. Both the volatile and fixed oils are obtained from plants, and sometimes from the same plant, but always from different parts of it. While the seeds yield fixed oil, the volatile oil is extracted from the bark or wood.

862 Found only in the seeds of vegetables.

2. One of the most distinguishing characteristics of the fixed oils is, that they exist only in one part of the vegetable. They are only found in the seeds. No trace of fixed oil can be detected in the roots, the stem, leaves, or flowers of those plants, whose seeds afford it in great abundance. The olive may seem an exception to this. The oil which it yields is extracted, not from the seed, but from its covering. Among plants too, fixed oils are only found existing in those whose seeds have a peculiar structure. The seeds of plants have sometimes one lobe, in which case they are called *monocotyledonous* plants; and sometimes they have two, when they are denominated *dicotyledonous*. The formation of fixed oil in plants is exclusively limited to the latter class. There is no instance of fixed oils being found in the seeds of plants which have only one lobe †. Those seeds which yield the fixed oils, contain also a considerable portion of mucilage, so that when such seeds are bruised and mixed with water, they form what is called an *emulsion*, which is a white fluid containing a quantity of the oil of the seed mixed with the mucilage. One of the most common emulsions, that of almonds, is an instance of this.

† *Fourcroy, Connaiss.* vii. 319.

Fixed oils are extracted from the seeds of a great number of plants. Those which yield it in greatest abundance are, the olive, thence called *olive oil;* the seeds of lint, and the kernels of almonds, called *linseed*, or *almond oil.* Fixed oils are also obtained from animals; such is *train oil*, as it is called, which is extracted from the fat or blubber of the whale. They are obtained in great abundance from the livers of animals, and a fixed oil is found to exist in the eggs of fowls.

863 Have different properties.

3. These different kinds of fixed oils, although they possess many common properties, are very different in others. Many of the vegetable oils have no smell, and scarcely any perceptible taste. The animal oils are generally nauseous and offensive. These differences are supposed to be owing to the admixture of extraneous bodies, or to certain chemical changes arising from the action of those bodies upon each other, or on the oil itself.

864 Preparation.

4. As the fixed oils exist ready formed in the seeds of plants, they are generally obtained by *expression*, and hence they have been called *expressed oils.* This is done by reducing the seeds to a kind of pulp, or paste, which is inclosed in bags, and subjected by means of machinery, when it is obtained in the large way, to strong pressure, so that the oil flows out, and is easily collected. The oil obtained by this process, which has been called *cold drawn;* because it is procured without the application of heat, and merely by pressure, is the purest; but the quantity of this which seeds in general yield is comparatively small, and some seeds, which contain a considerable portion of oil, scarcely afford any when treated in this way. It therefore becomes necessary for extracting the oil from seeds of the latter description, and to have it in greater abundance from all seeds, to employ heat, to facilitate the separation of the oil from the mucilage or other matters with which it is combined. For this purpose heat is applied, either to the apparatus which is employed in pressing out the oil, or the bruised seeds are exposed to the vapour of water, and sometimes they are boiled in the water itself, by which means those substances which are soluble in water, are separated, and thus the oily part which adhered to these substance, is disengaged.

865 Purification.

5. Oils obtained in this way are very impure. They are mixed with mucilage, and other parts of the substances from which they have been extracted. Many of these matters separate from the oils when they are left at rest. They are sometimes mechanically purified by filtration through coarse cloths, by which means the grosser parts are separated. Different oils too, it is said, are subjected to different kinds of purification by different manufacturers, but these processes are kept secret. After they have remained at rest for some time, they are filtered and agitated with water, by which the parts that are soluble in this fluid are separated from the oil. Sometimes they are gently heated, for a shorter or longer time, according to the nature of the substances with which the oil is contaminated. Acids diluted with water are employed to separate the mucilage; lime and the alkalies are also used to combine with an acid which holds this mucilage in solution, and thus to favour its precipitation. Alum, chalk, clay, and ashes, are also employed in the purification of oils.

866 Properties.

6. Fixed oils are generally liquid, but of a thick, viscid consistence. They are mild or insipid to the taste; sometimes, however, they have a peculiar taste, which is analogous to that of the plant from which they have been extracted. When pure, they have no smell, but are sometimes impregnated with the odour of the seed which produces them. The fixed oils are rarely quite colourless, but are generally green or yellowish. If they are green when fresh prepared, this colour changes to a yellow, and in time to an orange or red. Fixed oils in general are lighter than water. The specific gravity varies from 0.9153, which is that of olive oil, to 0.9403, that of linseed oil. The boiling point of the fixed oils is not under the temperature of 600°. When exposed to cold, they congeal, and even crystallize. There is, however, a considerable variety in this respect, among fixed oils; some become solid at the temperature of a few degrees above the freezing point of water; while others, on the contrary, require a degree of cold $= 5°$; and some remain fluid when exposed to the greatest cold. Those oils, it has been observed, which most readily become solid, such as olive oil, are least subject to change, while those which congeal with difficulty have a greater tendency to spoil and become rancid.

867 Action of heat.

7. When fixed oil is exposed to heat, it does not evaporate, till it is raised to the temperature of boiling, or 600°; but when it is thus raised in vapour its properties are changed. It is decomposed by the separation of some of its principles. The part that is volatilized has a greater proportion of hydrogen; charcoal is deposited

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Inflammable Substances. deposited, and water and sebacic acid are formed, while carburetted hydrogen gas is disengaged. By this distillation an oil was produced, denominated by the older chemists *philosophical oil.*

When oil is exposed to the open air, and a burning body is brought in contact with it, it readily takes fire, and burns rapidly, with a yellowish white flame. It is on this conversion of oil into vapour, and the inflammation of this vapour, that the application of oil in lamps and candles depends. The oil is gradually, and in small quantities, brought in contact with the burning part of the wick; it is converted into vapour, which is immediately inflamed, and continues to burn till new portions are supplied to undergo the same change, and thus keep up a constant and uniform light and heat.

868 Composition. 8. According to the analysis of olive oil by Lavoisier, it is composed of hydrogen and carbon. In the experiment which he instituted to ascertain its component parts, he burnt

oil	15.79 grs. troy.
oxygen gas	50.86
	66.65

The products of this combustion were water and carbonic acid. The weight of the water could not be ascertained with much precision, but the quantity of carbonic acid which was formed amounted to 44.50 grs. This quantity subtracted from the whole weight of the substances consumed, namely the oil and oxygen gas, left 22.15 grains for the weight of the water. The proportion of oxygen in this quantity of water is 18.82 grs. which leaves 3.33 grs. of hydrogen, the other component part. The proportion of oxygen in 44.50 grs. carbonic acid gas is 32.04 grs. which leaves 12.46 of carbon. The oxygen of the water and of the carbonic acid, namely 18.82 grs. of the one, with 32.04 grs. of the other, make up the whole quantity of oxygen, namely 50.86 grs. that was consumed. From this analysis, therefore, 15.79 of olive oil are composed of

12.46 carbon,
3.33 hydrogen.

15.79

The component parts, therefore, of 100 grains of olive oil are

78.92 carbon,
21.08 hydrogen.

100.00

869 Insoluble in water. 9. The fixed oils are insoluble in water. When it is necessary to combine them with this liquid, it is by means of mucilaginous substances, in which case the mixture is known under the name of *emulsion*, or with alkaline substances, when it is distinguished by the name of soap.

870 Action of air. 10. When fixed oils are exposed to the air, they undergo peculiar changes; and these changes are different, according to the nature of the oil.

11. Some of these oils become thick, opaque, white, granulated, and are analogous in appearance to tallow. Oils subject to this change are called *fat oils*, such, for instance, is olive oil, almond oil, and rapeseed oil. This change is more or less rapid in different circumstances. If a thin layer of oil be spread on the surface of water, and exposed to the air, it takes place in a few days, and this effect is owing to the absorption of oxygen, which combines with the oil. It was supposed by Berthollet, that it depended on the action of light; but his experiments were repeated by Senebier, who found that olive oil when kept in the dark became rancid, while the same kind of oil exposed to the light, but excluded from the air, remained unchanged *.

12. Other soils, when exposed to the air, dry altogether, yet have the property of retaining their transparency. Those which have this peculiar property are called *drying oils*. The oil of poppies, hempseed oil, and particularly linseed oil, are possessed of this property. The nature of the change which takes place in these drying oils, is supposed to depend on the absorption of oxygen; and this oxygen combining with the hydrogen of the oil forms water. This opinion is supported by the practice which is followed to increase the drying property of linseed oil. It is usually boiled with litharge, before it is employed by painters. The litharge in this case is partly reduced to the metallic state, by being deprived of its oxygen, which is supposed to combine with the oil. 871 Drying.

13. But many of the fixed oils, when exposed to the air for a sufficient length of time, undergo a farther change, and acquire very different properties. They are then said to become *rancid*. During this change, they assume a brown colour, have the property of changing vegetable blues to red, and acquire a peculiar smell and taste. In this change, the sebacic acid is formed, which depends on a new combination of the hydrogen and carbon of the oil, in certain proportions with the oxygen absorbed from the atmosphere. To this acid, therefore, the rancidity of oils seems to be owing. Part of the hydrogen of the oil too, it would appear, combines with the oxygen, and forms water †. 872 Rancidity.

14. Carbon in the state of charcoal has no action upon oils; but they are purified and rendered colourless by being passed through charcoal powder. 873 Action of charcoal.

15. Phosphorus combines with oils, with the assistance of heat. A small portion of the phosphorus is dissolved, which communicates a luminous property to the oils, so that when they are spread upon any surface, they shine in the dark. When the oil is completely saturated with the phosphorus, with the assistance of heat, and is allowed to cool, part of the phosphorus is deposited, and crystallized in transparent octahedrons. When this phosphureted oil is distilled, phosphureted hydrogen gas is disengaged. 874 Of phosphorus.

16. Sulphur easily combines with fixed oil, with the assistance of heat. The solution, which was formerly called *ruby of sulphur*, is of a reddish colour. When it cools, the sulphur crystallizes, by which process Pelletier obtained sulphur in the form of octahedrons. When the cooling is too rapid, the sulphur is precipitated 875 Of sulphur.

* Senel. Ann. de Chim. xi. 91.

† Fourcroy Connaiss. Chim. vii. 328.

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Inflammable Substances. tated of a yellow colour, in the shape of needles. If this sulphurated oil, which has a peculiarly fetid odour, be distilled, it affords a great quantity of sulphurated hydrogen gas †.

† Fourcroy, Connaiss. Chim. vii. 329.

876 Of Acids. 17. The acids have a powerful effect on the fixed oils. The sulphuric acid, when concentrated, decomposes them. They become brown, thick, and at last of a black colour. Water is formed, charcoal is precipitated, and even an acid is formed. Nitric acid in the cold, thickens fixed oils by communicating part of its oxygen. In the state of nitrous acid it produces a more violent action. There is a considerable effervescence, with the evolution of a great quantity of nitrous gas. If a mixture of nitrous acid and concentrated sulphuric acid be thrown upon fixed oils, they instantly inflame, and leave behind a spongy mass of charcoal. Muriatic acid has little effect on fixed oils, but the oxymuriatic acid thickens and bleaches them, in the same way as tallow or wax.

877 Uses. 18. The various purposes to which fixed oils are applied, are too well known to require particular enumeration. They are employed in domestic economy as articles of food, and for this purpose are used alone, or in combination with other substances. They are employed for giving light, by being burnt in lamps. They are used in medicine, either on account of the active properties which peculiar oils possess, or on account of the mechanical properties which they communicate to other substances with which they are combined. In this state the use of oils is well known in the form of unguents, plasters, and liniments. In the arts, fixed oils are of the most extensive utility. They are employed in the fabrication of soaps, for mixing colours in painting, for some kinds of varnish, and for defending substances from the action of air and moisture ‡.

‡ Ibid. vii. p. 330.

878 Affinities. 19. The order of the affinities of fixed oils is the following:

Lime,
Barytes,
Fixed alkalies,
Magnesia,
Ammonia,
Oxide of mercury,
Other metallic oxides,
Alumina.

Sect. IV. *Of Volatile Oils.*

879 Characters. 1. Volatile oils are distinguished from the fixed oils by their volatility, fragrance, and acrid taste. They are also known under the name of *aromatic oils*, from their odour; or *essential oils*, or simply *essences*, from being supposed to constitute the *essence* of the vegetable matters which furnish them.

880 Names. 2. Volatile oils are not limited to particular parts of plants, but are found to exist in every part of the plant, excepting in the seed, which furnishes the fixed oils. A great number of roots which are generally distinguished by an aromatic odour, and have more or less of an acrid taste, afford volatile oils. They are furnished also by many woods, such as those of the pine and fir tribe, and by many of those which are natives of warm climates. The leaves of a great number of plants belonging to the didynamia class also afford volatile oil, as well as many of the umbelliferous plants. It is obtained from many flowers of vegetables, and from the covering of many fruits, as the skin of oranges and lemons. It is also obtained from a great number of seeds; it is never found in the cotyledons or lobes themselves, but only in the external covering. The quantity of volatile oil which is obtained from vegetables, varies according to the age, the soil in which they grow, and the state of the plant. Some plants, while green, furnish it in greatest abundance; while others yield most when they are dry.

881 Found in all parts of plants but the lobes of the seeds.

882 Preparation. 3. There are two processes by which volatile oil may be obtained. When it exists in plants in great abundance, and in vesicles in a fluid state, it may be separated by mechanical means. Thus, by simple expression, the volatile oils are extracted from many plants, as, for instance, from the fruit of the orange and the lemon. From the outer rind of these fruits, when they are fresh, the volatile oil is obtained in the liquid form; but in general, the volatile oils of plants are neither so abundant, nor do they exist in that state of fluidity, by which they can be procured by so simple a process. In most cases they are subjected to the process of distillation; and for this purpose they are macerated for some hours in water. They are then introduced into a still along with the water; a moderate heat is applied and continued till the fluid boil, when a great quantity of vapour of water, mixed with the volatile oil, passes over, and is received in proper vessels. The oil collects on the surface of the water, from which it may be easily separated. The water itself is of a milky colour, on account of a small quantity of oil suspended in it; and even after the water becomes transparent by the particles of the oil separating from it, and rising to the top, it is still loaded with the peculiar odour of the plant. This was supposed to be a separate principle of vegetables, to which Boerhaave gave the name of *spiritus rector*, and which is still known by the name of *aroma*. This fragrance of the water is owing to the solution of a certain portion of oil in it. In the distillation of the volatile oils, different practices are followed, according to the nature of the plant, and the proportion of the oil existing in it. The roots, wood, bark, fruits, dried plants, after being cut in pieces, rasped down or bruised, are macerated for some hours, or for some days, according to the solidity or particular state of the vegetable matter. Fresh plants are distilled with the smallest quantity of water, have no need of previous maceration, and do not require so high a temperature.

883 Fragrance. 4. The volatile oils are particularly distinguished by their fragrance, which varies in the oils extracted from different plants. The consistence of the volatile oils also varies considerably. Sometimes they are as fluid as water, which is the case with those obtained by expression. Some are thick and viscid, as those generally are which are extracted from woods, roots, barks, and fruits of the warmer regions. Some congeal, or assume a granulated solid consistence at different temperatures. Of these last, some are always found to be in the concrete state. Several of the volatile oils are susceptible of crystallization, depositing in the remaining portion of the oil which continues liquid, transparent polyhedrons, more or less of a yellow colour, which are found to be pure oil. This last change, Vauquelin

884 Fluidity.

885 Crystals.

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Vauquelin thinks, is owing to an incipient oxidation; for it never takes place, unless oils have been kept for some time.

886 Colour.

5. There is great variety of colour among volatile oils. Some are nearly colourless, as the oil of turpentine; some are yellow, as the oil of lavender; some are of a reddish yellow or brown, as the oil of cinnamon or of rhodium; some blue, as the oil of chamomile; and some green, as that of parsley. But the most prevailing colour among volatile oils is yellow or reddish.

887 Taste.

6. Volatile oils have almost always an acrid, and even burning taste. Yet it is observed that the most acrid vegetable matters do not yield an oil possessed of this quality. The specific gravity of volatile oils is generally less than that of water. Some, however, as those of sassafras and canella, have a greater specific gravity. The specific gravity of oils varies from 0.8697 to 0.9910, in those which are lighter than water; but those which are heavier are from 0.0363 to 1.4049.

888 Action of light.

7. When volatile oils are exposed to the light, the colour becomes considerably deeper; they become thicker, and increase in specific gravity. In speaking of a similar change which takes place in the fixed oils, this change was ascribed to the absorption of oxygen; but, according to the experiments and observations of M. Tingry, it is effected merely by the action of light; for in his experiments oxygen gas was entirely excluded *.

* Journ. de Physique, xlvii. p. 169.

889 Of heat.

8. Volatile oils, when exposed to heat, evaporate very readily. They are much more combustible than the fixed oils; and in burning give out a great quantity of smoke, a very bright white flame, and a good deal of heat. They require a greater proportion of oxygen than the fixed oils, and yield a greater quantity of water. This arises from a greater proportion of hydrogen, and a smaller quantity of carbon, which they contain.

890 Of air.

9. When volatile oils are exposed to the open air, they undergo another change. They assume a deeper colour, and become viscid, exhaling at the same time a very strong odour. The air around is deprived of its oxygen; it combines with the hydrogen of the oil, and forms water, which is observed in drops on the surface. Many of the volatile oils when thus exposed pass into the resinous state, and are almost entirely deprived of their odour. This depends on the loss of part of their hydrogen, and the increase of the proportion of carbon.

891 Of water.

10. The volatile oils are in some degree soluble in water. When agitated with this liquid, they combine with it, and communicate to it a very strong odour, and a slightly acrid taste.

892 Phosphorus and sulphur.

11. Phosphorus and sulphur are soluble in volatile oils. With phosphorus the solution is luminous in the dark, is extremely fetid, and gives out, by the force of heat, phosphureted hydrogen gas. The combination with sulphur is known under the name of *balsam of sulphur*. This gives out sulphureted hydrogen gas on the application of heat.

893 Of acids.

12. The concentrated sulphuric acid produces a brown colour, increases the viscidity of the volatile oils, and disengages part of their hydrogen with effervescence and heat. Part of the oil is decomposed; charcoal is deposited, and it contains an acid. Nitrous acid, when brought into contact with the volatile oils, produces instantaneous deflagration; converts them in a great measure into water and carbonic acid; and a voluminous mass of charcoal remains behind. Muriatic acid has scarcely any action; but oxymuriatic acid renders them colourless, concrete in part, or viscid, and brings them more nearly to the state of resins.

13. Some of these oils are employed in medicine. They are used also for the solution of those substances which are to be employed as varnishes; and many of them are used in perfumery. 894 Uses.

14. Many of the volatile oils being produced in small quantity, are high priced. There is therefore some temptation to adulterate them with fixed oils, with cheaper volatile oils, or with other substances, to increase the quantity. Hence it is of some importance to be able to detect such frauds. When a volatile oil is adulterated with a fixed oil, there is a very easy test to discover it. Let a single drop of the oil that is suspected fall on clean paper, and expose it to a gentle heat. If the oil is pure, the whole will be evaporated, and no trace will remain on the paper; but if it has been mixed with a fixed oil, a greasy spot remains behind. Volatile oils are frequently adulterated with oil of turpentine; but this can only be detected by its peculiar odour, which continues for a longer time than most of the other volatile oils. When they are adulterated with alcohol, it is easily detected by mixing a little of the oil with water, which immediately produces a milkiness, by the abstraction of the alcohol from the oil, and its combination with the water. 895 Tests of purity.

15. There is another class of oils known under the name of *empyreumatic oils*, which have different properties from those which have been described. These oils are acrid and stimulating, with a strong fetid and disagreeable odour. It would appear that these properties are owing to a partial decomposition of other oils. These oils are produced, as the name imports, by the action of fire. They are obtained when oils are forced to rise in vapour, and pass over in common distillation, with a greater degree of heat than that of boiling water, or by the application of a strong heat to substances from which no oil was previously extracted. These empyreumatic oils agree in some of their properties with the volatile oils. They combine in small proportion with water, and they are soluble in alcohol; and probably any difference that exists between them is owing to a partial decomposition; for when they are distilled, the oil is restored to a state of purity, and the carbonaceous matter which had been separated, remains behind. 896 Empyreumatic oils.

Chap. XII. Of ALKALIES.

The word *alkali* is derived from the Arabian name of a plant, *kali*, which affords the substance now distinguished by that term. When other substances were discovered, possessed of similar properties, the meaning of the term was extended, and applied to such matters as had several common properties. Three substances have been generally ranked under the head of alkalies. These are potash, soda, and ammonia; to 897 Origin of the name.

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Inflammable Substances. to which has lately been added lithina. Some other substances, also, of vegetable origin, are now considered as alkalies. But these will be more advantageously introduced in a different place. The alkalies are characterised by the following properties.

898 Characters. 1. They have a peculiar taste, which is disagreeably caustic, even when they are diluted with water.

2. They change vegetable blue colours to a green.

3. They have a strong attraction for water, and combine with it in all proportions.

4. They have a strong affinity for acids.

5. They melt in a moderate heat, but with a stronger heat they are volatilized.

899 Natural division. The alkalies have been divided into two kinds, namely, the *fixed* and *volatile*. Potash and soda, and lithina, are denominated *fixed alkalies*, because they require a great degree of heat to dissipate or volatilize them. Ammonia has been called the *volatile alkali*, because a very moderate degree of heat is sufficient to volatilize it.

Fourcroy has classed two of the earths, namely, barytes and strontites, under the head of alkalies. In some of their properties, these earths, no doubt, are analogous to the alkalies; but in other properties they are more closely allied to the earths. There seems, therefore, to be no inconveniency or ambiguity in classing them, as usual, among earthy substances.

It may perhaps be considered as one of the general characters of the alkalies which we have now enumerated, that they have no action on oxygen, azotic, or hydrogen gases; nor is there any action between the alkalies and carbon.

SECT. I. *Of Potash and its Combinations.*

900 Names. 1. This substance has been long known in commerce, under many different names, derived from the substances from which it is extracted, or from the processes by which it is prepared. The name of *ash* or *ashes* has been given to this substance, because it is procured from the burnt ashes of vegetables; and it has received the epithet of pot-ashes, because it is prepared in iron pots. It got the name of vegetable alkali, because it was supposed that it only existed in vegetables. Being prepared from nitre and tartar, it was called the *alkali of nitre* or *tartar*, and the *salt of tartar*, a name which it still retains in the shops. It has been proposed also to distinguish it by the term *kali*, the name of the plant from which it was originally procured.

901 Preparation. 2. Potash is generally prepared by burning wood or other vegetable matters, and thus reducing them to ashes. The ashes are then to be washed repeatedly with water, till the liquid comes off perfectly tasteless. If the liquid thus obtained be purified by filtration, and evaporated to dryness, a salt is obtained, which is the potash. In this state it is contaminated with much extraneous matter; but if it be exposed to a red heat, many of the foreign substances with which it is mixed, are dissipated; it becomes whiter, and from its colour is then sold under the name of *pearl-ash*. This salt is prepared in great abundance in those countries where wood abounds, as in North America and the north of Europe; and hence it is known in commerce under the name of *Russian or American pearl-ash*.

3. Potash, in this state, is considered as sufficiently pure for the ordinary purposes of life to which it is applied; but it is still mixed with much foreign matter, which renders it unfit for the purposes of the chemist. It has therefore always been considered as an object of great importance, to obtain it in a state of purity. Potash, &c. 902 In this state is impure.

But even when it is seemingly pure, by being deprived of all extraneous substances, it is found to possess very different properties, after being subjected to certain processes. In one state it is comparatively mild and inactive; in another, extremely acrid and corrosive. Various opinions were entertained of the cause of this remarkable difference. The true cause was discovered and demonstrated by Dr Black in the year 1756. This ingenious philosopher, by a few simple and satisfactory experiments, clearly proved, that the different states of the alkalies, lime, and magnesia, are owing to their combination with a peculiar substance, to which he gave the name of *fixed air*, because it is fixed in these bodies. This fixed air, it has been already observed, is now known by the name of *carbonic acid*. When the alkalies are in combination with carbonic acid, they are in the mild state; but, when they are deprived of this acid, their effects being more powerful and corrosive, they are said to be in the caustic state. 903 Black's discovery.

When sulphuric acid is poured upon a quantity of potash in its ordinary state, an effervescence takes place. This, Dr Black proved, is owing to the escape of the carbonic acid in the state of gas; for when the alkali is in its pure or caustic state, no effervescence takes place. He also proved, that the alkalies and lime in their mild state, that is, when combined with carbonic acid, are heavier than in the caustic state, and that this difference of weight is exactly equal to the quantity of carbonic acid which escapes. Since, then, these substances exhibit such different properties in these two states, it is necessary to procure them in a state of purity, to examine their properties and effects. This is not without difficulty, on account of the strong affinity which exists between the alkalies and carbonic acid; for although previously pure, as soon as they are exposed to the air, they begin to attract the carbonic acid, and return to their former mild state.

4. As this, therefore, is an object of importance, various processes have been proposed, to procure them as pure as possible. In these processes the principle is to separate the carbonic acid by the superior affinity of quicklime, and to dissolve it in alcohol, which leaves other substances behind. 904 Purification.

a. The following process for the purification of potash is recommended by Berthollet. It is to be mixed with double its weight of quicklime, with eight or ten times the weight of the whole mixture, of pure or rain water. Boil it for two or three hours in an iron vessel; then let it remain in a close vessel for 48 hours, taking care to agitate it occasionally. Let it afterwards be filtered, and boiled in a silver vessel with a strong heat, till it assume the consistence of honey. Pour a quantity of alcohol upon it, equal in weight to one-third of the alkali which has been employed; then put it on the fire, and let it boil for some minutes. Pour it afterwards into a bottle and allow it to cool. The matter in the bottle separates into three different strata: 905 Berthollet's process.

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Potash, &c. strata: at the bottom are deposited solid bodies; in the middle there is an aqueous solution, or carbonate of potash; and on the top a liquor of a reddish brown colour, mixed with alcohol. Let this be carefully decanted off by means of a syphon. This is a solution of pure potash in alcohol. Put it into a bason of silver, or of tinned copper; evaporate it rapidly, till a dry, black and charry crust forms on the surface, and the liquor below, which has an oily appearance, becomes solid by cooling. Let the crust be removed, and pour the solution into porcelain vessels. When it cools, it becomes solid. It is then to be broken in pieces, and put into close vessels. This is the potash in a state of purity, not only freed from foreign matters, but also deprived of the carbonic acid.

Lime has a stronger affinity for carbonic acid than potash. When, therefore, lime deprived of its carbonic acid, as it is in the state of quicklime, is brought into contact in sufficient quantity with the potash, it deprives it of the carbonic acid. It is with this view that the lime is employed in this process. The alcohol has the property of dissolving potash, but has no action on the other substances with which it is combined. This is the reason why the alcohol, holding in solution the pure potash by its less specific gravity, forms the upper stratum in the bottle. By the evaporation, the last step of the process, the alcohol and water are driven off, and the pure potash remains behind in the solid state.

906 By Lowitz. *b.* A more economical process has been proposed by Professor Lowitz of Petersburgh. He boils together the potash and quicklime, as in the former process; filters the liquor, and evaporates, till a thick pellicle is formed on the surface. It is then set by to cool, till crystals are formed in it, which are crystals of extraneous salts, and are to be removed. He then continues the evaporation, and removes the pellicle as it forms on the surface during the process. When the fluid ceases to boil and no more pellicle is formed, he removes it from the fire, and keeps constantly stirring it while it cools. He then dissolves it in double the quantity of cold water, filters the solution, and evaporates in a glass retort, till regular crystals begin to be deposited. If the mass should consolidate ever so little by cooling, a small quantity of water is to be added, and it must be heated again, to render it fluid. When a sufficient quantity of regular crystals has been formed, he decants the liquid, which has a brown colour, and re-dissolves the salt after it is suffered to drain, in the same quantity of water. The decanted liquor is preserved in a well-closed bottle for several days, till it subside and become clear. He then decants it, evaporates, and crystallizes a second time, and repeats this process as long as the crystals afford, with the least possible quantity of water, solutions that are perfectly limpid. These solutions are to be preserved in well-closed bottles, to defend them from the access of air *.

* Nicholson's Journal, 4to, vol. i. p. 164.

907 By Klaproth. *c.* The method of preparing pure potash by the indefatigable and accurate Klaproth, is somewhat different from this. We shall detail it in his own words. "As many persons think that the preparation of a perfectly pure caustic ley is subject to more difficulties than it really is, I will here briefly state my method of preparing it. I boil equal parts of purified salt of tartar, (carbonate of potash, or vegetable alkali prepared from tartar) and Carrara marble, burnt to lime, with a sufficient quantity of water, in a polished iron kettle; I strain the ley through clean linen, and though yet turbid, reduce it by boiling, till it contain about one half of its weight of caustic alkali; after which I pass it once more through a linen cloth, and set it by in a glass bottle. After some days, when the ley has become clear of itself, by standing, I carefully pour it off from the sediment into another bottle. To convince myself of its purity, I saturated part of it with muriatic or nitric acid, evaporate it to dryness, and re-dissolve it in water. If it be pure, no turbidness will take place in the solution. The quantity of caustic alkali which this ley contains, I ascertain by evaporating a certain weighed portion of the ley to dryness, in an evaporating dish of a known weight. I also take care, in the preparation of this caustic ley, that the alkali be not entirely deprived of carbonic acid; because, in that case, I can with greater certainty depend on the total absence of dissolved calcareous earth. By employing burnt marble, or in its stead burnt oyster-shells, I avoid the usual contamination of the caustic ley by aluminous earth; because lime, prepared from the common species of lime-stone, is seldom entirely free from argil" *.

† *Analyt. Essays, Pref.* p. 8. *Transl.*

908 Properties. 5. Potash, thus obtained, is a white solid substance, which is susceptible of crystallization, in long, compressed, quadrangular prisms, terminating in sharp-pointed pyramids. These crystals, which are only obtained from very concentrated solutions, are soft and deliquescent, i. e. they attract moisture from the atmosphere. The taste is extremely acrid; and it is so corrosive, that it destroys the texture of the skin, the moment it touches it. It is from this property that it has derived the name of caustic, or the *potential cautery*, because it is employed for the purpose of destroying excrescences. According to Hassenfratz, the specific gravity of potash is 1.7085. It converts vegetable blues into a green colour.

909 Action of heat. 6. Light has no action on potash. When it is heated in close vessels, it becomes soft and liquid, and is afterwards converted into a white, opaque, and granulated mass, when it cools. If the heat be increased to redness, it swells up, and rises in vapour. If the vessel be opened, a white smoke arises, which is extremely acrid, and condenses on cold bodies with which it comes in contact. But though it is thus sublimed, it undergoes no other change than assuming a slight green colour.

7. There is no action between potash and oxygen or azotic gases, nor is there any direct action between it and carbon. Phosphorus and sulphur enter into combination with potash, and form peculiar compounds, the nature of which we shall consider, after having detailed the general properties of potash.

910 Of water. 8. Potash has a very strong affinity for water. Water, at the ordinary temperature, dissolves double its weight. The solution, when the potash is pure, is colourless and transparent, and nearly of the consistence of oil.

911 Acids. 9. Potash combines readily with the acids, and forms compounds with them, having different properties, according to the nature of the acid employed. Its affi- 912 Affinities. nities for the acids are in the following order:

 Sulphuric,

Sulphuric,
Nitric,
Muriatic,
Phosphoric,
Phosphorous,
Fluoric,
Oxalic,
Tartaric,
Arsenic,
Succinic,
Citric,
Lactic,
Benzoic,
Sulphurous,
Acetic,
Saclactic,
Boracic,
Carbonic,
Prussic.

913 Uses. 10. Potash is employed for a great variety of purposes; it enters into combination with many substances, and forms with them valuable and important compounds. It is employed in medicine as a useful and powerful remedy; and in many arts and manufactures, as in bleaching, dyeing, and glass-making.

914 Composition. This substance, though the subject of various conjectures as to its composition, was never analyzed till the year 1807, when Sir H. Davy effected this object by the application of a powerful galvanic apparatus. A piece of potash, slightly moistened, is laid on a plate of platinum, which is connected with the one end of the battery. The potash is, at the same time, touched with a wire of platinum, connected with the opposite end of the series. Fusion takes place at the two points of contact; oxygen is given out at the positive end, and at the negative, globules of metallic lustre make their appearance. These globules, with the oxygen, form the constituents of potash. The metalloid thus discovered has received the name of potassium. It is remarkably light, more so than alcohol, ether, or any known liquid. Potassium has a strong attraction for oxygen, and decomposes water with great readiness, combining with the oxygen to form potash, and setting hydrogen gas at liberty. When burnt in oxygen gas, it combines with a larger proportion of oxygen; the compound is called a peroxide; and when this compound is thrown into water, its superabundant oxygen is given off in the gaseous form, and the proportion just requisite to constitute potash is established.

Potash may also be decomposed by means of iron filings, under an intense white heat, in an iron tube; the due provision being made for preserving the potassium, which is distilled over in union with hydrogen, from the contact of air or water.

The strong affinity of potassium for oxygen, renders it a convenient instrument for analysing those bodies containing oxygen, which retain that principle by an affinity too strong to yield to other agents. Thus, by means of potassium, several other simple bodies have been detected; and the discovery of it forms on that account one of the most memorable eras in the history of chemistry.

I. Action of Phosphorus on Potash.

1. There is no direct combination between potash and phosphorus; but although these two bodies have little tendency to unite, they have a very powerful effect upon each other when they are heated together with water. It was in this way that Gengembre first obtained the singular gas, which has been already described, when treating of phosphorus, under the name of *phosphureted hydrogen gas*. 915 Phosphureted hydrogen gas.

2. If one part of phosphorus and ten parts of concentrated solution of pure potash be introduced into a small retort, and exposed to heat till it boils, phosphorated hydrogen gas will pass over, which may be received in jars over water: or if the beak of the retort be kept under the surface of water, the bubbles of the gas, as they rise to the surface, explode, and form the beautiful coronet of white smoke, formerly mentioned. In making this experiment, the retort should not be larger than to hold the solution, or it should be filled with hydrogen or azotic gases, in which the phosphorated hydrogen gas will not inflame and explode, with the risk of breaking the vessel; for the inflammation can only take place when it comes in contact with the oxygen of the atmosphere. 916 Process for obtaining it.

3. In this process, the water which holds the potash in solution, is decomposed. The oxygen combines with part of the phosphorus, and forms phosphoric acid, while another part of the phosphorus unites with the hydrogen, and passes over in the form of phosphorated hydrogen gas. Thus, without any perceptible action between the phosphorus and the potash, the decomposition of the water is aided by means of the potash, in consequence of its attraction for the phosphorus, combined with the oxygen in the state of phosphoric acid. For it is found, that a quantity of phosphorus of potash is formed, corresponding to that of the phosphorated hydrogen gas which is obtained. The decomposition is also assisted by the affinity of the phosphorus for the oxygen and hydrogen of the water. The whole of the phosphorated hydrogen gas which is formed, being disengaged, shows that no combination takes place between it and the potash *. 917 Nature of the process.

* *Fourcroy, Connais.* tom. ii. p. 202.

II. Action of Sulphur on Potash.

1. Sulphur and potash very readily combine together. If one part of potash and three of sulphur be triturated together in a glass or porcelain mortar, the mixture becomes hot, the sulphur loses its yellow colour, and acquires a greenish tinge. There is disengaged a fetid smell of garlic; the mixture attracts moisture from the air, becomes soft, and is almost entirely soluble in water.

If two parts of potash and one of sulphur be well mixed together, and heated in a crucible, the mixture fuses; and by this process is obtained *sulphuret of potash* in the dry state. This was formerly called *hepar sulphuris*, or *liver of sulphur*, from its resemblance to the liver of animals. The same substance may be obtained by treating sulphur with the potash of commerce, with this precaution, not to apply too strong a heat, to occasion a sublimation of the sulphur, and the too rapid evolution of the carbonic acid from the potash. When the fusion is completed, it is poured out on a marble slab; it is covered up from the air, allowed to cool, and broken into small pieces, to be instantly put up in well-closed glass vessels. 918 Sulphuret of potash.

2. The solid sulphuret of potash, thus prepared, is of 919 Properties.

Potash, &c. a shining brown colour like that of the liver of animals, from which it derived its former name. Exposed to the air, it becomes green, then passes to grey, and even to white. It is dense, smooth, and has a vitreous fracture. It has no other smell than that of heated or sublimed sulphur; is acrid, caustic, and bitter to the taste, and leaves a brown spot on the skin. With a strong heat, in a porcelain retort, the sulphur is sublimed, and the potash remains in a state of purity at the bottom of the vessel. The sulphuret of potash converts vegetable blue colours to green, and afterwards destroys them.

920 Hydro-sulphuret. 3. But the sulphuret of potash possesses these properties, only while it is recently prepared, and very pure. When exposed to the air, it is readily decomposed, and more so, as the air is loaded with moisture. It absorbs water with avidity, acquires a green colour, and exhales the fetid odour of sulphurated hydrogen gas. This change is owing to the decomposition of the water which has been absorbed. Part of the sulphur combines with the hydrogen, and forms sulphurated hydrogen gas, which combines with the sulphuret, and forms hydrogenated sulphuret of potash.

921 Obtained by another process. 4. This may also be formed by passing the sulphurated hydrogen gas into a solution of potash. The gas is absorbed and condensed, till the potash is fully saturated. To this substance Berthollet, who particularly investigated the nature of these compounds, gave the name of *hydro-sulphuret of potash*.

922 Properties. This compound crystallizes, and is more permanent than the sulphuret. The crystals are transparent and colourless, while those of the sulphuret are brown and opaque. The crystals are large and in the form of four-sided prisms, terminating in four-sided pyramids. It is decomposed by heat, and by the action of the acids. Sulphurated hydrogen gas is disengaged, but there is no deposition of sulphur. The oxymuriatic acid decomposes the sulphurated hydrogen, and then sulphur is precipitated. The pure hydro-sulphuret has no smell, when it has no addition of sulphur beyond the saturation of the hydrogen. The alkali seems to have a stronger affinity for the sulphureted hydrogen than for the sulphur, so that when it is saturated with the first, that is, in the state of hydro-sulphuret of potash, which is in the form of crystals, and without smell or inodorous, it combines with no more sulphur; but when sulphureted hydrogen gas is made to pass into a solution of the sulphuret of potash, already hydrogenated by its solution in water to a certain degree of saturation, the sulphureted hydrogen acts in the manner of acids, precipitates the sulphur like them, renders the liquid colourless, and leaves behind nothing but the hydro-sulphuret of potash *.

* *Fourcroy, Connaiss. Chim.* tom. ii. p. 206.

923 Hydrogureted sulphuret. 5. Sulphur combines with the latter compound, and forms a new compound, which may be obtained by pouring a liquid hydro-sulphuret upon sulphur. The sulphur is dissolved without the assistance of heat; the liquid assumes a darker colour, and then it is converted into the *hydrogureted sulphuret*. Hydrogureted sulphuret of potash is prepared by boiling together a mixture of pure potash and sulphur in water. This solution is of a deep greenish yellow colour, has a very acrid bitter taste, and a powerful action on many substances. It readily absorbs oxygen when exposed to the air. When it is kept in close vessels, sulphur is deposited; the liquid becomes transparent, and the smell is dissipated. Thus, there are three different compounds of sulphur with potash; namely, sulphuret of potash, hydro-sulphuret of potash, and hydrogureted sulphuret, which are all distinguished by peculiar properties.

III. Compounds of Potash with Acids, or Neutral Salts.

1. Sulphate of Potash (U).

1. This salt, which was one of the most early known, is a compound of sulphuric acid and potash. It has been distinguished by a great variety of names, as *sal de duobus*, *sal polychrestus*, or salt of many virtues, *arcanum duplicatum*, and more lately *vitriolated tartar*, till in the new nomenclature it received the name of *sulphate of potash*. 924 Names.

2. It is prepared by different processes, either by directly combining the sulphuric acid with the potash, and evaporating and crystallizing it; or by decomposing other salts which have potash for their base, by means of the sulphuric acid, which, having a stronger affinity for the potash, combines with it and forms the new compound. 925 Preparation.

3. The sulphate of potash crystallizes in hexaëdral prisms, terminated by six-sided pyramids; but this form is susceptible of several varieties. It has a disagreeable bitter taste; it is not very hard, and may be easily reduced to powder. The specific gravity is 2.4073. At the temperature of 60°, it is soluble in 16 times its weight of water; boiling water dissolves about one-fifth part; on cooling, it crystallizes in a confused mass; and it is only by slow spontaneous evaporation that regular crystals can be obtained. 926 Properties.

4. It suffers no change by the action of the air. When placed upon burning coals, it decrepitates, and loses its water of crystallization. At a greater heat it melts, and is converted into a kind of enamel as it cools. 927 Action of air and heat.

5. When this salt is exposed to a red heat, along with hydrogen gas or carbon, it is decomposed, and converted into a hydrogenated or carbonated sulphuret of potash.

6. The sulphuric acid, with the assistance of heat, combines with the salt, and forms another with excess of acid. It undergoes a partial decomposition by the action of nitric acid. The nitric acid combines with nearly $\frac{1}{7}$ of potash, which is owing to the action of double affinity. The nitric acid combines with one part of the potash, while the sulphuric acid unites with the sulphate of potash, and forms a salt with excess of acid. A similar decomposition takes place by means of the muriatic acid.

7.

(U) In the present chemical nomenclature the compounds of acids with any base are known by names analogous to this; and when the acid has its greatest proportion of oxygen, as in this case the sulphuric acid, the name of the compound terminates in the syllable *ate*, as sulphate of potash, nitrate of potash; but when the acid has its smaller proportion of oxygen, the name of the compound terminates in *ite*, as sulphite and nitrite of potash.

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Potash, &c. 7. The component parts of sulphate of potash are, according to

928 Composition.

	Bergman.		Kirwan.
Acid	40	-	45.2
Potash	52	-	54.8
Water	8	-	00.0
	100	-	100

929 Names. *Acidulous sulphate*, or *super-sulphate of potash*.—1. This salt was formerly called *vitriolated tartar with excess of acid*. It is prepared by heating together, in a retort, three parts of the sulphate of potash, with one part of its weight of concentrated sulphuric acid.

930 Properties. 2. It crystallizes in long flexible, shining crystals, and sometimes it exhibits the form of six-sided prisms. It has a sharp, acrid, and hot taste. It reddens vegetable blues. Exposed to the air, it becomes a little more opaque, but without any other change. It is more soluble in water than the sulphate of potash, requiring only 2 parts of water at 60°, and dissolves in less than its own weight of boiling water. It melts very readily, and has the appearance of a thick oil. When it cools, it becomes a white, opaque mass, exhibiting on its surface shining silky crystals. When exposed to a great heat, the excess of acid is driven off, and it is converted into the sulphate of potash.

931 Action of water.

932 Of heat.

933 Hydrogen. 3. It is readily decomposed by the action of hydrogen and of red-hot charcoal, which deprive it of a great portion of the sulphur; and by sulphur itself, which carries off the excess of sulphuric acid in the form of sulphurous acid.

4. The first of these salts, the sulphate of potash, is employed in medicine as a purgative; the last has been applied to no use whatever.

2. Sulphite of Potash.

934 Names and preparation. 1. This salt was long known under the name of the *sulphurous salt of Stahl*. It is a compound of the sulphurous acid and potash. Its nature and properties have been particularly investigated by Berthollet, Fourcroy, and Vauquelin. It may be formed by passing a current of sulphurous acid gas into a solution of carbonate of potash in three times its weight of distilled water, till the effervescence ceases. The liquor becomes transparent and hot, and, as it cools, the sulphite of potash is deposited in crystals.

935 Properties. 2. This salt is in the form of long, small needles, diverging from a centre, or in rhomboidal plates, or in dodecahedrons formed by two tetrahedral pyramids, united and truncated very near the base. The crystals are white and transparent, but sometimes of a slight yellow colour. The taste is acrid and sulphureous. The specific gravity is 1.586. The sulphite of potash, exposed to the air, very readily effloresces (x); becomes white and opaque, and is converted into sulphate of potash. This is owing to the sulphurous acid abstracting oxygen from the air, and becoming sulphuric acid. It is very soluble in water, at the temperature of the atmosphere, and much more so in boiling water. When this solution is exposed to the air, it is soon covered with a thick pellicle, which falls to the bottom, and is afterwards replaced by another. This is sulphate of potash, which is formed in contact with the air. The oxymuriatic acid gas combined with this solution, forms almost immediately shining crystals of the sulphate of potash.

936 Action of the air.

3. Charcoal heated with this salt in a retort, yields sulphurated hydrogen gas, and carbonic acid; and there remains in the retort, a hydrogenated sulphuret of potash. 937 Of charcoal.

3. Nitrate of Potash.

1. This salt is composed of nitric acid and potash, and is well known under the names of *saltpetre* and *nitre*. It has also been denominated *salt of nitre*, *nitre of potash*, or *nitrated potash*. It is one of the most important of the salts, not only on account of the attention which it has excited, in tracing its formation, and studying its nature and composition, but also on account of its numerous and valuable applications in domestic economy and in the arts. 938 Constituent parts and names.

2. The nitrate of potash exists ready formed in many plants, as in tobacco, borage, bugloss, pellitory. It has been observed crystallized in needles in their dried stalks. According to some, it has been absorbed by the vegetable from the soil in which it grows, while others suppose that it is formed within the plant, from the elementary principles. 939 Found in many plants.

Nitre exists in great abundance on the surface of the earth in different parts of the world, especially in the warmer regions, as in India, Egypt, and South America. But the production of nitre is not limited to these countries. It is produced artificially in Germany and France, by means of what are called *nitre beds*. These are formed by collecting together the refuse of animal and vegetable matters, in which the putrefactive process is going on. They are mixed with earthy substances, but chiefly with calcareous earth, such as the rubbish from buildings, or collections of the soil in which lime abounds. All that is necessary to favour the formation of the nitre, is to moisten occasionally with water, the mixture of the animal, vegetable, and earthy matters; to expose it to a moderate temperature, and to defend it from rains, which would carry off the salt as it is formed. This artificial production of nitre was greatly improved and extended by the French during the late war, when they were precluded from the usual supply of this salt from India. It is now produced, it is said, in great abundance in France. 940 Prepared artificially.

The nature of the process, and the change which takes place in this artificial production of nitre, will be understood by considering its component parts. The constituent parts of the nitric acid are azote and oxygen.

(x) A salt is said to effloresce, when deprived of its water of crystallization in the ordinary temperature of the atmosphere. A powdery crust is first formed on the surface; and as the process goes on, the whole falls down into powder. The term *efflorescence* is opposed to *deliquescence*, by which the deliquescent substance attracts moisture from the air.

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Potash, &c. gen. The oxygen is furnished by the air: and unless there is a supply of air, no change takes place. A great quantity of azotic gas is given out by animal matters during the putrefactive process. But although these substances, when brought into contact with each other, do not combine to form nitric acid, it has been found by experiment, that azote, in its nascent state, or in the moment of evolution, enters into union with oxygen, and forms nitric acid, while the nitric acid thus formed combines with the potash which is furnished by the soil, or the vegetable matters.

941 Purification. 3. After the nitre is formed, it is mixed with water, which is evaporated, and a salt is obtained of a brown colour, which is called *crude nitre*. This is a mixture of several salts, and from these the pure nitre is separated by other processes. When it is sufficiently purified, it is obtained in crystals of six-sided prisms, terminating in six-sided pyramids. The primitive form of its crystals is a rectangular octahedron, in which two faces of a pyramid are inclined to the other pyramid at an angle of 120°, and the two others at an angle of 111°. The form of the integrant molecule is the tetrahedron; but there are considerable varieties in the crystals of this salt, according as it is slowly or more rapidly evaporated.

942 Properties. 4. This salt is distinguished by a cool, sharp, and bitterish taste. It is very brittle. When nitre in large crystals is reduced to powder, it is found to be a little humid; but that which is in the form of a white, opaque, irregular mass, yields a dry powder, on which account it is generally preferred for many purposes, particularly in the manufacture of gunpowder. The specific gravity of nitre is 1.9369. It is not altered by exposure to the air. At the temperature of 60° it dissolves in seven times its weight of water, and during the solution, a great degree of cold is produced. Boiling water dissolves twice its weight of this salt.

943 Action of heat. 5. When the nitre of potash is exposed to heat, it fuses before it becomes red, and is converted into a liquid of an oily consistence. It loses but very little of its water of crystallization, and if it be allowed to cool, it congeals into an opaque mass with a vitreous fracture, which is known by the name of *mineral crystal*. While it is melted, it undergoes no change; but when the temperature necessary for simple fusion is increased, it gives out oxygen gas to the amount of about $\frac{1}{3}$ of its weight. Towards the end of the process, azotic gas is evolved, and the potash remains behind pure, so that the salt has been completely decomposed. But to effect this decomposition, a very strong heat is necessary. When only part of the gas is extracted, the nitrate of potash is converted into the *nitrite*.

944 Of charcoal. 6. When nitre is mixed with charcoal in the proportion of three parts of the former to one of the latter, a violent inflammation takes place, either by exposing the mixture to a red heat, or by bringing it into contact with a burning body. Or the mixture may be projected into a red-hot crucible, when a deflagration or detonation takes place, and when the residuum in the crucible is examined, it is found to be potash partly united with carbonic acid, or the carbonate of potash. This was formerly called *nitre fixed by charcoal* or an *extemporaneous alkali of nitre*. The deflagration in this case is owing to the combustible matter, the charcoal coming in contact with the oxygen which is evolved by the nitre, exposed to a high temperature. In another process, this experiment was performed in close vessels, to collect the elastic fluids which are disengaged; and besides the carbonic acid gas which is formed by the union of the carbon and oxygen, and the azotic gas disengaged by the decomposition of the nitre, a small quantity of water was found in the vessels. To this product the alchemists gave the name of *clyssus*, and ascribed to it very wonderful properties in the preparation of the philosopher's stone.

7. A violent deflagration also takes place when phosphorus and nitre are treated in the same way. But this experiment should be performed with very small quantities, and with great caution. A mixture of nitre and phosphorus struck smartly with a hammer, produces a very violent detonation. 945 Of phosphorus.

8. When sulphur is combined with three times its weight of nitre, it burns with great rapidity. This preparation was formerly made by detonating the two substances in a red-hot crucible. The product is sulphate of potash, known by the name of *sal polychrest of Glaser*. The sulphur combines with the oxygen of the nitric acid, and forms sulphuric acid, which enters into combination with potash. 946 Of sulphur.

9. But one of the most important combinations of nitre is with charcoal and sulphur, in the formation of gunpowder. This substance was first known in Europe in the 14th century. It is said that it was known to the Chinese much earlier. The proportions of the materials which enter into the composition of gunpowder are, 947 Gunpowder.

Nitre	76
Charcoal	15
Sulphur	9
	100

The materials are first reduced to a fine powder separately. They are then carefully mixed together, and formed into a paste with a little water. When the paste has dried a little, it is forced through a sieve, by which means it is reduced to grains of such a size as may be wanted. The powder is then dried in the air, or in the sun; and after being dried, it is put into barrels which turn round by means of machinery, and thus by the friction of the grains of powder against the sides of the barrel and against each other, it is polished. This is called *glazing* the powder. 948 Preparation.

10. The theory of the combustion, and terrible effects of gunpowder is thus explained. The sulphur and the charcoal burn with great rapidity by the addition of the nitre with which they are intimately mixed. During the combustion carbonic acid gas, azotic gas, sulphurous acid gas, and according to some, sulphurated hydrogen gas, are formed. Water and ammonia also are said to be produced*. But according to Mr Cruickshank, the quantity of water formed is not perceptible. The substances which remain after the deflagration are, carbonate of potash, sulphate and sulphuret of potash, and some charcoal. It is obvious, that the irresistible effects of gunpowder are owing to the sudden evolution and expansive force of the elastic fluids which are formed and disengaged. 949 Nature of its action.

* Fourcroy Connaiss. Chim. iii. 122.

11. Another combination of nitre produces effects still more terrible. When three parts of nitre, two parts of potash, and one of sulphur, are previously well dried and mixed 950 Fulminating powder.

mixed together by trituration, they form a compound which is known by the name of *fulminating powder*. A few grains of this mixture exposed to heat in an iron ladle first melt, assuming a darker colour; and when the whole is in fusion, there is a violent explosion. The heat should be applied slowly and gradually, till it is completely fluid, and then by bringing it nearer the heat, the full effect of the explosion is obtained. This combustion and explosion are also owing to the instantaneous evolution of elastic fluids. The potash unites with the sulphur, and forms a sulphuret, which, with the assistance of the nitre, is converted into sulphurated hydrogen. At a certain temperature the sulphurated hydrogen gas is disengaged, along with the oxygen gas of the nitre, and suddenly taking fire, strikes the air by the explosion which accompanies the evolution of the gases. When the mixture is made with equal parts of nitre and solid sulphuret of potash, the detonation is

951 Powder of fusion. more rapid, but the explosion is less violent. With three parts of nitre, one of sulphur, and one of sawdust, well mixed together, what is called *powder of fusion* is formed. If a little of this powder is put into a walnut shell, with a thin plate of copper rolled up, and the mixture set fire to, it detonates rapidly, and reduces the metal to a sulphuret, without any injury to the shell.

952 Fluxes. 12. A mixture of equal parts of nitre and tartar detonated in a crucible, gives a product which is much employed in metallurgy. This compound, called *white flux*, is a mixture of pure potash with the carbonate. When one part of nitre and two of tartar are treated in the same manner, the product obtained is a mixture of potash and charcoal. From its black colour, it is known under the name of *black flux*. This also is employed for a similar purpose.

953 Composition. 13. Nitrate of potash, according to Bergman, is composed of

31 acid,
61 potash,
8 water.

100

According to Kirwan, it is composed of

44 acid,
51.8 potash,
4.2 water.

100.0

954 Uses. 14. Nitre is not only employed for the purposes already mentioned, but it is used in medicine as a cooling remedy in feverish disorders, and as a diuretic in urinary affections. It is employed also in many arts, as in dyeing, and in domestic economy, for the preservation of animal matters, which are to be used as food. To these substances it imparts a red colour. From nitre, nitric acid is obtained, by decomposing it by means of sulphuric acid. Nitre is also employed to burn along with sulphur in the formation of sulphuric acid.

4. Nitrite of Potash.

This salt cannot be formed by direct combination of the nitrous acid with potash; but if a quantity of nitre be exposed for some time in a crucible or retort, to a strong heat, it becomes deliquescent and acid. It changes the blue colours of vegetables into green, attracts moisture from the air, detonates feebly with combustible substances, and gives red thick vapours by the action of sulphuric, nitric, muriatic, phosphoric, and fluoric acids. This is the nitrite of potash, which is decomposed by these acids, and gives out the red fumes of nitrous acid. Little more is known of the nature of this salt, with regard to its form, solubility, affinities, or the proportions of its constituent parts.

5. Muriate of Potash.

1. This salt was formerly known by the name *febrifuge salt of Sylvius*. It was afterwards called *digestive salt*, *regenerated sea salt*, and by Bergman *salited vegetable alkali*. 955 Names.

2. It is prepared by the direct combination of muriatic acid and potash. The solution is evaporated till a pellicle appears, when it is set by to crystallize.—It is a curious effect of the new opinions already adverted to respecting muriatic acid and chlorine, that when the muriate of potash is deprived of water, it must be considered as a substance of totally different composition, as now containing neither muriatic acid nor potass, but consisting entirely of chlorine and potassium, and therefore called a chloride of potassium, or in the French nomenclature, a chloruret. It becomes necessary to maintain this, because, when potassium is introduced into dry chlorine gas, a combination is effected, and the compound thus formed cannot be considered as muriate of potash, since there is no oxygen present to form potash, and no hydrogen to form muriatic acid. Both these elements are afforded when water is presented, and muriate of potash is established. 956 Preparation and properties.

3. The crystals are in the form of regular cubes, or rectangular parallelopipeds. It has a disagreeable bitter taste, and by this is easily distinguished from muriate of soda or common salt. The specific gravity of this salt is 1.836. When the air is moist, it deliquesces; but when the air is dry, it parts with its moisture. Three parts of cold water are sufficient for its solution. Boiling water dissolves a little more, but regular crystals cannot be obtained by cooling. The solution must be left to slow spontaneous evaporation.

4. When the muriate of potash is exposed to heat, it decrepitates, loses its crystalline form, and falls into powder by the separation of .08 parts of its weight of water. When it acquires a red heat, it melts; if the temperature be elevated, it is sublimed in the form of white vapour, unchanged. After complete fusion, if it is allowed to cool suddenly, it becomes solid, and divides on the surface, into many small plates of a square form. 957 Action of heat.

5. This salt is decomposed by means of the sulphuric and nitric acids. The first disengages the muriatic acid with effervescence in the gaseous form. By the action of the nitric acid the muriatic acid is converted into the oxymuriatic by combining with the oxygen of the nitric acid. With one part of nitric acid and two parts of muriate of potash, a compound of the two acids is formed, which was formerly employed in the solution of gold. This is a *nitro-muriatic acid*, or *aqua regia*.

6. This salt is no longer employed in medicine. It is recommended to be used for the decomposition of nitrate of lime in the mother waters of nitre, to obtain the 958 Uses.

Potash, &c. the nitrate of potash, and also for procuring the crystallization of alum.

6. Hyper-oxymuriate or Chlorate of Potash.

959 Discovery and history. 1. This singular salt was the first known of all the combinations of this kind. Fourcroy mentions, that Dr Higgins prepared this salt, which he calls *nitre*, by passing the oxymuriatic acid gas into a solution of potash; but he seems to have paid no farther attention to it, except observing, that it detonated on red-hot coals (X). It was by Berthollet that it was first formed with any thing approaching to an intelligent view of its composition. And since its discovery, it has been particularly examined by Lavoisier, Dolfuz, Vanmons, Fourcroy, and Vauquelin, on the continent, and in England by Hoyle and Chenevix. It is prepared by introducing chlorine into a solution of the alkali. Two different salts are formed. One portion of the chlorine combines with the hydrogen of the water to form muriatic acid, and this acid combines with the alkali, forming a muriate of potash, which remains in solution. Another portion of the chlorine combines with the oxygen of the water to form chloric or hyper-oxymuriatic acid, and this combines with another portion of the potash to form the salt now under consideration, which makes its appearance in the form of crystals at the bottom of the liquid. The old mode of explaining these phenomena was, that one part of the oxymuriatic acid (or chlorine) gave oxygen to the other part, so that the portion which lost oxygen was converted into muriatic acid, and that which gained oxygen into hyper-oxymuriatic acid. The decomposition of water, however, is a more probable theory, whatever view we entertain of the nature of chlorine. After the salt has been removed from the solution in which it crystallizes, it may be purified by dissolving it in boiling water. The solution may be filtered, and allowed to cool, when the crystals are deposited.

960 Properties. 2. The crystals of this salt are most commonly in the form of square plates or of parallelopipeds, of a shining silvery white colour. The primitive form of the crystals is an obtuse, rhomboidal prism; they are very transparent and brittle; the taste is cool, pungent, and disagreeable, very different from that of nitrate of potash. When it is rubbed smartly, it phosphoresces, and gives out a great quantity of sparks or luminous traces.

3. It becomes yellow after long exposure to the air, but is otherwise not changed. It is soluble in about 20 parts of water at the ordinary temperature of the atmosphere; but boiling water dissolves about one-third of its weight, so that the whole is nearly crystallized by cooling.

961 Action of heat. 4. When this salt is exposed to heat, although it contains a considerable proportion of water of crystallization, it fuses quietly; and when the heat is increased, it gives out a quantity of oxygen gas nearly equal to one-third of its weight. This is the purest oxygen gas that can be obtained. Potash, &c.

5. But the most extraordinary effects of this salt are those produced by its action on combustible substances.

962 Of charcoal. *a*. If a small quantity of charcoal reduced to powder and this salt be rubbed together in a mortar, there is a slight explosion, and the charcoal is inflamed.

963 Of sulphur. *b*. Three parts of the salt with one of sulphur, rubbed together in a mortar, produce a violent detonation. Or, if the same mixture is struck with a hammer on an anvil, there is an explosion like the report of a pistol (Y).

964 Of phosphorus. *c*. The same effect is produced by employing phosphorus, and treating it in the same way with this salt. One or 1½ grains of the salt should first be reduced to powder, and brought together to one place in the bottom of the mortar, and then introducing the phosphorus, and rubbing it strongly on the salt, a violent explosion will instantly take place. A similar detonation may be produced with the same substances by percussion.

d. Three parts of the salt, one-half part of sulphur, and one-half charcoal, give more rapid and stronger detonations, with the evolution of a very bright flame. Detonations are also produced, by treating this salt with sugar, gums, oils, and some metallic substances.

965 Of acids. 6. When concentrated sulphuric acid is poured upon this salt, there is a considerable detonation; it is thrown about to a great distance, sometimes with a red flame; and there is exhaled a brown vapour, accompanied with a strong odour of oxymuriatic acid. Even when a lighted taper is brought into contact with the gas which is disengaged, it explodes more violently than when the acid first came in contact with the salt. In some cases, the explosion was so sudden and so violent, that it broke the vessels in which the mixture was made. This happened to Mr Hoyle of Manchester, and afterwards to Mr Chenevix; so that experiments with sulphuric acid and this salt should be conducted with small quantities, and with great caution. If concentrated sulphuric acid be poured on any of the mixtures of this salt with sulphur, charcoal, the metals, or with sugar, there is an instantaneous inflammation, the most brilliant that can be conceived. There is no detonation, but the combustion is extremely rapid, and the odour of oxymuriatic acid is perceptible. Concentrated nitric acid poured upon this salt, causes it to crackle and effervesce, but without explosion, and without flame; oxymuriatic acid gas is disengaged. With the muriatic acid, this last produces effervescence, with the evolution of a considerable quantity of

(X) "The acid elastic fluid (says Dr Higgins), which issues when two pounds of manganese are mixed and distilled with two or three of ordinary spirit of sea salt (muriatic acid), may all, except a small portion of phlogistic air, be condensed in a solution of fixed vegetable alkali; and the solution, thus impregnated, yields a considerable quantity of nitre, which crystallizes in the ordinary form, and detonates on red-hot coals. The solution at the same time yields regenerated sea-salt (muriate of potash)." *Higgins*, *Exper*. p. 181.

(Y) In experiments with this salt, the quantity employed should never exceed one or two grains, at least by those who have not been previously acquainted with its terrible effects.

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Potash, &c. of gas, similar in colour and smell to oxymuriatic acid gas; but in some of its properties considerably different. This gas is more rapidly absorbed by water. If a small jar or bottle be filled with this gas, and a slip of paper moistened with ether be introduced into it, and the mouth of the jar be slightly covered to prevent the contact of air, an explosion takes place, with a deposition of charcoal. A similar experiment may be made, by moistening a feather with oil of turpentine, and introducing it into the jar filled with this gas. It instantly takes fire with a red flame, and a great quantity of black smoke.

966 Composition. 7. According to the analysis of this salt, as given by Fourcroy, it consists of

Muriate of potash,	67
Oxygen,	33
	100*.

* Fourcroy Connaiss. Chim. iii. p. 226.

But according to the experiments of Mr Chenevix, its constituent parts are,

Acid,	58.3
Potash,	39.2
Water,	2.5
	100.0 †.

† Philos. Trans. 1802.

967 Uses. 8. This salt has been employed in bleaching; but other substances, particularly lime, have been substituted for the potash; so that at present it is more rarely used. It was proposed by M. Berthollet, when he first observed its effects, to employ it as a substitute for nitre in the manufacture of gunpowder; and when it was tried in the way of experiment, it seemed to be more powerful than the usual component parts of powder; but when it was attempted to be made in the large way, at Essone, in the year 1788, a dreadful accident, which happened by the spontaneous explosion of the mixture, in the death of M. le Tors, and Mademoiselle Chevraud, prevented its effects from being fairly proved. The danger which attends the trituration of the proper materials with this salt, has precluded any future attempt.

7. Fluate of Potash.

968 Little known. This salt has only been examined by Scheele and Bergman. It is the combination of fluoric acid with potash. When the acid is saturated, there is formed a gelatinous mass, which does not crystallize, and which has a slightly acrid saline taste. When it is evaporated to dryness, and exposed to the air, it attracts moisture. If it be strongly heated in a crucible, it fuses without effervescence. It then becomes caustic, is very soluble in water, and is decomposed by the sulphuric and nitric acids.

8. Borate of Potash.

This is a compound of the boracic acid and potash; but very little is known of its nature and properties. It is prepared by decomposing nitre by means of the boracic acid with the assistance of heat. The heat drives off the nitric acid, and there remains behind a white, half-fused porous mass, which is soluble in water, and yields, by evaporation and cooling, small crystals. The same salt may be formed by direct combination of the boracic acid and potash. This salt seems to be analogous in many of its properties to borax. Potash, &c.

9. Phosphate of Potash.

This combination of phosphoric acid with potash was announced and described by Lavoisier in the year 1774. Its properties have been more carefully investigated by Vauquelin; but from the investigation of other chemists it appears, that there are two salts formed from the same acid and base; the one in which they are neutralized, and the other in which there is an excess of acid.

a. Superphosphate of Potash, is formed by the direct combination of phosphoric acid and potash. This salt does not crystallize, but exists in a gelatinous form, and has a sweetish saline taste. Its specific gravity when dry, is 2.8516. It is very soluble in water; it attracts the moisture from the air, and becomes thick and viscid. 969 Properties.

1. When heated, it undergoes the watery fusion, then froths up, and becomes dry. When the temperature is raised, it melts into a transparent glass. The sulphuric, nitric, and muriatic acids decompose this salt. It has been applied to no use. 970 Action of heat.

b. Phosphate of Potash.—This salt may be formed by exposing pure potash and the former variety to a strong heat. The alkali combines with the excess of acid, and neutralizes the whole. By the action of heat, a white-coloured substance is obtained, which is the phosphate of potash. It is scarcely soluble in cold water, but soluble in hot water; and as the solution cools, there is deposited a shining gritty powder. This salt is very fusible. Before the blow-pipe it melts into a transparent bead, which becomes opaque on cooling. 971 Action of heat.

2. This salt is soluble in nitric, muriatic, and phosphoric acids, and forms with them thick glutinous solutions. It has not yet been applied to any use. 972 Of acids.

10. Phosphite of Potash.

This salt is prepared by dissolving carbonate of potash in phosphorous acid. The solution is evaporated, and it deposits crystals of the *phosphite of potash*. It has a sharp saline taste. It is crystallized in four-sided rectangular prisms with dihedral summits. It is very soluble in water, requiring only three parts of it for solution. It is not altered by exposure to the air.

11. Carbonate of Potash.

1. This salt, which is a compound of carbonic acid and potash, has been known under a great variety of names, in some measure descriptive of its properties, before its composition was discovered by Dr Black.

2. This salt is obtained from vegetable matters by burning, and washing out the salt and evaporating it; but the potash obtained in this way is not fully saturated with carbonic acid. After it has been purified from foreign ingredients, the saturated carbonate of potash may be prepared by exposing a pure solution of potash to carbonic acid gas, as it is disengaged from fermenting liquors. The carbonate of potash, as it is formed, crystallizes in the solution. The crystals may be taken out and dried upon unsized paper, and put up in well-closed bottles. Or it may be prepared by passing a current of carbonic acid gas, disengaged from the 973 Preparation.

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the carbonate of lime by an acid, into a solution of potash, in tall narrow bottles. The carbonate crystallizes at the surface of the liquid. It may also be obtained by the process of Berthollet, which is to distil with an unsaturated solution of potash, solid carbonate of ammonia, from which the potash carries off the carbonic acid, while the ammonia is disengaged in the state of gas.

974 Properties.

3. The carbonate of potash crystallizes in quadrangular prisms, terminated by quadrangular pyramids. It has a sweet alkaline taste, and changes vegetable blues to a green colour. The carbonate of potash requires very near four times its weight of water to dissolve it. At the boiling temperature it dissolves five-sixths of its weight. It does not crystallize by cooling, but only by slow evaporation. Pelletier has observed, that carbonate of potash dissolved in boiling water, gives out bubbles of carbonic acid gas, which shews that this salt loses a portion of its acid at this temperature. Its specific gravity is 2.012. When it is exposed to the air, it soon effloresces. When it is deliquescent, it is owing to part of the potash being unsaturated with carbonic acid.

975 Action of heat.

4. When it is exposed to a slight degree of heat, it loses its water of crystallization. Part of its carbonic acid also separates from it, but the whole cannot be driven off by this process. The last portions adhere with a very strong affinity.

976 Decomposed by sulphur.

5. When the carbonate of potash is heated with sulphur at a high temperature, the acid escapes in the state of gas; and there is formed a sulphuret, at the moment of the effervescence produced by the extrication of the acid.

977 By all acids.

6. All the acids hitherto discovered, have the property of separating the carbonic acid from potash, and of forming with its base particular salts. This salt loses more than a third of its weight, by being deprived of its carbonic acid. The component parts of carbonate of potash are, according to

	Bergman,	Pelletier,	Kirwan.
Carbonic acid,	20	43	43
Potash,	48	40	41
Water,	32	17	16
	100	100	100

978 Potash of commerce.

7. Potash of commerce is never saturated with carbonic acid. It is in this state that the carbonate of potash is generally employed. It has a stronger alkaline taste, and is more acrid and corrosive. It soon deliquesces when exposed to the air. It does not combine with a greater proportion of carbonic acid, merely by exposure to the atmosphere. For the purposes of the manufacturer it is of great importance to be able to ascertain, by a simple test, the quantity of pure potash in the different kinds which are brought to market. 979 Tests of its purity.
Mr Kirwan has proposed to discover the proportion of the salt, by determining the quantity of the earth of alum which is precipitated by the potash. A different method has been proposed by Vauquelin with the same view. His method is to saturate a given weight of the salt with nitric acid of known density. He has also made a number of experiments to discover the quantity of foreign ingredients in different kinds of potash. The following table shews the kinds of matter and the proportions in six species of potash *.

* *Annal. de Chim.* xl. 284.

	Potash.	Sulphate of Potash.	Muriate of Potash.	Insoluble Residue.	Carbonic Acid and Water.	Total.
Potash of Russia,	772	65	5	56	254	1152
Potash of America,	857	154	20	2	119	1152
American pearl-ash,	754	80	4	6	308	1152
Potash of Treves,	720	165	44	24	199	1152
Potash of Dantzic,	603	152	14	79	304	1152
Potash of Vosges.	444	148	510	34	304	1140

12. Arseniate of Potash.

980 Preparation.

1. The compound of arsenic acid and potash forms a salt which does not crystallize. When evaporated to dryness, this salt deliquesces in the air, gives a green colour to syrup of violets without changing the tincture of turnsole.

981 Properties.

2. When strongly heated it fuses into a white glass; and by the contact of silica and alumina in the crucible it passes to the acidulous state, having been deprived of part of the potash. Exposed to a red heat, in close vessels with charcoal, the arsenic is sublimed. It is decomposed by the sulphuric acid. It decomposes salts which have bases of lime and magnesia; forming in the solution arseniates of lime and magnesia *.

* Fourcroy *Connaiss.* v. 85.

982 With more acid crystallizes.

Superarseniate of Potash.—If the arsenic acid be added to the arseniate of potash till it no longer change the colour of violets, but reddens that of turnsole, it yields regular transparent crystals in quadrangular prisms, terminated by tetrahedral pyramids. This salt is the *arsenical neutral salt* of Macquer. He obtained it by decomposing the nitrate of potash, by means of the white oxide of arsenic, employing equal parts

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Potash, &c. parts of each. It is different from the former, because it crystallizes, reddens vegetable blues, and does not decompose salts with a base of lime or magnesia.

13. Tungstate of Potash.

983 Preparation. 1. This compound of tungstic acid and potash, is formed by dissolving the oxide of the metal in a solution of pure potash, or its carbonate. The alkali is not fully neutralized. The salt precipitates from the solution by evaporation, in the state of a white powder.

984 Properties. 2. It is distinguished by a caustic metallic taste, deliquesces in the air, and is soluble in water. This solution in water is decomposed by all the acids which produce a white precipitate. This precipitate is a triple salt, differing according to the nature of the acid which is employed †.

† Jour. de Mines, No. xix. p. 21.

14. Molybdate of Potash.

985 Preparation. 1. The compound of molybdic acid and potash is formed by detonating three parts of nitre and one of sulphuret of molybdena in a crucible; or by combining directly the molybdic acid with potash. The salt affords small irregular crystals, from its saturated solution in boiling water. According to Klaproth, the crystals are in the form of small rhomboidal plates, of a shining appearance, and heaped together.

986 Properties. 2. The taste is metallic. When exposed to the blow-pipe on charcoal, they fuse rapidly, without swelling up, and are converted into small globules, which are absorbed by the charcoal. In a silver spoon they are melted by the blow-pipe into small gray particles, which shrink on cooling, and deposite, during the process, a whitish powder. This salt is completely soluble in distilled water with the assistance of heat. It has an excess of acid, and is therefore an acidulous molybdate of potash, or supermolybdate of potash. It is decomposed by the nitric acid, which unites with the alkali, and precipitates the molybdic acid in the form of small crystals ‖.

‖ Annal. de Chim. viii. p. 106.

15. Chromate of Potash.

Nothing farther is known of the nature of this salt, than that it is easily formed by the combination of the chromic acid with potash, and that the crystals are of an orange colour, which sufficiently distinguishes them from the crystals of all other salts.

16. Columbate of Potash.

Columbic acid, digested for an hour with a solution of potash, affords this salt by evaporation and cooling, in the form of white glittering scales, resembling the concrete boracic acid. It is not changed by exposure to the air, has a disagreeable acrid taste, and is not very soluble in cold water; but after it is dissolved, the solution is perfect and permanent. It is decomposed by nitric acid, and precipitates in the form of white powder §.

§ Phil. Trans. 1802, p. 58.

17. Acetate of Potash.

1. This salt, which is a compound of acetic acid and potash, has been long known under a variety of names, which were derived from the substances from which it was obtained; or from its properties and effects.

987 Names. It was called *regenerated tartar*, *secret foliated earth of tartar*, *essential salt of wine*, *digestive salt of Sylvius*, *diuretic salt*. It may be formed by saturating carbonate of potash with distilled vinegar, and by evaporating the solution slowly to dryness. When the heat is too great, the acid is decomposed, and the salt assumes a brown colour. 988 Preparation.

2. This salt has a pungent, and somewhat alkaline taste. Exposed to the air, it becomes moist. It is very soluble in water, and if the solution be diluted, it is spontaneously decomposed in close vessels. Thick, mucous flakes are deposited. 989 Properties.

3. When it is heated, it melts and froths up, and is then decomposed and charred. When distilled in a retort, it yields an acid liquid, an empyreumatic oil, and a great deal of carbonic acid gas, and carbonated hydrogen gas. In this process the acid is completely decomposed; what remains in the retort is potash mixed with charcoal. According to Proust, this acid liquid contains ammonia and the prussic acid, and the carbonate and prussiate of potash are found in the retort ‡. 990 Action of heat.

‡ Ann. de Chim. xlii. p. 132.

4. This salt is decomposed by the strong acids. Distilled with sulphuric acid, it yields an acetic acid which is very acrid. The component parts of the acetate of potash are, according to Dr Higgins, 991 Composition.

38.5 Acid and water,
61.5 Potash.

100.0

18. Oxalate of Potash.

The compound of oxalic acid and potash may be formed by direct combination of the acid and the alkali. The oxalic acid combines in two proportions with potash, either in a small quantity, or in sufficient quantity to saturate the potash. When the acid is in excess, it is called the *acidulous oxalate*, or *superoxalate of potash*.

1. The oxalate of potash is formed by completely saturating the oxalic acid with potash; and by adding an excess of the alkali, crystals are obtained. 992 Preparation.

2. Without this excess of acid, the salt does not crystallize, but assumes a gelatinous form.

3. When this salt crystallizes, it is in the form of six-sided prisms, with two-sided summits. It is decomposed by heat, and also by the strong acids, which deprive it of a portion of the potash, and convert it into the acidulous oxalate. With an addition of oxalic acid the acidulous oxalate is also formed. 993 Properties.

Superoxalate of Potash.—1. This salt exists ready formed in the *rumex acetosa*, and the *oxalis acetosella*; hence it has been distinguished by the name of *salt of sorrel*, because it is extracted from this plant. 994 Exists in plants.

2. This salt may be formed by gradually combining potash with a saturated solution of oxalic acid. When a sufficient quantity of the alkali has been added, the salt is precipitated in crystals. Scheele discovered that the salt which is extracted from these plants, is in this state of combination. He proved the existence of the acid, and he shewed that the natural salt might be imitated by this process. 995 Preparation.

3. The crystals of this salt are in the form of small opaque parallelopipeds. The taste is acid, pungent, and bitter. It is not very soluble in cold water, but soluble 996 Properties.

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Potash, &c. soluble in about ten times its weight of boiling water. Exposed to the air, it undergoes no change. It is decomposed by heat.

19. Tartrate of Potash.

997 Preparation.
1. This is a compound of tartaric acid and potash. It has been long known under the name of *soluble tartrate*, and *vegetable salt*. It is formed by adding tartar or cream of tartar to a hot solution of carbonate of potash. The additions of the tartar are to be continued as long as there is any effervescence. The solution is then boiled for half an hour, filtered and evaporated, till a pellicle appears on the surface, and when it is allowed to cool slowly, it deposits crystals.

998 Properties.
2. The crystals of this salt are in the form of long, rectangular prisms, terminated by two-sided summits. This salt has a bitter taste. The specific gravity is 2.5567. Exposed to the air, it is deliquescent. Four parts of cold water dissolve one of the salt; hot water dissolves a greater quantity. When heated, it swells up and blackens. By distillation it yields an acid liquid, some oil, and a great quantity of gas. It leaves behind a considerable portion of alkali, mixed with charcoal. It is decomposed by the stronger acids, which deprive it of a portion of its potash, and reduce it to the acidulous tartrate, which is precipitated in the solution. By the addition of tartaric acid to the solution of this salt, it is also converted into the acidulous tartrate.

999 Tartar.
Supertartrate of Potash.—1. This is a compound of tartaric acid with potash, but with an excess of acid. The substance which is well known under the name of *tartar*, and which is found encrusted on the bottom and sides of vessels in which wine has been kept, is the supertartrate or the acidulous tartrate of potash;

1000 Purification.
but in this state it is very impure. It is purified by solution in boiling water, and by filtration while it is hot. When it cools, there is a copious deposition of the pure salt in crystals. These are the crystals or cream of tartar.

1001 Contains an alkali.
2. It had been long known to chemists, that potash could be obtained from tartar, by exposing it to a strong heat, which produced a controversy whether the alkali existed ready formed in the tartar, or whether it was not, in some way or other, produced by the action of heat during the process. This point was not fully settled till Scheele discovered the method of extracting the acid, the other component part of tartar.

1002 Properties.
3. The crystals of tartar are in the form of small irregular crystals, but chiefly of six-sided prisms. This salt has an unpleasant acid taste, is very brittle, and its specific gravity is 1.953. It requires for its solution 30 parts of boiling water, and 60 of cold water. It undergoes no change when exposed to the air, but in the solution in water the salt is decomposed, depositing a mucous matter, and leaving behind an impure carbonate of the alkali.

1003 Action of heat.
4. Exposed to heat, it melts, swells up, blackens, and the acid is totally decomposed. When it is distilled, an oily matter, and an acid liquid, which is an impure acetic acid, with a great quantity of carbonic acid, are obtained. This acid was formerly called *pyrotartarous acid* (z).

1004 Composition.
5. The component parts of tartar, according to Bergman, are,

Acid	77
Potash	23
	100

Or of the saturated salt,

Tartrate of potash	56
Acid	44
	100

By the analysis of Thenard, it is composed of

Acid	57
Potash	33
Water	7
	97 *

* Annal. de Chim. xxxviii. p. 39.

20. Citrate of Potash.

1005 Properties and composition.
This compound of citric acid with potash may be formed by combining together 36 parts of the acid with 61 parts of the carbonate of the alkali. This salt is very soluble in water, but little disposed to crystallize. It is very deliquescent. According to the analysis of Vauquelin, it consists of

Acid	55.55
Potash	44.45
	100.00

21. Malate of Potash.

This salt, which is a compound of malic acid and potash, is deliquescent, and very soluble in water, but its properties are little known.

22. Gallate of Potash.

The compound of gallic acid and potash has little solubility in water, but its other properties are unknown.

23. Benzoate of Potash.

This salt, composed of benzoic acid and potash, crystallizes on cooling, into small needles. A drop of the solution spread on the side of the vessel, as it evaporates, exhibits an arborescent crystallization. It has a sharp saline taste, is deliquescent in the air, and very soluble in water.

24. Succinate of Potash.

This compound of succinic acid and potash, forms crystals in three-sided prisms; the taste is bitter and saline; it deliquesces in the air, and is very soluble in water.

25.

(z) The pyrotartarous acid, the pyromucous, and the pyroligneous acids, were discovered by Fourcroy and Vauquelin to be nothing else than the acetic acid impregnated with extraneous substances, particularly with what is called an empyreumatic oil. See *Annales de Chimie*, xxxv. p. 161.

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25. Saccolate of Potash.

This is the compound of saclactic acid and potash. It forms small crystals, which are soluble in eight times their weight of boiling water.

26. Camphorate of Potash.

1006 Preparation. 1. This salt, which is a combination of camphoric acid and potash, may be formed by saturating a solution of carbonate of potash with camphoric acid. When the effervescence has ceased, the solution is to be evaporated with a gentle heat, when it affords crystals by cooling.

1007 Properties. 2. The camphorate of potash is in the form of regular hexagonal crystals, which are white and transparent; the taste is bitterish and slightly aromatic. Exposed to the air, when it is moist, the salt loses its transparency; but if the air is dry, there is no change. It is soluble in four parts of boiling water; but in water at the temperature of 60° requires 100 parts.

1008 Action of heat. 3. Exposed to heat before the blow-pipe, it burns with a blue flame, and the potash remains behind pure. When the heat is stronger, it froths up, the acid is sublimed, and it gives out a thick smoke, which is slightly aromatic.

1009 Of acids. 4. It is decomposed by the mineral acids. If the solution be much diluted with water, the decomposition is not perceptible; but if brought to the consistence of a thick syrup, the camphoric acid crystallizes in cooling. A new salt also is partially crystallized. By solution in cold water the acid may be separated.

1010 Of alcohol. 5. The camphorate of potash is soluble in alcohol, and it burns with a deep blue flame.

1011 Decomposition. 6. It is decomposed by, 1. Nitrate of barytes and of silver; 2. By all the salts whose base is lime; 3. Sulphate of iron; 4. Muriate of tin and of lead *.

* *Annal. de Chim.* xxvii. p 24.

27. Suberate of Potash.

1012 Preparation. 1. This salt, which is a compound of suberic acid with potash, is formed by saturating the acid with the crystallized carbonate of the alkali.

1013 Properties. 2. It crystallizes in four-sided prisms, which have unequal sides. The taste is bitter and saline. It reddens vegetable blues, and is very soluble in water.

1014 Action of heat. 3. Exposed to heat, it swells up and melts; the acid is dissipated, and the potash remains behind. It is decomposed by the mineral acids, which, combined with the potash, precipitate the suberic acid. It is decomposed also by barytes, by all the metallic salts, by sulphate and phosphate of alumina, by the nitrates and muriates of lime and of alumina †.

† *Ann. de Chim.* xxiii. p. 52.

28. Mellate of Potash.

The mellitic acid combines with potash, and forms this salt, which is fully saturated with the acid, and in this state it crystallizes in long prisms; but with an additional portion of acid, an acidulous mellate, or supermellate, is formed. This salt, as Vauquelin observes, also crystallizes; but the properties of these salts have not been much examined ‡.

‡ *Ibid.* xxxvi. p. 208.

29. Lactate of Potash.

This salt is only known as being deliquescent, and soluble in alcohol.

30. Prussiate of Potash.

The compound of prussic acid and potash, is formed by dissolving the alkali in the acid. The salt is very soluble in water, produces a green colour on vegetable blues, and with the application of a moderate heat, it is decomposed.

31. Sebate of Potash.

This salt has been little examined. According to the experiments of Thenard, it has little taste, is not affected by exposure to the air, and is decomposed by the sulphuric, nitric, and muriatic acids: the solution, if it be concentrated, becoming solid on the addition of the acid from the crystallization of the sebacic acid ‖.

‖ *Ibid.* xxix. p. 193.

32. Urate of Potash.

This compound of the uric acid with potash, is formed by triturating the acid with the alkali. The mixture assumes the form of a saponaceous paste, which is very soluble in water, when there is an excess of the alkali, but less so when the acid is saturated. This salt has little taste; when neutralized is not very soluble in water, and seems little disposed to crystallize. It is decomposed by the muriatic acid *.

* Fourcroy Connaiss. Chim. t. p. 221.

IV. Compounds of Potash with Inflammable Substances.

1. Potash is very soluble in alcohol. The solution assumes a red colour, and becomes acrid. It is by a solution of potash in alcohol, that the former is obtained in a state of purity; for the alcohol dissolves the potash, while other substances are deposited. By the application of heat to this solution, there is a partial decomposition of the alcohol. 1015 Alcohol.

2. Ether has no perceptible action on potash. 1016

3. Potash readily enters into combination with the fixed oils, but particularly with that class of them denominated *fat oils;* and forms with them very important compounds, namely, soaps. The compound with potash and the fat oils is a *soft* soap. Fixed oils.

4. Potash also enters into combination with the volatile oils, but in very small proportion, which likewise forms a species of soap. 1017 Volatile.

Sect. II. *Of Soda and its Combinations.*

1. Soda, the other fixed alkali, has been distinguished by a great number of different names. It was called *fossil* or *mineral alkali*, because it was supposed that it only existed in the mineral kingdom. It is the substance which is mentioned in Scripture as a detergent, under the name of *nitre*. 1018 Names.

2. This alkali exists in great abundance in different parts of the earth, and particularly on the surface of the soil in Egypt, where it is distinguished by the name of *natron*. It is also found on the walls of caves and places under ground, and old edifices. 1019 Found in the soil.

But the soda of commerce is generally obtained from different species of plants which grow on the sea-shore; and as it is prepared from them, it has received different names in different countries. The *salsola soda* yields this alkali in greatest abundance. This plant is called *barilla* in the Spanish language, and from this the 1020 Obtained from plants.

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 the soda which is prepared on the shores of that country, has been called *barilla ashes*. For the purposes of commerce also, soda is prepared in great quantities from the ashes of another tribe of marine plants, namely the *algæ*, and particularly from the *fuci*, all of which yield it in greater or less proportion. As it is prepared from these plants, it is known in France by the name of *varec*, and in Britain by the name of *kelp*. Soda exists in great abundance in the waters of the ocean. There it is in combination with the muriatic acid, forming the well-known compound of *common salt*.

1021 First distinguished from potash. 3. In many of their properties soda and potash approach very near to each other. They were accordingly considered as the same alkali, till, towards the middle of the 18th century, by the experiments of Duhamel, Pott, and Margraff, they were distinctly characterised, and the properties of each fully ascertained.

1022 Purification. 4. The soda of commerce is in very different degrees of purity, according to the care and attention with which it is prepared, and the purposes for which it is intended. To have it perfectly pure, it must be subjected to a similar process with those which have been already detailed for the purification of potash; and by means of these processes it may be procured in a solid and crystalline form.

1023 Properties. 5. When soda is in a state of purity, it is usually in the form of solid plates, of a grayish white colour, and the taste exactly similar to that of potash. It is also extremely caustic and corrosive. By slow evoporation from a solution in alcohol, it assumes the form of prismatic crystals; but these, when exposed to the air, very soon effloresce, and fall to powder. Soda changes the blue colour of vegetables to green. Its specific gravity is 1.336.

1024 Action of heat. When it is exposed to heat, it softens, and readily melts. It liquefies by the action of heat like an oily matter, and when it becomes red-hot, boils, and is reduced to vapour, which is the soda unchanged, extremely acrid, and corroding the skin when it comes in contact with it.

1025 Of air and water. 6. When exposed to the air, it first becomes moist and soft, by absorbing water and carbonic acid; but when the air becomes dry, it effloresces and falls into a powder; and in this respect is sufficiently distinguished from potash. Soda has a very great affinity for water. When the dry alkali is moistened with water, it is absorbed, and becomes solid, with the extrication of caloric. When more water is added, it dissolves, and also gives out heat, and a peculiar odour, which is no doubt owing to a portion of the alkali raised in the state of vapour along with the water.

1026 Composition. 7. Soda is a similar compound to potash, and the decomposition is effected by the same process, though somewhat more difficult. It is an oxide of sodium.

1027 Properties of sodium. Sodium is a soft metalloid, less fusible than potassium, its melting point being about 180°. It attracts oxygen slowly from the air. It rapidly decomposes water by combining with its oxygen. Its different chemical habitudes are closely analogous to those of potassium.

8. The affinities of soda are the same with those of potash.

9. Soda is employed for many similar purposes as potash. On account of some of its qualities, it is preferred to potash, in many manufactures, because it is less acrid and corrosive, and is therefore less apt to destroy the texture of animal and vegetable matters to which it is applied.

I. Action of Phosphorus on Soda.

Soda scarcely enters into combination with phosphorus. 1028 Phosphorus. There is no phosphuret formed either by the dry or humid way; but when phosphorus is boiled with a pure solution of soda, phosphorated hydrogen gas is evolved in the same way as when it is treated with potash.

II. Action of Sulphur on Soda.

Soda readily combines with sulphur by simple trituration, by fusion, and by the humid way. 1029 Sulphur. In the two first cases, there is formed a sulphuret of soda, which may be decomposed by heat, and by the acids, and which decomposes water in the same way as the sulphuret of potash. By the humid way there is formed a hydrogenated sulphuret of soda, which has an extremely fetid odour, and emits, by the action of the acids which decompose it, sulphurated hydrogen gas.

Hydrosulphuret of Soda.

This may be prepared in the same way as the hydrosulphuret of potash. It forms a crystallized salt in the shape of four-sided prisms, terminated by quadrangular pyramids. The crystals are colourless, inodorous, and very soluble in water. When this salt is exposed to the air, it deliquesces, and becomes of a green colour. It is decomposed by the action of acids. Soda, it would appear, has less affinity for sulphur and sulphurated hydrogen than potash.

III. Compounds of Soda with the Acids.

1. Sulphate of Soda.

1. This salt, which is a compound of sulphuric acid and soda, is well known under the name of *Glauber's salt*, from the name of Glauber, a German chemist, who discovered it, in examining the residuum of the decomposition of common salt by means of sulphuric acid. 1030 Names. It has also been called the *admirable salt of Glauber*, *vitriolated mineral alkali*, and *vitriol of soda*.

2. This salt may be obtained by the direct combination of sulphuric acid and soda. 1031 Preparation. But it is more commonly prepared by the decomposition of muriate of soda or sea salt, by means of sulphuric acid. The solution is then to be filtered, purified, and crystallized in the usual way.

3. It crystallizes by slow evaporation, in transparent six-sided prisms, terminated by two-sided summits; 1032 Properties. but the crystals are seldom regular, and the sides of the prisms are furrowed. The taste is cool, bitter, and nauseous. The specific gravity is 1.4457 *.

* Manches. Mem. vol. xxviii. p. 12.

4. When it is exposed to the air, especially when the air is dry, it effloresces, 1033 Action of air. which is owing to the escape of the water of crystallization. It loses about 0.3 of its weight. It is very soluble in cold water, and it requires only $\frac{1}{4}$ths of its weight of boiling water.

5. When it is exposed to heat, it melts, on account of the great quantity of water of crystallization 1034 Of heat. which it contains; and this is called the *aqueous fusion*. Afterwards it dries when the water is evaporated. It loses about .58 of its weight. To melt it afterwards, it

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Soda, &c. it must be exposed to a red heat long continued, which is called the *igneous fusion*. After it is cooled, it is found to have suffered no change. When water is added, it returns to its former state.

6. It is decomposed by means of charcoal, which at a red heat converts it into sulphuret of soda, by de-
1035 Composition. priving the acid of its oxygen. The component parts of this salt, according to Bergman, are

Acid	27
Soda	15
Water	58
	100

But according to Mr Kirwan, it is composed of

	Crystallized.		Dried at 700°.
Acid	23.52	-	56
Soda	18.48	-	44
Water	58.	-	0
	100.00		100 *

* Nichol. Journ. iii. p. 215.

It is decomposed by barytes; and by potash, but less powerfully. Lime and strontites are also capable of producing a partial decomposition in the humid way, and in contact with the air.

7. This salt is a good deal employed in medicine, as a purgative; in chemistry, for the purpose of decomposing other substances; and in the arts, for the extraction of soda.

2. Sulphite of Soda.

1036 Discovery. 1. This salt, which is a compound of sulphurous acid and soda, was first taken notice of by Berthollet. It is prepared by passing sulphurous acid gas into a saturated solution of carbonate of soda. The sulphite of soda is precipitated at first, in a confused mass of very small crystals, which are re-dissolved in warm water,
1037 Properties. and crystallize again on cooling.

2. The crystals of sulphite of soda are in four-sided prisms, two broad, and two narrow, terminated by two-sided summits. They are perfectly transparent. The taste is cool and sulphureous. The specific gravity is
1038 Action of the air. 2.9566.

3. Exposed to the air, it effloresces, and the powder formed on the surface is converted into a sulphate. It
1039 Of water. is extremely soluble in water. Boiling water takes up more than its own weight. It crystallizes again on cooling, but sometimes the solution is formed into a single mass when it is exposed to the air; and if quickly cooled with agitation, it affords nothing but needle-formed crystals. This solution exposed to the air is
1040 Of heat. converted into the sulphate.

4. This salt readily undergoes the aqueous fusion; if the heat be increased, a portion of sulphur is driven off, and it is converted into a sulphate.

5. It is decomposed by means of the acids, which disengage the sulphurous acid in the state of gas. The oxymuriatic acid gas, brought into contact with a solution of this salt in water, instantly converts it into sulphate. It is decomposed by barytes, lime, and potash; by the sulphates of lime, of ammonia, and of magnesia.

6. The component parts of this salt have been found Soda, &c.
by analysis to be, 1041 Composition.

Sulphurous acid,	31
Soda, -	18
Water. -	51
	100

It has not been applied to any use.

3. Nitrate of Soda.

1. This compound of nitric acid and soda was for- 1042 Names.
merly known by the name of *cubic nitre*, and *rhomboidal nitre*. It is prepared by the direct combination of the acid with the alkali; or by decomposing the muriate or carbonate of soda by nitric acid.

2. It crystallizes in the form of rhomboids and prisms. 1043 Properties.
The taste is cooling, but more bitter than that of the nitrate of potash.

3. The specific gravity is 2.0964. Exposed to the air, it attracts moisture in a slight degree. It is soluble in three parts of cold water, and in less than its own weight of boiling water.

4. When it is thrown on red-hot coals, it decrepitates 1044 Heat.
slightly; it is not so fusible as nitre, but it is also decomposed, and gives out oxygen gas mixed with azotic gas.

5. In its decomposition it is similar to the nitrate of potash. It detonates, however, less powerfully with combustible bodies, and burns them with less facility. It is decomposed by barytes and potash.

6. The proportions of its constituent parts are, ac- 1045 Composition.
cording to Bergman,

Acid,	43
Soda,	32
Water,	25
	100

According to Mr Kirwan,

	Dried in a heat of 400°.		After being ignited.
Acid,	53.21	-	57.55
Soda,	40.58	-	42.34
Water,	6.21	-	00.00
	100.00		99.89 †.

† Nichol. Jour. iii. p. 215.

4. Nitrite of Soda.

Chemists are not acquainted with the properties of this salt, although it is known to be formed after the partial decomposition of nitrate of soda by means of heat.

5. Muriate of Soda.

1. The muriate of soda, which is a compound of mu- 1046 Common salt.
riatic acid and soda, of all the other salts, from its great abundance in nature, and its valuable uses, was the
earliest known under the name of *salt*. It has been 1047 Names.
distinguished by the names of *common salt*, *kitchen salt*,
sea-salt, and sometimes *sal gem*, *rock salt*. 1048 Abundance in nature.

2. This salt, which is found in such abundance in nature,

nature, is never formed by art. In some parts of the world it exists in the bowels of the earth in large masses, from whence it is dug out, and simply reduced to powder, to be applied to use. But to obtain it from the waters of the ocean, in which it exists in different proportion, according to the temperature, the climate, and other circumstances, it must be extracted by evaporation, which is effected by different processes, according to the strength of the solution, and the art of the manufacturer. In some parts of the world, all that is done is to collect the salt as it forms on the shores of the sea, or on the rocks, by the evaporation of the water; but, in general, some art is necessary, even when the salt is obtained by spontaneous evaporation. On the coasts of France, Spain, Portugal, and the shores of the Mediterranean, the sea water is admitted into ponds during the flowing of the tide, and its return is prevented by sluices which are shut. It is then evaporated by the heat of the sun; and, as this evaporation is gradual and slow, the salt crystallizes in large cubes, and it is known in commerce by the name of *bay salt*, from the circumstance of its having been formed in creeks and bays of the sea.

1049 By art. 3. But as this process can only be followed in those climates where there is a sufficient degree of temperature to promote the evaporation speedily, artificial heat is generally employed in the manufacture of salt. Sometimes the water is received in large ponds or flat vessels, where it is allowed to evaporate for some time in the open air. It is afterwards boiled in flat iron pans; and, during the boiling, the impurities which rise to the surface are removed. When the water is sufficiently concentrated by the evaporation, a pellicle forms on the surface, which is the crystallization of the salt. This falls to the bottom, and another pellicle forms, till the whole of the salt is crystallized. The purity of the salt and the size of the crystals depend on the slow evaporation; and hence it is, that the purest salt, as it is manufactured in Britain, is that which is called *Sunday salt*. This is obtained from the last quantity of water which is boiled on the Saturday night; and as it has time to cool slowly, the evaporation is more gradual, and the crystals are purer and larger.

1050 Purification. 4. But in this state the muriate of soda is far from being pure. A very ingenious method has been proposed for the purification of sea-salt by Lord Dundonald. The salts with which common salt is impregnated, are more soluble in water than the salt itself, and they dissolve in much greater proportion in hot than in cold water. But common salt is nearly equally soluble in both. On this principle, therefore, the process proceeds. A quantity of salt to be purified is put into a conical vessel or basket, which is slightly stopped at the apex, so that the water may pass through. A saturated solution of common salt is then prepared. This solution of salt is poured boiling hot over the salt in the basket. It can dissolve none of the common salt in the basket, because it is already saturated; but, as it passes through, it dissolves the other salts, and carries them along with it. It was found by experiment, that a saturated solution of 1 lb. of common salt poured upon 10lbs. removes about $\frac{4}{5}$ths of all the foreign salts with which it is impregnated.

1051 By other processes. 5. But, even after this process, the salt is not perfectly pure for the purposes of chemistry. For this purpose it may be dissolved in four parts of cold water. Filter the solution, to separate any substances with which it is mixed. Pour into it some drops of a solution of soda, till no farther precipitate is observed. The fluid is then to be evaporated, and the salt, as it forms on the surface in small cubical crystals, may be extracted; or it may be obtained in larger crystals by slow evaporation.

It may also be purified, by dropping into a solution of common salt a solution of muriate of barytes, and then of carbonate of soda, as long as any precipitate is formed. The liquid may then be filtered and evaporated, till the solution crystallizes.

6. The muriate of soda crystallizes in perfect cubes; 1052 Properties. but from these there are several deviations in the form of its crystals. Sometimes the angles of the cubes are truncated; sometimes they are in the form of octahedrons; which is the case when common salt is dissolved in human urine, and allowed to evaporate spontaneously. But the primitive form of the crystal, as well as of the integrant particle, according to Hauy, is the cube. The taste is sweetish and agreeable, and is that which is properly called *salt*, with which all similar tastes are compared. The specific gravity is 2.120. When all the water that can be driven off is expelled, it is considered as a chloride of sodium, in the same way as has been mentioned of muriate of potash. See N° 956.

7. It undergoes no change by exposure to the air. 1053 Action of air, Common salt attracts moisture from the atmosphere; but this is owing to an impregnation of other salts which are deliquescent. These salts are muriate of magnesia, sulphate of magnesia, and sulphate of lime. It is from these that it is to be purified by the processes which have been described above. 1054 and water. It is soluble in little more than $2\frac{1}{2}$ times its weight of water; and it is almost equally soluble in hot and cold water.

8. When it is exposed to a strong heat, it decrepitates and gives out its water of crystallization. It melts in a red heat, and rises in the air in the state of white vapour; but it is unchanged; for if this vapour be collected by condensing it in the cold, it is found to possess all the properties of common salt.

9. The muriate of soda is decomposed readily by 1055 Decomposition. sulphuric acid, as well as by several other acids which have a stronger attraction for its base than the muriatic acid; or by the aid of double affinity, when an acid is in combination with a base, which at the same time acts on the muriatic acid. 1056 By sulphuric acid. It is by means of the sulphuric acid that the chemist procures muriatic acid from the muriate of soda. Sometimes the salt is decomposed by the same acid to obtain the soda. The sulphuric acid combines with the soda, and forms sulphate of soda, while the muriatic acid is disengaged, and that it may not be lost, it is conveyed into a leaden chamber, which contains a solution of ammoniac, where it forms sal ammoniac. The sulphate of soda is exposed to strong heat in a furnace, to drain off any portion of sulphuric acid that it may contain. It is then mixed with its own weight of chalk, and half its weight of charcoal in powder. The mixture is strongly heated in a reverberatory furnace, and occasionally stirred to permit the escape of gas and sulphur, which fly off. When the mass cools, it becomes solid and black.

Soda, &c. black. The charcoal, in decomposing the sulphuric acid of the sulphate of soda, sets the sulphur free, which combines with the lime of the carbonate of lime, and is partly sublimated; while a part of the carbonic acid combines with the soda, so that the product is a mixture of carbonate of soda, of lime and charcoal, analogous to the soda of commerce. In this way 0.58 of crude soda may be extracted. Other acids, as well as the sulphuric, such as the acetic, the phosphoric, and boracic, have been proposed to be employed with the same view; or indeed, any acid which has a stronger affinity for the soda than the muriatic acid, and is not decomposed with much difficulty.

10. But these processes are not sufficiently economical to answer the purposes of the manufacturer: Other processes have, therefore, been proposed and tried with the same view; but scarcely any has succeeded. This salt is very readily decomposed by barytes or potash, which combines with the muriatic acid, and sets the soda free; but the expence of preparing these substances far exceeds the price of the soda in the market, so that they cannot be employed to advantage.

1057 By lime. It has been proposed to decompose sea salt by means of lime, for obtaining the soda. Soda is separated from the acid by mixing the common salt with lime, in the form of paste, and by exposing it to moisture. In a short time the soda appears on the surface in the state of efflorescence. Scheele, it is observed by Berthollet, was the first who noticed the decomposition of the muriate of soda by means of lime. He explains this decomposition by showing, that lime acts on salts with fixed alkaline bases. It decomposes a small part of the muriate of soda, with which it is in contact, and the soda, eliminated by this means, combines with the carbonic acid of the atmosphere. The carbonate of soda effloresces, so that it opposes all resistance to the action of the lime, and the decomposition of the muriate of soda continues until it is impeded by the quantity of muriate of lime formed. It is in this way that the same philosopher accounts for the formation of soda in the soil of Egypt. The circumstances necessary for this are, 1st, A sand containing a great quantity of carbonate of lime; 2d, moisture; and 3d, muriate of soda; and these circumstances are found to exist in those places where there is an abundant production of soda *. A manufactory for the purpose of extracting soda from sea salt, by means of lime, was established in France by Guyton.

* Research. p. 59, and 112.

1058 By lead. 11. Common salt is decomposed for the purpose of obtaining the soda, by means of litharge. In a mixture of four parts of litharge, and one of sea salt, with a little water, in the course of a few hours, a decomposition of the salt is effected. The muriatic acid of the salt combines with the lead, and is precipitated; while the soda remains in the solution, from which it may be separated by filtration and evaporation.

1059 By iron. It has been found too, that sea salt may be decomposed by other metallic substances. Scheele observed, that iron produced this effect. By dipping a plate of iron in a solution of salt, and exposing it in a moist place, it was incrusted with soda. From other experiments it appears, that this decomposition may be effected by means of copper and zinc.

1060 Composition. 12. Muriate of soda, according to Bergman, is composed of

Acid	52
Soda	42
Water	6
	100

According to Kirwan, when dried in the temperature of 80°, it is composed of

Acid	38.88
Soda	53.00
Water	8.12
	100.00

13. Common salt may be regarded almost as a necessary of life. It is the most useful of all substances for the preservation of animal matters which are intended for food. It is probable that it is highly useful, not merely as a seasoning for food, of which it is one of the most agreeable, but also to promote its digestion. It is also employed in many arts, as in metallurgy, in dyeing, and in the enamelling of stoneware. 1061 Uses.

6. Hyperoxymuriate, or Chlorate of Soda.

1. This salt is prepared in the same manner as the combination of this acid with potash. It is, however, difficult to obtain it pure, as it has nearly the same degree of solubility in water as the muriate of soda. It is soluble in three parts of cold and less of warm water. It is also soluble in alcohol, and it seems to communicate a greater degree of solubility to the muriate of soda. 1062 Preparation.

2. The crystals of this salt are in the form of cubes, or in rhomboids. It produces the sensation of cold in the mouth, and its taste is easily distinguished from muriate of soda. It is decomposed by heat, by combustible bodies, and by acids, in the same manner as the hyperoxymuriate of potash. 1063 Properties.

3. This salt is composed of 1064 Composition.

Hyperoxymuriatic acid	66.2
Soda	29.6
Water	4.2
	100.0*

* Philos. Trans. 1802. p. 144.

7. Fluate of Soda.

1. This salt, which is a compound of fluoric acid and soda, is formed by saturating the acid with the alkali. If the solution be evaporated till a pellicle appears, crystals of fluate of soda are obtained. 1065 Preparation.

2. These crystals are in the form of small cubes, have a bitter and astringent taste, are not deliquescent, and not very soluble in water. They decrepitate on hot charcoal, and melt before the blow-pipe into a semitransparent globule. 1066 Properties.

3. The concentrated acids disengage the fluoric acid with effervescence. This salt is also decomposed by lime-water, barytes, and magnesia.

8. Borate of Soda.

This salt, a compound of the boracic acid and soda, is formed by saturating the acid with the alkali; but nothing is known of its nature and properties. The specific

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Soda, &c. specific gravity is 1.1351. But the combination of soda with this acid, which is a natural production, has been particularly examined.

Sub-borate of Soda, or Borax.

1067 History. 1. This substance has been long known. Indeed it is supposed, that the ancients were acquainted with it, and that they employed it for several purposes, under the name of *chrysocolla*, which is mentioned by Pliny. It received this name from them, it is supposed, from knowing its property of soldering gold and the other metals. The name borax is derived from some of the oriental languages. Although borax was the subject of research among the alchemists and earlier chemists, yet nothing was known of its nature and composition till the beginning of the 18th century. It was then decomposed by Homberg, by exposing it to heat with sulphate of iron. The acid was separated by sublimation, and long after known by the name of the *sedative salt of Homberg*. In 1732 its real composition was discovered by Geoffroy. He obtained the acid crystallized in the humid way. In 1748 Baron decomposed borax by means of the vegetable acids, and he completed the knowledge of its composition, by forming it with the acid and the alkali. Bergman afterwards shewed, that borax is a salt with excess of soda; and to be neutralized, it requires one half of its weight of boracic acid.

2. Borax is a natural production of the earth in many parts of the world. It is formed at the bottom of some lakes in Persia, the Mogul territory, in Thibet, in China and Japan. It has been also found in some lakes in Tuscany. In the East Indies it is known under the name of *tincal*, and in commerce under that of *crude borax*. In this state the borax is in the form of small, semitransparent, greenish crystals, intermixed with a greasy matter, of a dirty gray colour, and of a sweetish alkaline taste.

1068 Purification. 3. The purification of borax was originally in the hands of the Venetians; but it has since been practised, and now almost exclusively, by the Dutch. Their process is not exactly known. Valmont-Bomare, who visited one of these places in Holland, says, that 80 parts of purified borax are obtained from 100 of the crude materials; and to extract the salt completely, from eight to twelve solutions and crystallizations are necessary; that all the vessels employed in the purification of this salt, are either of lead, or covered with lead; but he adds, that one part of the process was concealed from him, and he suspects that lime-water may have been employed in this part of the process.

1069 Properties. 4. Borax, after being thus purified, is in the form of compressed six-sided prisms with three-sided summits. The taste is sweetish, and perceptibly alkaline. It changes the vegetable blues to a green colour. The specific gravity is 1.742. It effloresces slightly in the air, and is soluble in water. Twelve parts of water of the temperature of 60° dissolve one of borax. Six parts are only necessary at the boiling temperature.

1070 Action of heat. 5. When borax is exposed to heat, it readily melts. As the water of crystallization flies off, it swells up and acquires a greater bulk, and assumes the form of a porous mass. By this process it loses more than one-third of its weight, and in this state it is called *calcined borax*. When it is exposed to a red heat, it is converted into a transparent glass, which is soluble in water.

6. Borax is decomposed by all the acids which have a stronger affinity for the soda. It is by means of the sulphuric and the nitric acids, that boracic acid is obtained from borax. 1071 Of acids.

7. The component parts of borax, according to Kirwan, are 1072 Composition.

Boracic acid	36
Soda	17
Water	47
	100

It is supposed that only five parts of the soda are saturated with the acid, and that the other twelve parts form the excess of alkali which is contained in the salt.

8. Borax is much employed in the arts, as a flux for metals, and to promote the soldering of the more precious metals. It is also employed by the mineralogist, as a flux for treating minerals by the blow-pipe. Calcined borax is employed in medicine as an absorbent *. 1073 Uses.

* Fourcroy Connaiss. Chim. iii. p. 325.

9. Phosphate of Soda.

1. This compound of phosphoric acid and soda was the first discovered of the combinations of phosphoric acid. Margraaf was the first who extracted it from human urine, then in combination with ammonia, forming a triple salt, which was known by the name of *fusible* or *microscomic salt*. Haupt afterwards obtained it separate, and distinguished it by the name of *sal mirabile perlatum*, or wonderful perlated salt, on account of its pearl-like colour. At last the younger Rouelle discovered that soda was one of its constituent parts. By some it was supposed, that the acid was different from the phosphoric, because no phosphorus could be obtained from it. To this acid Bergman gave the name of perlated acid; but by the analysis of Klaproth, it was proved that this salt consists of phosphoric acid and soda, with an excess of acid. 1074 History.

2. This salt is prepared by saturating the liquid acid phosphate, which is obtained from burnt bones by means of the sulphuric acid, with carbonate of soda, which must be added in excess. The carbonate and a little phosphate of lime are precipitated in the solution, which must be filtered and evaporated till a thin pellicle appears on the surface. The phosphate of soda is crystallized by cooling. Or it may be obtained by the direct combination of phosphoric acid and soda, which must also be added in excess. 1075 Preparation.

3. The phosphate of soda crystallizes in lengthened rhomboids, whose angles are often truncated, and sometimes it affords rhomboidal prisms, and several other varieties. The excess of soda is necessary, to make it assume a regular form, and thus it changes vegetable blues to a green. The specific gravity is 1.33. It has a sweetish, saline taste, similar to that of common salt. 1076 Properties.

4. It effloresces in the air, and is very soluble in water. Four parts of water at the temperature of 60°, and one half its weight of boiling water, are sufficient to dissolve it. 1077 Action of water.

5. The phosphate of soda, exposed to heat, undergoes the watery fusion. In a red heat it melts, and is converted, 1078 Of heat.

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Soda, &c. converted, on cooling, into a milky white glass. By the action of the blow-pipe on charcoal, it melts into a globule, which is transparent while it is hot, but becomes opaque on cooling, and assumes the polyhedral form when it becomes solid.

1079 Of acids. 6. The sulphuric, nitric, and muriatic acids decompose it partially, and convert it into the acidulous phosphate of soda.

1080 Uses. 7. Since the properties of this salt was discovered, it has become an object of considerable importance, on account of the various uses to which it has been applied. It was introduced into medicine by Dr Pearson, and is found to be a mild laxative, particularly agreeable on account of its taste, as it may be taken in broth, as a substitute for common salt. It is employed by mineralogists as a test for the fusion of mineral substances by the blow-pipe, and in soldering, as a cheap substitute for borax.

10. Phosphite of Soda.

1081 Preparation. 1. This compound of phosphorous acid and soda, may be formed by the direct union of the acid and alkali in solution; and by evaporation crystals may be obtained.

1082 Properties. 2. This salt crystallizes sometimes in four-sided prisms with unequal faces; sometimes in long rhomboids, or in the form of feathers. The taste is cool and sweetish. It effloresces in the air, and is soluble in two parts of cold water, and little more soluble in warm water; so that it crystallizes by evaporation rather than in cooling.

1083 Action of heat. 3. It melts readily under the blow-pipe, gives out fine phosphoric light, and is converted into a glass which continues transparent while it is hot, but becomes opaque when it cools.

1084 Composition. 4. The component parts of this salt are,

Phosphorous acid	16.3
Soda	23.7
Water	60.0
	100.0

5. This salt is easily decomposed by lime, barytes, and magnesia. It decomposes the sulphates, nitrates, and muriates of lime, of barytes, strontites, and magnesia. It has not yet been applied to any use.

11. Carbonate of Soda.

1085 History. 1. This salt, which is a compound of carbonic acid and soda, was long applied to various uses, before its nature and composition were known; nor was it perfectly understood till the discovery of Dr Black, which shewed the two states in which the alkali exists; in the caustic or pure state, and in the mild state, when it is combined with fixed air, or carbonic acid. The different names under which it is known, have been already mentioned in treating of soda. It is found in great abundance in Egypt, where it effloresces on the soil, and is distinguished by the name of *natron*. In a similar state of efflorescence, the carbonate of soda is found in subterraneous places, and on the walls of buildings; but it is chiefly extracted, as has been already observed, from sea-plants, especially from those which belong to the genus of *fuci*.

1086 Preparation. 2. Carbonate of soda may be obtained by dissolving a quantity of the soda of commerce with three or four times its weight of pure cold water, and then by filtering the liquor, and evaporating till a slight pellicle is formed. This pellicle, which consists of small cubes of common salt, is to be removed. The heat is to be continued as long as any pellicle is formed, after which the liquid is set by to cool, and the carbonate of soda crystallizes. 1087

3. The form of the crystals of carbonate of soda are irregular or rhomboidal octahedrons, formed by two quadrangular pyramids, truncated near the base, which exhibits dicahedral solids, with two acute and two obtuse angles. The taste is slightly acrid; it converts vegetable blues to a green colour, and its specific gravity is 1.3591. Properties. 1088

4. The carbonate of soda effloresces very rapidly in the air. It is soluble in two parts of cold, and little more than its weight of boiling water. It crystallizes on cooling; but to obtain regular crystals, the evaporation must be slow and spontaneous. Action of water. 1089

5. When exposed to heat, it undergoes the watery fusion, and if the heat be continued, it passes into the igneous fusion. It is somewhat more fusible than the carbonate of potash, which renders it preferable in the manufacture of glass. Of heat.

6. In its decomposition by other substances, it is exactly similar to the carbonate of potash. 1090

7. The component parts of carbonate of soda are, according to Composition.

	Bergman.	Kirwan. In crystals.	Kirwan. Dry.
Carbonic acid	16	14.42	40.05
Soda	20	21.58	59.86
Water	64	64.00	00.00
	100	100.00	99.91

12. Arseniate of Soda.

1. This is the compound of the arsenic acid with soda; and when the acid is saturated with the alkali, the salt crystallizes.

2. According to Scheele the form of the crystals of this salt is like those of the acidulous arseniate of potash. Pelletier observes that the arseniate of soda crystallizes in six-sided prisms, terminated by planes perpendicular to their axis. In other respects it is similar to the arseniate of potash, being decomposed by charcoal, by the acids and the earths. With an excess of acid, it does not crystallize, but becomes deliquescent.

13. Tungstate of Soda.

1. This salt, which is the compound of tungstic acid and soda, may be formed by dissolving the oxide of tungsten in a solution of pure soda, or carbonate of soda. By evaporating the solution, crystals of tungstate of soda are obtained. 1091 Preparation.

2. The crystals of this salt are in the form of elongated, six-sided plates. The taste is acrid and metallic. It is soluble in four times its weight of cold water; and boiling water dissolves one half of its weight. It restores the colour of turnsole which has been reddened by an acid. 1092 Properties.

3. This salt is decomposed by the sulphuric, nitric, muriatic, acetic, and oxalic acids. They form a white triple 1093 Action of acids.

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triple salt, which is also produced by lime-water. The phosphoric acid produces no change, and if the sulphuric acid be afterwards added, it no longer causes a precipitate. The tungstate of soda is not decomposed by the sulphate of potash or of magnesia. The muriates of lime and barytes occasion a white precipitate. The solution of tin, and all other metallic solutions, also decompose it *.

* Jour. de Mines, No. 19. p. 21.

14. Molybdate of Soda.

15. Chromate of Soda.

The chromic acid combines with soda, and forms a salt, the crystals of which are of an orange colour, but its other properties are unknown.

16. Columbate of Soda.

Columbic acid enters into combination mith soda, but little is known of its properties.

17. Acetate of Soda.

1094 Preparation and properties.

1. The combination of the acetic acid with soda was formerly known by the name of *crystallized foliated earth*. This salt is prepared by saturating the acetic acid with carbonate of soda. The solution is then filtered, and evaporated till a slight pellicle appear on the surface; and when it is set by to cool, crystals are deposited.

2. The crystals of acetate of soda are in the form of striated prisms, like those of sulphate of soda. It has a bitter, pungent taste, is not deliquescent in the air, and is soluble in about three parts of cold water. The specific gravity is 2.1. When exposed to heat it is decomposed, being first deprived of its water of crystallization. After distillation, the residuum has the property of phosphorus. It is decomposed by barytes and potash †.

† Fourcroy Connais. Chim. tom. viii. p. 198.

18. Oxalate of Soda.

The oxalic acid is capable of forming an acidulous salt with soda; but when it is fully saturated, the oxalate of soda thus formed is difficult of crystallization. If two parts of crystallized carbonate of soda are dissolved in one part of oxalic acid, part of the oxalate of soda is precipitated, and what remains in the solution, being evaporated, affords crystals in the form of small grains. This salt is more soluble in warm than in cold water, and gives a green colour to the syrup of violets. It is decomposed by potash. In other respects it resembles the oxalate of potash.

19. Tartrate of Soda.

This compound of tartaric acid and soda is formed by saturating the acid with the alkali. The form of the crystals of this salt is that of fine needles. The specific gravity is 1.7437. This salt combines with another portion of acid, and forms an acidulous tartrate or supertartrate of soda, which is not more soluble in water than the acidulous tartrate of potash.

20. Citrate of Soda.

1. This salt, which is a compound of citric acid and soda, is formed by directly combining the acid and alkali.

2. It crystallizes in six-sided prisms, which are not terminated by a pyramid. It has a saline taste, effloresces in the air, and is soluble in two parts of water. When heated, it boils up, swells, and is charred. It is decomposed by barytes and lime water. It is composed of

Acid	60.7
Soda	39.3
	100.0

21. Malate of Soda.

This salt, formed of malic acid and soda, is deliquescent in the air, and very soluble in water. Its other properties are unknown.

22. Gallate of Soda.

The nature of the compound of gallic acid with soda has not yet been ascertained. A green colour is produced, when the alkali is dropt into the acid.

23. Benzoate of Soda.

The compound of benzoic acid with soda forms a salt which readily crystallizes. It is deliquescent in the air, and very soluble in water. The taste is sharp and saline. This salt exists ready formed in the urine of graminivorous animals.

24. Succinate of Soda.

The combination of succinic acid with soda, forms beautiful transparent crystals by spontaneous evaporation. The crystals are in the form of four-sided prisms with two-sided summits. The taste of the salt is bitter. It is not deliquescent in the air, and it requires about three times its weight of water to dissolve it. It is decomposed when it is exposed to heat in close vessels.

25. Saccolate of Soda.

All that is known of this salt is, that it crystallizes in small crystals, and is soluble in five times its weight of boiling water.

26. Camphorate of Soda.

1. This compound of camphoric acid with soda is formed by saturating a solution of carbonate of soda in water with the acid; and by evaporation with a gentle heat, the crystals are obtained, when the solution cools.

2. The crystals of camphorate of soda are irregular. They are white and transparent. The taste is bitter. Exposed to the air, this salt effloresces. It is soluble in eight parts of boiling water.

3. Exposed to heat, it melts and swells, and the acid is dissipated in thick vapours of an aromatic odour. With the blow-pipe it burns with a blue flame, and is decomposed. The acid is sublimed, and the alkali remains behind. It is decomposed by potash, and by the strong acids *.

* Ann. de Chim. xxvii. p. 28.

27. Suberate of Soda.

The compound of suberic acid with soda forms a salt which does not crystallize. It has a slightly bitter taste, and reddens the tincture of turnsole. It deliquesces in the air, and is very soluble in water. Exposed

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posed to heat, it swells and melts; the acid is sublimed, and the alkali remains behind. The mineral acids decompose it, and it is also decomposed by the calcareous, aluminous, and magnesian salts †.

† *Ibid.* xxiii. p. 33.

28. Mellate of Soda.

The compound of mellitic acid with soda, when it is saturated, forms crystals in cubes or three-sided tables. Sometimes they are formed in groups, and sometimes they are insulated.

29. Lactate of Soda.

All that is known of this salt is, that it does not crystallize, but is soluble in alcohol.

30. Prussiate of Soda.

This salt, which is a compound of prussic acid and soda, is very soluble in water, converts vegetable blues to green, and when it is exposed to a very moderate heat, it is partially decomposed.

31. Sebate of Soda.

Nothing farther is known of the compound of sebacic acid with soda, than that it is soluble in water.

IV. Compounds of Soda with Inflammable Substances.

1. Soda enters into combination with alcohol, and forms a reddish-coloured acrid solution; but when heat is applied to this solution, it appears that the alcohol is partially decomposed.

2. There is no action between ether and soda.

3. Soda readily combines with the fixed oils, and especially that class of them called *fat oils*, and forms with them compounds called soaps.

4. Soda combines in very small quantity with the volatile oils, and the compounds thus formed have some of the properties of soap.

Sect. III. *Of Lithina and its Combinations.*

This alkali was discovered by M. Arfvredson, a pupil of Berzelius, in 1818, in a mineral called *petalite*. It is also contained in spodumene and in crystallized lepidolite. It is distinguished from potash and soda, chiefly by neutralizing a much larger quantity of the different acids than either of those alkalies, surpassing in this respect even magnesia.

1095 History and properties. Like the two preceding alkalies, it is a compound of oxygen with a metalloid called *lithium*, which in properties greatly resembles sodium.

With the acids, lithina forms salts similar to those of soda, but differing from them in some slight particulars. Their crystalline forms are not exactly the same, and they are generally more deliquescent.

Sect. IV. *Of Ammonia and its Combinations.*

1096 History. 1. This substance has been long known under the names of *volatile alkali*, *volatile spirit of sal ammoniac*, *caustic volatile alkali*, *hartshorn*, *spirit of hartshorn* and *of urine*, because it was obtained from these substances. It has received the name *ammonia*, from *sal ammoniac*, a salt which was extracted from the urine and dung of camels, collected near the temple of Jupiter Ammon in Africa. This salt was first known to the ancients. It is first mentioned by Basil Valentine, who lived in the 15th century, as being prepared from certain substances, with an account of some of its properties. But the difference between the pure salt and its compound with the carbonic acid, was not known till the discovery of Dr Black. It was supposed to be in the state of greatest purity in the solid and crystalline form; and in its pure, caustic, and liquid state, it was supposed to be changed, and contaminated with the lime or the different matters which had been employed in extracting it from sal ammoniac. It was afterwards examined by Dr Priestley in the state of gas, and he decomposed it by electricity, but without discovering its constituent parts. This was at last effected by the researches and experiments of Scheele and Bergman, and finally confirmed by those of Berthollet. 1097

Preparation. 2. Ammonia may be obtained by the following process. Three parts of quick lime, and one part of sal-ammoniac reduced to powder, are to be put into a retort, and the beak of the retort immersed under mercury in the mercurial apparatus. A jar filled with mercury is inverted above it. Heat is applied to the retort, and a gas comes over in great abundance. This gas is *ammonia*, or *ammoniacal gas*. Sal-ammoniac consists of the muriatic acid and ammonia. The affinity of lime for muriatic acid is stronger than that of ammonia, and therefore the ammonia is disengaged in the state of gas, while the lime combines with the acid. The gas must be received over mercury, because it is readily absorbed by water. 1098

Properties. 3. Ammonia in the state of gas resembles common air. It is transparent and colourless, and may be indefinitely compressed and dilated. The smell is extremely pungent and acrid, particularly irritating the eyes and nostrils. It has an acrid and caustic taste, but is much less corrosive than the other alkalies. It changes vegetable blues to a green colour. It is lighter than common air. Its specific gravity is 0.000732; so that it is nearly one half lighter. According to Mr Kirwan, a cubic inch of this gas weighs only .27 of a grain.

It is totally unfit for respiration. No animal can breathe it without instant death. It is also unfit for the support of combustion; but although it extinguishes burning bodies, the flame of a candle let down into this gas is considerably enlarged in volume by the addition of another flame, which is of a pale yellow colour. 1099

Action of heat. 4. This gas is unaltered by the action of light. When it is exposed to a strong heat, as when it is passed through a red-hot porcelain tube, it is decomposed and converted into azotic and hydrogen gases. It is also decomposed by the electric spark. When it is exposed to the temperature of —45°, it is condensed, and assumes a liquid form; but it returns to the gaseous state by an elevation of temperature. 1100

Of oxygen. 5. There is no action between oxygen gas and this gas in the cold; but if the two gases mixed together are made to pass through a red-hot porcelain tube, the ammonia is decomposed; a detonation takes place, the hydrogen combines with the oxygen and forms water. The azote passes off in the state of gas. 1101

Common air. 6. There is no action between this gas and azotic gas, nor is there any action between common air and ammoniacal gas in the cold; but if the mixture be made

Ammonia, &c.

made to pass through a red-hot porcelain tube, water is formed, and the gas which escapes is a combination of the azotic gas of the atmosphere, and of that which entered into the composition of ammonia. But if the same experiment be made with a greater proportion of oxygen gas, the product is nitric acid, which is formed by the combination of part of the oxygen and the azote *.

* Fourcroy Connaiss. Chim. ii. p. 236.

1102 Composition. 7. It has been already mentioned, that the constituent parts of ammonia were discovered by Scheele and Bergman, and Priestley and Berthollet. According to the experiments of the latter, ammonia is composed of 121 parts of azote, and 29 of hydrogen. This result was obtained by decomposing the ammonia by means of electricity. One hundred parts of ammonia, therefore, are composed of

Azote	80
Hydrogen	20
	100

1103 Of water. 8. Ammoniacal gas combines very rapidly with water. If a bit of ice be brought into contact with this gas, it absorbs and condenses it, and instantly becomes liquid. There is at the same time a production of cold; but water in the liquid state, as it absorbs this gas, becomes warm, because the gas is deprived of that quantity of caloric which is necessary to retain it in the gaseous form. The water, as it absorbs the gas, becomes specifically lighter. When water is saturated with this gas, it is known under the name of liquid ammonia. The specific gravity of a saturated solution is 0.9054. When this solution is exposed to the temperature of 130° the ammonia is driven off, and assumes the gaseous form; and when it is slowly and gradually cooled to the temperature of from —35 to —42°, it crystallizes; but when the temperature is rapidly diminished to —58° it assumes the form of jelly. At that temperature it has no smell †.

† Ann. de Chim. xxxi. p. 289.

By Sir H. Davy's experiments, a saturated solution of ammonia contains, in 100 parts,

Water	74.63
Ammonia	25.37
	100.00

He has also ascertained the different proportions of water and ammonia which are contained in 100 parts of liquid ammonia of different specific gravities ‡. These are exhibited in the following table.

‡ Davy's Researches, p. 68.

Table of the quantities of Ammonia, such as exists in the aëriform state, saturated with water at 52°, in Aqueous ammoniacal Solutions of different specific gravities.

100 Specific grav.		Ammoniac.	Water.
9054	contain	25,37	74,63
9166		22,07	77,93
9255		19,54	80,46
9326		17,52	82,48
9385		5,88	84,12
9435		14,53	85,47
9476		13,46	86,54
9513		12,40	87,60
9545		11,56	88,44
9573		10,82	89,18
9597		10,17	89,83
9619		9,60	90,40
9684		9,50	90,5
9639		9,09	90,91
9713		7,17	92,83

9. The order of affinities of ammonia is the same as that of the fixed alkalies. 1104 Affinities.

I. Action of Phosphorus on Ammonia.

1. There is no action between ammonia and phosphorus in the cold; but when the two gases are passed through a red-hot porcelain tube, the ammonia is decomposed, and its constituent parts enter into combination with the phosphorus. There is formed phosphorated hydrogen gas, and phosphorated azotic gas. In this case there is a double action of the phosphorus, one part combining with the hydrogen, and another with the azote. 1105 With heat.

2. Ammonia is also decomposed by red-hot charcoal, when it passes over in the state of gas at this temperature. Part of the carbone of the charcoal combines with the ammonia, and forms prussic acid.

II. Action of Sulphur on Ammonia.

1. Ammonia combines with sulphur in the state of vapour. This combination constitutes a sulphuret of ammonia, which has the property of decomposing water, and is then converted into a hydrogenated sulphuret of ammonia. This may be prepared by distilling, in a retort, a mixture of muriate of ammonia, lime, and sulphur. By this process a liquid of a deep orange colour, which exhales extremely fetid vapours, on account of the excess of ammonia which it contains, is produced. This was known under the name of the *fuming liquor of Boyle*. This sulphuret is decomposed by heat, by the acids and sulphurated hydrogen gas.

2. When ammonia absorbs sulphurated hydrogen gas, either by agitating the gas in a vessel with liquid ammonia, or by passing a current of the gas through it, there is an evolution of caloric and the formation of vapour, and the liquid is converted into an orange colour. This is the hydrosulphuret of ammonia. It has no longer the fetid odour of the hydrogenated sulphurate,

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Ammonia, &c. phuret, and it may be crystallized. It is decomposed by the action of heat, by the acids, and by the metallic oxides.

III. Compounds of Ammonia with the Acids.

1. Sulphate of Ammonia.

1106 History. 1. The compound of sulphuric acid with ammonia was formerly called *secret sal ammoniac of Glauber*, because it was discovered by that chemist. It was also called *vitriolated ammonia*, and *vitriolated volatile alkali*. It was discovered by Glauber in examining the residuum of the decomposition of ammonia by means of sulphuric acid.

1107 Preparation. 2. This salt may be formed by saturating the acid with the alkali, and afterwards crystallizing it.

1108 Properties. 3. The crystals of sulphate of ammonia are six-sided prisms with unequal sides, terminated by six-sided pyramids. The sulphate of ammonia undergoes little change in the air. It slowly attracts moisture in a humid atmosphere. It is soluble in two parts of cold water, and in a similar quantity of boiling water.

1109 Action of heat. 4. When exposed to heat, it melts; and if the heat be continued, it loses a part of its base, and is converted into the acidulous sulphate of ammonia. This differs from the sulphate by its sharp taste, and its property of reddening vegetable blues, greater solubility, and a different action on several compounds.

5. This salt is not decomposed like the other sulphates, on account of its greater volatility. The component parts of this salt, according to Mr Kirwan, are,

Acid	54.66
Ammonia	14.24
Water	31.10
	100.00

2. Sulphite of Ammonia.

1110 Preparation. 1. The compound of sulphurous acid with ammonia is prepared by passing a stream of sulphurous acid gas into a vessel with liquid ammonia. The gaseous acid is readily absorbed, much heat is produced, and the sulphite of ammonia crystallizes on the cooling of the saturated solution.

1111 Properties. 2. This salt is in the form of six-sided prisms terminating in six-sided pyramids, or in that of four-sided rhomboidal prisms, with three-sided summits. The taste is at first cool and pungent, and afterwards sulphurous. It is deliquescent in the air, from which it absorbs oxygen, and is converted into the sulphate. It is soluble in its own weight of cold water. The solution produces a great degree of cold. Boiling water dissolves still more. Water saturated with sulphite of ammonia, and agitated in the open air, presents this salt in a few hours converted into the sulphate, without any crust on the surface, or muddiness in the liquid, because it is very soluble in water.

3. It decrepitates slightly on red-hot coals; when it is gradually heated in a close vessel, it gives out at first water and ammonia, and then sublimes totally in the state of acidulous sulphite.

4. The constituent parts of this salt are,

Sulphurous acid	60
Ammonia	29
Water	11
	100

1112 Composition.

3. Nitrate of Ammonia.

1. This compound of nitric acid and ammonia was formerly called *nitrous sal ammoniac*, *inflammable nitre*. This salt has been particularly examined by Berthollet, and more lately by Sir H. Davy. 1113 History.

2. Nitrate of ammonia is prepared by directly combining the acid and the alkali, and it may be obtained in crystals by careful evaporation and slow cooling. 1114 Preparation.

3. This salt crystallizes in six-sided prisms, terminating in long six-sided pyramids; but the appearance of the crystals varies with the temperature in which the evaporation goes on. Sometimes they are in long silky threads, soft and elastic; the taste is very acrid, bitter, and penetrating; and the specific gravity is 1.5785. 1115 Properties.

4. When the nitrate of ammonia is exposed to the air, it attracts moisture, and deliquesces. It is soluble in two parts of cold water. Boiling water dissolves double of its own weight. 1116 Action of water.

5. Nitrate of ammonia very readily undergoes the watery fusion. If the heat be continued, it is entirely deprived of its water of crystallization; and when the temperature is increased, it explodes spontaneously, giving out at the same time a white brilliant flame, with considerable noise; it is then entirely dissipated into vapour. This detonation instantaneously takes place, when the nitrate of ammonia is thrown on a red-hot iron. It was from this property that the salt derived its name of *inflammable nitre*. The nature of this rapid combustion will be understood by considering the component parts of the salt. The hydrogen of the ammonia enters into combination with the oxygen of the acid; water is formed, and azotic gas is disengaged from each of the component parts of the salt. In the different states of crystallization, this salt requires different temperatures for its fusion and decomposition. The following are the conclusions from Sir H. Davy's experiments. 1117 Of heat.

" *a*. Compact or dry nitrate of ammonia undergoes little or no change at temperatures below 260°.

" *b*. At temperatures between 275° and 300°, it slowly sublimes without decomposition, or without becoming fluid.

" *c*. At 320° it becomes fluid, decomposes, and still slowly sublimes; it neither assuming nor continuing in the fluid state, without decomposition.

" *d*. At temperatures between 340° and 480°, it decomposes rapidly.

" *e*. The prismatic and fibrous nitrates of ammonia become fluid at temperatures below 300°, and undergo ebullition at temperatures between 360° and 400°, without decomposition.

" *f*. They are capable of being heated to 430° without decomposition or sublimation, till a certain quantity of their water is evaporated.

" *g*. At temperatures above 450°, they undergo decomposition,

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Ammonia, &c. composition, without previously losing their water of crystallization *."

* Research. p. 85.

6. The component parts of nitrate of ammonia are, according to

1118 Composition.

	Kirwan.	Fourcroy.
Acid,	57	46
Ammonia,	23	40
Water,	20	14
	100	100

Sir H. Davy has ascertained the proportions of the component parts of this salt in its three different states †.

† Ibid. p. 72.

	Fibrous.	Prismatic.	Compact.
Acid,	72.5	69.5	74.5
Ammonia,	19.3	18.4	19.8
Water,	8.2	12.1	5.7
	100.0	100.0	100.0

1119 Uses.

7. This salt has been applied to no use but for the purposes of chemical experiment, and especially for the preparation of the nitrous oxide or gaseous oxide of azote, which has been already described in treating of the compounds of azote.

4. Nitrate of Ammonia.

If this salt be formed by depriving the nitrate of ammonia of part of its acid, it must be extremely difficult, Fourcroy observes, to obtain it in this way, before the salt is totally decomposed ‡.

‡ Fourcroy, Connaiss. Chim. iii. p. 160.

5. Muriate of Ammonia.

1120 History.

1. The compound of muriatic acid and ammonia has been known, from time immemorial, by the name of *sal ammoniac*. It derives this name from Ammonia, a country of Libya, which name is descriptive of the sandy soil of that region (A). Hence too is the origin of the epithet *Ammon* given to Jupiter, to whom a temple was erected in that country. This salt was originally collected in great quantities near this temple, where it was formed in the sand, from the excrementitious matters of different animals, particularly camels. It was well known to the Greeks and Romans, and was employed by them in several arts. Before the nature of this salt was known, it was chiefly brought from Egypt; but it is now found to exist, ready formed, in different countries, particularly in the vicinity of volcanoes, where it seems to be sublimed. It is found also in the mountains of Tartary and Thibet, in grottoes in the neighbourhood of Puzzuoli, and dissolved in the waters of some lakes in Tuscany. The nature of the muriate of ammonia was first discovered by Geoffroy; it was afterwards more accurately examined by Duhamel; and, at last, its properties were fully developed by Black, Bergman, and Scheele, Berthollet and Fourcroy.

1121 Purification.

2. The muriate of ammonia, which is found ready prepared in nature, is extremely impure. It must therefore be subjected to several processes, to separate the foreign matters with which it is impregnated. The salt which is found sublimed in the crater of volcanoes, is generally mixed with arsenic and sulphur. In Egypt it is prepared by collecting together the excrements of animals which feed on saline plants. These substances are dried and burnt in furnaces which are constructed on purpose, or used as the common materials of fuel. The soot which is thus formed, is collected, and put into large glass bottles, and exposed to a strong heat, which is gradually increased for 72 hours. Towards the second day the salt is sublimed, and attaches itself to the upper part of the bottles. When the apparatus has cooled, the bottles are broken, and the salt in form of a cake is taken out, which amounts to little less than one-third of the soot which was employed. This manufacture is carried on at Grand Cairo; and the French consul then resident there, communicated an account of it to the Academy of Sciences, in the year 1719. But it was not till 40 years after this period that it was manufactured in Europe. The first manufactory was established in Germany in 1759; others afterwards commenced in France, and in different parts of Britain.

In the European manufactories it is prepared by different processes. Sometimes the calcareous muriate is precipitated by a carbonate of ammonia extracted from animal matters. After the lime is deposited, the liquor is evaporated, and the muriate of ammonia is sublimed. Sometimes too it is prepared by forming a sulphate of ammonia; and by mixing the salt with a muriate of soda, and exposing the mixture to heat, a double decomposition is effected, and the muriate of ammonia is sublimed. It is also prepared by the direct combination of muriatic acid and ammonia. 1122

3. Prepared in this way by sublimation, it is in the form of a solid mass, which has some degree of elasticity. Properties. It yields to the pressure of the finger, may be compressed into smaller bulk, and is with difficulty reduced to powder. The specific gravity is 1.42. The taste is pungent, acrid, and cooling. By solution in water and slow evaporation, it crystallizes in the form of long four-sided pyramids. The primitive form of the crystal is the regular octahedron; and that of the integrant particle, the regular tetrahedron. Sometimes it crystallizes in cubes, and sometimes the prisms are very small, and grouped together, exhibiting a feathery appearance. 1123

4. The muriate of ammonia is not altered by exposure to the air. Action of water. It is soluble in three or four times its weight of cold water. Great cold is produced during the solution; and on this account it is employed with snow and ice in the production of artificial cold. Boiling water dissolves nearly its own weight of this salt. 1124

5. The muriate of ammonia is fusible and volatile. Of heat. When it is thrown on red-heat coals, it is entirely dissipated in white vapour. Exposed to a high temperature, it is decomposed. 1125

6. This salt is readily decomposed by the sulphuric Of acids. acid, which disengages the muriatic acid with violent effervescence. It is also decomposed by the nitric acid, which oxygenates the muriatic acid. In this way a nitro-muriatic

(A) From the Greek word αμμος, which signifies *sand*.

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Ammonia, &c. nitro-muriatic acid is prepared, which is employed for the solution of gold. Barytes, potash, soda, and lime, decompose the muriate of ammonia, and disengage the ammonia in the state of gas, merely by trituration; but if heat be applied, the decomposition is more rapid and complete.

1126 Composition. 7. According to the analysis of Mr Kirwan, the component parts of the muriate of ammonia are,

Acid,	42.75
Ammonia,	25.00
Water,	32.25
	100.00 *

* *Nichol. Journ.* iii. 216.

1127 Uses. 8. No salt is more generally employed than muriate of ammonia. In chemistry it is used for the extraction of ammonia, and the carbonate of ammonia; for the production of cold, and as an instrument of analysis. It is also employed in medicine; in the art of dyeing, for the preparation of colours; in metallurgy, for the indication and separation of some metallic substances, and in the arts, for covering the surface of copper and other vessels, to prevent oxydation in the process of tinning; and for the same purpose in soldering.

6. Hyperoxymuriate, or Chlorate of Ammonia.

1128 Preparation. The compound of hyperoxymuriatic acid and ammonia is formed by pouring carbonate of ammonia into a solution of any of the earthy hyperoxymuriates. A double decomposition takes place, and a hyperoxy-
1129 Properties. muriate of ammonia is formed. This salt is very soluble in water and in alcohol. It is decomposed at a low temperature, and gives out a quantity of gas together with a smell of hyperoxymuriatic acid. Such a smell, Mr Chenevix observes, is doubtless owing to the great quantity of oxygen contained in the acid, which is more than what is necessary to combine with the hydrogen contained in the alkali. Some part, therefore, is disengaged without decomposition. Mr Chenevix who formed this salt, could not succeed in ascertaining the proportion of its constituent parts †.

† *Phil. Trans.* 1802, p. 148.

7. Fluate of Ammonia.

1130 Preparation and properties. 1. This compound of fluoric acid and ammonia is prepared by saturating the acid with the alkali. By evaporation it crystallizes in small needles or prisms, which have a pungent taste analogous to that of sulphate of ammonia.

2. When it is heated, this salt gives out ammonia, and is sublimed in the state of an acidulous fluate. This salt decomposes the nitrate and muriate of lime, and the sulphate of magnesia.

8. Borate of Ammonia.

The compound of boracic acid and ammonia is little known. It is formed by the direct union of the acid with the alkali. It has so little permanency, that the solution being evaporated, the whole of the ammonia is volatilized, while the boracic acid crystallizes. The base of every other salt decomposes it *.

* *Fourcroy Connaiss. Chim.* iii. p. 336.

9. Phosphate of Ammonia.

1. This salt, the compound of phosphoric acid and ammonia, was long confounded with the phosphate of soda, as it exists with it in urine, under the names of *fusible salt*, *native salt of urine*, *microcosmic salt*. It was first accurately distinguished by Schlosser, De Chaulnes, and Rouelle, about the year 1770; soon after by Lavoisier, and more lately by Vauquelin. 1131 Names and history.

2. At first it was extracted from the salt of urine; and many processes were adopted to obtain it pure, and separate from the muriate and phosphate of soda, with which it is always accompanied. It is now prepared artificially by directly combining phosphoric acid with ammonia; and by slow evaporation of the solution to a certain consistence crystals are obtained on cooling. 1132 Preparation.

3. The phosphate of ammonia crystallizes in regular four-sided prisms, terminated by four equal-sided pyramids, and sometimes in the form of small needles closely interwoven with each other. It has a cooling, saline, pungent taste, and changes the syrup of violets to a green colour. Its specific gravity is 1.8051. 1133 Properties.

4. In a moist air, it is slightly deliquescent, but otherwise it is unchanged. It is soluble in four parts of cold water, and still more so in boiling water. 1134 Action of water.

5. Exposed to heat, it undergoes the watery fusion, swells up, and melts into a transparent glass, which is acid, part of the base being driven off. Hence it derived the name of *fusible salt*. 1135 Of heat.

6. It is readily decomposed by charcoal, by the sulphuric, nitric, and muriatic acids, and by the two fixed alkalies. 1136 Acids.

7. The phosphate of ammonia is employed as a flux in essaying mineral substances with the blow-pipe. It is greatly used also in the fabrication of coloured glasses and artificial precious stones. 1137 Uses.

10. Phosphite of Ammonia.

1. This is a compound of phosphorous acid and ammonia. It is prepared by the direct combination of the acid with ammonia or the carbonate of ammonia, and by slow evaporation it may be obtained in crystals. 1138 Preparation.

2. It sometimes crystallizes in long transparent needles, and sometimes in four-sided prisms, terminated by four-sided pyramids. It has a strong pungent taste. 1139 Properties.

3. This salt is slightly deliquescent in the air, is soluble in twice its weight of cold water, and being more soluble in boiling water, it crystallizes on cooling. 1140 Action of water.

4. When it is heated on charcoal with the blow-pipe, it boils up, and loses its water of crystallization. When this has escaped, it is surrounded with a fine phosphoric light; and as the salt begins to vitrify, there are evolved bubbles of gas, which burn as they come in contact with the air, with a vivid flame, and form with the atmosphere a ring of white vapour of phosphoric acid. What remains is phosphoric acid in the vitreous state. The same effect may be produced by heating six or seven grains of the salt in a small glass globe to which a tube is adapted, and immersed under jars over mercury. The salt melts, swells, and gives out bubbles of phosphorated hydrogen gas, which spontaneously inflame as they come in contact with the air, and exhibit the white coronet of vapour which is the characteristic property of the combustion of this gas. During this decomposition, the base of the salt, the ammonia, is also volatilized, and pure phosphoric acid 1141 Of heat.

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Ammonia, &c. acid remains behind. This salt is decomposed by charcoal, the acids, and by potash and soda.

1142 Composition. 5. The constituent parts of this salt are the following,

Phosphorous acid,	26
Ammonia,	51
Water,	23
	100

6. It has not hitherto been applied to any use,

11. Carbonate of Ammonia.

1143 Names. 1. The compound of carbonic acid with ammonia has been distinguished by different names, as *concrete volatile alkali*, *aërated volatile alkali*, and *cretaceous sal ammoniac*. Its peculiar nature and properties were not clearly understood, till, by the discovery of Dr Black, it was demonstrated to be a compound salt. This salt is obtained by a great many different processes. Formerly it was procured by distilling animal matters, and particularly horns, as the horns of the hart, whence it derived the name of volatile salt of hartshorn.

1144 Preparation. 2. Carbonate of ammonia may be prepared by directly combining carbonic acid and ammonia in the state of gas over mercury; or it may be obtained by mixing together two parts of chalk, and one part of muriate of ammonia, well dried and reduced to powder, and exposing them to heat in a porcelain retort. The gas, as it comes over, is collected in a receiver, which is to be cooled with cloths moistened with water. This is the carbonate of ammonia, which is sublimed and attaches itself to the sides of the receiver. In this process there is a double decomposition. The carbonic acid of the lime combines with the ammonia, and forms carbonate of ammonia, which is driven off by heat; and the muriatic acid of the muriate of ammonia combines with the lime and forms muriate of lime, which remains in the retort.

1145 Properties. 3. The carbonate of ammonia is crystallized; but the crystals are so irregular, that their form has not been accurately ascertained. Bergman describes them as octahedrons, whose four angles are truncated; while according to Romè de Lisle, they are compressed four-sided prisms, terminated by a two-sided summit. The taste of this salt is slightly acrid, and the smell is perceptibly that of ammonia, though more feeble. It converts vegetable blues to green. Its specific gravity is 0.966.

1146 Action of water. 4. When this salt is pure, it is not sensibly changed by exposure to the air. It is very soluble in water, and, during its solution, produces cold. Two parts of cold water dissolve more than one of the salt. Water, at the temperature of about 120°, dissolves more than its own weight, &c. When it is rapidly cooled, the salt crystallizes in the most regular form which it assumes. Boiling water cannot be employed for its so-

1147 Of heat. lution, because at this temperature the salt is driven off in the state of vapour. When this salt is thrown upon hot iron, it melts, boils, and is converted into vapour.

1148 Of acids. 5. It is decomposed by all the acids with effervescence; and the effervescence with this salt is more violent than with the carbonate of the two fixed alkalies, because the proportion of carbonic acid is greater.

1149 Composition. 6. The constituent parts of this salt, according to Bergman, are,

Carbonic acid,	45
Ammonia,	43
Water,	12
	100

But Mr Davy has found, that the proportion of acid and water in this salt depends on the temperature at which it is formed. It is greater when the temperature is low, and diminishes as the temperature is increased.

7. This salt is employed in medicine, and also in the manufacture of muriate of ammonia, for which purpose it is produced by distillation from animal matters. The use of it, when it is mixed with volatile oils, as a perfume, or as a stimulant in smelling bottles, is well known. 1150 Uses.

12. Arseniate of Ammonia.

1. This salt, the compound of arsenic acid and ammonia, is formed by combining the acid with the alkali. When the solution is evaporated, it affords crystals of arseniate of ammonia. 1151 Preparation.

2. It crystallizes in the form of rhomboidal prisms; or, with an excess of acid, in the form of needles. The crystals of the first convert the syrup of violets into green, and those of the second are deliquescent in the air. 1152 Properties.

3. When this salt is gently heated, the ammonia is disengaged, and the arsenic acid remains behind; but when the heat is violent and sudden, part of the alkali and of the acid are decomposed, water is formed, azotic gas is disengaged, and the arsenic is sublimed in the metallic state. 1153 Action of heat.

13. Arsenite of Ammonia.

This is a compound of the white oxide of arsenic, or arsenious acid, with ammonia; but nothing is known of its properties.

14. Tungstate of Ammonia.

1. This compound of tungstic acid and ammonia is formed by dissolving the oxide of tungsten in the solution of ammonia or carbonate of ammonia; and by evaporating the solution, the salt is obtained in the form of crystals. 1154 Preparation.

2. It crystallizes in small scales, which have some resemblance to boracic acid; or in small needles, which are four-sided. This salt has a metallic taste. It is not deliquescent in the air, but is soluble in water. When it is exposed to heat, it is decomposed. 1155 Properties.

3. The component parts of this salt are,

Tungstic acid,	78
Ammonia and water,	22
	100

15. Molybdate of Ammonia.

16. Chromate of Ammonia.

 17. Acetate

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Ammonia, &c.

17. Acetate of Ammonia.

1156 Preparation. 1. This compound of acetic acid and ammonia has been long known by the name of *spiritus mindereri*. In this state it is combined with an excess of acid. It may be obtained, but with some difficulty, on account of its volatility, by slow evaporation. It then crystallizes in the form of needles. Crystals are also obtained by very slow sublimation of this salt.

1157 Properties. 2. The crystals of acetate of ammonia are long, slender, flat, and pointed, of a pearly white colour *. The taste is cooling, with a mixture of sweet. Exposed to air, it is deliquescent, and is very soluble in water. When it is heated to the temperature of 170°, it melts; and when the temperature is raised to 25°, it is sublimed. By distillation of the salt in solution, with a strong heat, it is partly decomposed. The ammonia is first driven off, then the acid, and, towards the end of the process, part of the neutral salt.

* *Higgins's Experiments*, p. 188.

18. Oxalate of Ammonia.

1158 Preparation. 1. The compound of oxalic acid and ammonia may be prepared by directly combining the acid with the alkali. By evaporating the solution, the salt crystallizes.

2. When the acid is saturated with the alkali, the crystals are in the form of four-sided prisms, terminated by two-sided summits; one of which is larger, and includes three sides of the prism. These salts are soluble in water.

1159 Action of heat. 3. When this salt is exposed to heat, carbonate of ammonia is driven off, and nothing remains behind but a little charcoal. From this it appears, that the acid is decomposed, the carbon and oxygen combining together to form carbonic acid, which enters into combination with ammonia. It is decomposed by the mineral acids. The oxalic acid combines with it, and forms an acidulous oxalate of ammonia. The oxalates of potash and soda form compounds with this salt, which are known by the name of *triple salts*.

1160 Uses. 4. This is one of the most useful salts to be employed as a reagent in detecting lime in liquid solutions, and for ascertaining the nature and proportions of calcareous salts.

19. Tartrate of Ammonia.

The compound of tartaric acid and ammonia forms a salt which very readily crystallizes. This salt has a cooling bitter taste, is very soluble in water, and easily decomposed by heat. It is subject also to spontaneous decomposition. By the action of the stronger acids, part of the base is separated, and it is converted into an acidulous tartrate of ammonia.

20. Citrate of Ammonia.

1. This salt, which is a compound of citric acid and ammonia, is formed by the direct combination of the acid and alkali, and it crystallizes when the solution is evaporated to the consistence of a thick syrup.

2. The crystals are in the form of an elongated prism. They are very soluble in water, and have a saline cooling taste. This salt is decomposed by heat, the ammonia being driven off.

3. It is composed of,

Acid	62
Ammonia	38
	100

Ammonia, &c.

21. Malate of Ammonia.

This salt, which is a compound of malic acid and ammonia, is a very soluble and deliquescent salt. Its other properties are unknown.

22. Benzoate of Ammonia.

The compound of benzoic acid and ammonia forms a very soluble salt, which readily crystallizes, and the crystals arrange themselves in an arborescent or plumose form. This salt is volatile, and is decomposed by all other acids *.

* Fourcroy Connais. Chim. vii. 193.

23. Succinate of Ammonia.

The compound of succinic acid and ammonia forms a salt, which affords needle-shaped crystals that are deliquescent, and are sublimed by heat, without being decomposed.

24. Saccolate of Ammonia.

Nothing farther is known of this salt, than that it has an acid taste, and is readily decomposed by heat.

25. Camphorate of Ammonia.

1. This salt, which is a compound of camphoric acid and ammonia, is prepared by adding the acid to a solution of carbonate of ammonia, and hot water, till effervescence ceases. The evaporation must be conducted with a very gentle heat, on account of the volatility of the ammonia. 1161 Preparation.

2. It is difficult to obtain this salt crystallized. When the solution is too much evaporated, it affords a crystalline mass, in which appear small needles; but if it be evaporated to dryness there remains a solid opaque mass, which has a slightly bitter and pungent taste. 1162 Properties.

3. This salt is slightly deliquescent in the air; it is not very soluble in cold water, but may be dissolved in three parts of boiling water. In these salts, it would appear that the acid resists the action of the water; for when there is an excess of base, they become more soluble.

4. Exposed to heat on red-hot coals, it swells and melts, and then rises in vapour. With the blow-pipe, it gives a blue and red flame, and is entirely dissipated. 1163 Action of heat.

5. This salt is decomposed by the sulphuric, nitric, and muriatic acids, and if the solution be sufficiently concentrated, the camphoric acid is deposited. It is also decomposed by potash and soda, and more rapidly with the assistance of heat. This salt is completely soluble in alcohol †. 1164 Of acids.

† Ann. de Chim. xxvi. p. 31.

26. Suberate of Ammonia.

This compound of suberic acid with ammonia affords crystals in the form of parallelopipeds. It has a slight saltish taste, leaving an impression of bitterness. It reddens vegetable blues, and is deliquescent in the air. It is very soluble in water. When it is thrown on

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Ammonia, &c. on burning coals, it swells up, and is deprived of its water of crystallization. It is entirely dissipated by the action of the blow-pipe. It is decomposed by the sulphuric, nitric, muriatic, and oxalic acids, by the fixed alkalies, and the aluminous and magnesian salts*.

* Annal. de Chim. tom. xxiii. p. 55.

27. Mellate of Ammonia.

This salt, which is a compound of mellitic acid and ammonia, is formed by saturating the acid with the alkali. By evaporation it affords transparent, six-sided crystals. This salt, when exposed to the air, becomes opaque, and of a silvery white colour.

28. Lactate of Ammonia.

This compound of lactic acid and ammonia forms a salt which crystallizes. It is deliquescent in the air, and is decomposed by heat, great part of the ammonia being driven off.

29. Prussiate of Ammonia.

The compound of prussic acid and ammonia affords a salt which has the odour of ammonia. When this salt is exposed to heat, it is entirely dissipated.

30. Sebate of Ammonia.

31. Urate of Ammonia.

The compound of uric acid and ammonia forms a salt which is not very soluble in water, and in many of its properties resembles the acid itself.

IV. Compounds of Ammonia with Inflammable Substances.

1. Ammonia enters into combination with alcohol, with the assistance of a moderate heat; but the ammonia is separated when the mixture is exposed to a temperature below the boiling point of alcohol.

2. Ammonia readily mixes with ether; but the nature of the compound, or whether it be a chemical combination, is not known.

3. Ammonia forms a compound with the fixed oils, which is well known under the name of *soap* or *liniment*.

4. With the volatile oils it forms compounds, which have somewhat similar properties.

Chap. XIII. Of EARTHS.

1. The word *earth* is taken in different significations. Sometimes it signifies the globe, and sometimes it is used to denote the soil on the surface of the globe. In chemistry it is employed to signify certain elementary substances, of which a great proportion of the solid parts of the globe is composed; and these substances are found to possess many peculiar, and some common properties.

1165 Properties. 2. The general properties of the earths are the following.

a. They have neither taste nor smell.

b. They are incombustible.

c. They are nearly soluble in water.

d. They have a specific gravity which is under 5.

1166 Enumeration. The number of the earths which are at present known, is ten, and we shall treat of them in the following order. Lime, &c.

1. Lime,
2. Barytes,
3. Strontites,
4. Magnesia,
5. Alumina,
6. Silica,
7. Yttria,
8. Glucina,
9. Zirconia.
10. Thorina.

Sect. I. *Of Lime.*

1. Lime has been known from the remotest antiquity. The great abundance in which it is found in nature, and the important uses to which it may be applied, led men to employ it for many purposes from the earliest ages of the world. It was well known to the ancients as mortar, and as a manure, and they were not unacquainted with some of its medicinal virtues. But it was long before the nature and properties of lime were fully known; and particularly those changes which quicklime undergoes when it is exposed to the air, or limestone to the action of heat. It was not till Dr Black made his brilliant discoveries, that the nature of these changes was fully developed, and the fanciful theories which had been proposed to account for them were entirely rejected. 1167 Early known.

2. Lime is seldom found perfectly pure in nature; but it is universally diffused, and exists in some places in the greatest abundance, in combination with other substances, and particularly with carbonic acid. To obtain it pure, a quantity of chalk, or marble, or limestone, is exposed to a strong heat, by which means the carbonic acid with which it is in combination, is driven off. When the limestone, or marble, or chalk, which has been employed, is sufficiently burnt or calcined, and removed from the fire, and water poured upon it, it swells up, and at last falls down into a powder. This powder is called *quicklime*. In this process of slaking lime, as it is called, a great quantity of water is quickly absorbed, and the water being fixed in the lime in the solid state, gives out that caloric which is necessary to retain it in the state of liquidity, so that a great quantity of heat is evolved. Part of the water, also, rises in vapour in consequence of the great heat, before it is consolidated with the lime. The heat produced is so great, that water may be boiled, and combustible bodies may be inflamed. Accidents have happened to carriages and vessels loaded with lime, to which water had been admitted. So much heat was produced, that they have been set fire to, and burnt. Light is also emitted when lime is slaked. This, it is said, is seen when the process is conducted in a dark place, and the quantity of lime is considerable. 1168 Preparation of pure lime. 1169 Slaking.

3. The purity of lime, thus obtained, is in proportion to the purity of the substance which was calcined. The lime which is obtained by burning pure white marble, or what is called *calcareous spar*, is tolerably

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Lime, &c. lerably pure. But there are other processes by which those substances with which it may happen to be mixed may be separated. If a quantity of chalk be washed in pure water, dissolved in distilled acetic acid, and afterwards precipitated by carbonate of ammonia, the precipitate being washed and calcined, pure lime is the product. The lime which is obtained from oyster-shells, may be rendered pure by the following process. First wash the shells in different quantities of water, and boil them, to separate any mucilaginous substance. Introduce them into a furnace, and calcine them to whiteness. After the first calcination, put them into a porcelain retort, and expose it to a red heat. By this process pure lime is obtained. To preserve it in this state of purity, it must be kept in close vessels.

1170 Properties and composition.

4. Pure lime is of a white colour, has a hot, sharp, caustic taste, and destroys the texture of animal substances, to which it is for some time applied. It converts the syrup of violets and other vegetable blues to a green colour. The specific gravity of lime is 2.3. This earth may be decomposed by the galvanic battery, in contact with mercury, a substance, the affinities of which materially promote the object. The metallic base or calcium forms an amalgam with the mercury, which may be afterwards expelled by heat, and the calcium is obtained pure. It is a white metal, and when gently heated, burns and resumes the state of lime.

1171 Action of water.

5. After the lime has been prepared and slaked; if more water be added to dilute it, and reduce it to the consistence of thick cream, this is what was formerly called *milk* or *cream of lime*. But if a greater quantity of water be added, and the solution be filtered, a transparent liquid is thus obtained, which is known by the name of lime-water. Four hundred and fifty parts of water are required, it is said, to dissolve one of lime. This water is clear and limpid, has a sharp acrid taste, and renders the syrup of violets green. When this water is evaporated, and the whole driven off, the lime remains pure. If the solution of lime-water be exposed to the air, the surface is soon covered with a pellicle, which gradually acquires solidity and thickness. The pellicle is owing to the attraction of the lime for the carbonic acid of the atmosphere, forming a carbonate of lime, which being insoluble in water, is precipitated.

1172 Crystallizes.

6. Lime, according to Trommsdorf, crystallizes. This was first discovered by Scheele. The method by which Mr Trommsdorf obtained the crystals lime is the following. Boil any quantity at pleasure of muriate of lime, with one-fourth or less of caustic lime, and evaporate the solution till a drop of it let fall on a cold stone assume the consistence of a syrup. It is then to be filtered, and put into a close vessel, that the solution may cool as slowly as possible. Crystals of lime are thus obtained, which must be washed in alcohol, to separate any part of the muriate of lime which may adhere. For the complete success of this experiment, some pounds of the muriate of lime must be employed *.

* Phil. Mag. xii. 53.

1173 Action of heat.

7. Lime undergoes no change by the action of light, and it remains unaltered when it is exposed to the greatest heat.

8. Lime is one of the most important of the earthy bodies. It is applied to a great many valuable purposes, and fortunately it can be obtained in the greatest abundance. It is employed in medicine, both as an internal remedy, and an external application. As a manure, it is of the most extensive utility; nor is it of less importance, as it is employed for a cement in building. When quicklime is mixed with sand and water, and reduced to the form of a thick paste, it is in the state of mortar. It is an object of the utmost importance that the mortar which is employed as a cement in building, should be durable. To obtain this object, a good deal of attention has been paid by different philosophers in ascertaining the proportions which seem to answer best, or the additions which may be made to the usual materials in the formation of good and durable mortar. The proportions which have been proposed by Dr Higgins are, 1174 Mortar.

Coarse sand,	4	parts,
Fine sand,	3	
Quicklime,	1	

The lime should be recently slaked, and the quantity of water should be just sufficient to bring it to a proper consistency.

Dr Higgins found that burnt bones, if they did not exceed one-fourth of the lime, added to the mortar, improved its tenacity, and prevented it from cracking in drying.

It has been proposed to add a certain proportion of unslaked lime to the mortar, with the view of giving it greater solidity. Mortar acquires its hardness from the lime absorbing carbonic acid, and returning to the state of lime-stone, and also from the combination of part of the water with the lime. According to Guyton's experiments, the following proportions compose a good, durable mortar,

Fine sand,	3	parts
Cement of well-baked bricks,	3	
Slaked lime,	2	
Unslaked,	2	

It is sometimes necessary to use mortar as a cement under water, but common mortar is unfit for this purpose. It has been found by experiment, that manganese added to mortar gives it the property of consolidating under water. To prepare a mortar for this purpose, Guyton recommends the following process. Mix together 90 parts of limestone, six parts of black oxide of manganese, and four parts of blue clay in the state of powder. Let the mixture be calcined, to drive off the carbonic acid; then add 60 parts of sand, and mix it together with a sufficient quantity of water, to bring it to the consistency of mortar. 1175

9. The order of the affinities of lime is the following: Affinities.

Oxalic acid,
Sulphuric,
Tartaric,
Succinic,
Phosphoric,
Saclactic,
Nitric,
Muriatic,
Suberic,

Fluoric,

Lime, &c.

Fluoric,
Arsenic,
Lactic,
Citric,
Benzoic,
Sulphurous,
Acetic,
Boracic,
Carbonic,
Prussic.

I. Phosphuret of Lime.

1176 Preparation. 1. Lime combines with phosphorus, and forms a compound which is called *phosphuret of lime*. To prepare this compound, introduce into the bottom of a glass tube, closed at one end, one part of phosphorus, and afterwards place a little above it four or five times its weight of quicklime in powder. Expose to a heat that part of the tube which contains the lime, so that it may become red hot. In this state raise the tube and draw it along the coals, till that part of it containing the phosphorus be also exposed to the heat. The phosphorus is raised in the state of vapour through the lime, and combines with it, so that the whole mass forms a compound of a brown colour. This is the phosphuret of lime.

1177 Properties. 2. It has a deep brown colour, no smell, and when it is exposed to the air it falls to pieces. It is insoluble in water, but it decomposes that liquid at the moment it comes in contact with it. An effervescence takes place, and phosphorated hydrogen gas is emitted, which is spontaneously inflamed when it comes to the surface of the water. It is owing to this gas that phosphuret of lime, when it is moistened, gives out the fetid smell of garlic; and as this gas is formed by the decomposition of the water, part of it combines with the phosphuret of lime, and forms a hydrogenated phosphuret, so that the phosphuret when it is taken from the water and dried, gives out flame, when concentrated muriatic acid, which disengages the phosphorated hydrogen gas, is poured upon it.

II. Sulphuret of Lime.

1178 Preparation. 1. This compound of sulphur and lime may be formed by exposing to heat in a crucible, sulphur and lime reduced to powder. They fuse slightly, or rather combine into an acrid, reddish mass, which is the sulphuret of lime, formerly called *calcareous liver of sulphur*.

1179 Hydrogenated sulphuret. 2. When it attracts moisture from the air, or if a little water be thrown upon it, it changes colour, and passes to a greenish yellow, emitting at the same time an extremely fetid odour, and forming sulphurated hydrogen gas, becomes a hydrogenated sulphuret.

3. When sulphur and lime are combined together by means of water, the result is not a simple sulphuret, but always a hydrogenated sulphuret, on account of the water which is decomposed. This may be prepared, either by throwing water on quicklime, covered with sulphur in powder; the heat which is emitted by the slaking of the lime effecting the combination: or it may be prepared by heating in a matrass, sulphur and lime in powder with ten times their weight of water, or by heating lime water on sulphur. By the two first processes, a liquid is obtained of a red, orange, or yellow colour, of an extremely fetid odour, and a pungent acrid taste. This hydrogenated sulphuret of lime exposed to the air, is deprived of its colour, gradually decomposed, and the sulphur combining with the oxygen of the air, is first converted into sulphurous, and afterwards into sulphuric acid. It is decomposed by the acids, sulphur is precipitated, and sulphurated hydrogen gas is disengaged. 1180

Hydrosulphuret. 4. Lime combines readily with sulphurated hydrogen. When sulphurated hydrogen gas is passed into a bottle of lime-water, the gas is absorbed and fixed by combining with the lime, it renders it more soluble, and forms the hydrosulphuret of lime. This hydrosulphuret, as Berthollet observes, performs the part of an acid, by saturating the lime, and gives it the property of crystallizing. This hydrosulphuret has no colour, and, exposed to the air, emits a strong fetid odour. It is extremely soluble in water, and is decomposed by the acids with effervescence, while sulphurated hydrogen gas is given out. Thus, lime enters into three different combinations with sulphur, namely, into the sulphuret of lime, the hydrosulphuret, and the hydrogenated sulphuret.

III. Compounds of Lime with acids.

1. Sulphate of Lime.

1. The compound of sulphuric acid and lime has been known under a great variety of names, as *selenite*, *gypsum*, *plaster of Paris*, *alabaster*, *vitriol of lime*. The sulphate of lime is found in great abundance in nature; and it is found sufficiently pure, so that artificial preparation is not required. 1181 Names. 1182 Found native.

2. When sulphate of lime is pure, it is frequently found crystallized. The primitive form of its crystals is a quadrangular prism, whose bases are rhomboidal, and the angles 113° and 67°. The integrant particle has the same form. The specific gravity is from 2.1679 to 2.3114. It is not changed by exposure to the air. It is little soluble in water. Five hundred parts of cold water, and 450 of boiling water, are required to dissolve it. When it is exposed to heat, it loses its water of crystallization, decrepitates, becomes very friable, and falls down into a very white opaque powder. When this powder is reduced to a paste with water, it absorbs it very rapidly, and becomes in a very short time solid. From this peculiar property, it is employed for forming *casts*, under the name of plaster of Paris. When it is strongly heated for a long time, it becomes phosphorescent, and then melts; and before the blow-pipe it gives an opaque, vitreous globule. 1183 Properties. 1184 Action of heat.

3. This salt becomes more soluble by the action of sulphuric acid, without being converted into an acidulous sulphate of lime. The nitric and muriatic acids increase its solubility without decomposing it. It is partly decomposed by the phosphoric acid in the cold. 1185 Of acids.

4. The component parts of sulphate of lime, according to Bergman, are, 1186 Composition.

Acid	46
Lime	32
Water	22
	100

After

Lime, &c. After being dried in different temperatures, according to Mr Kirwan, the component parts are,

	Dried in 270°	In a red heat.	In a white heat.
Acid	50.39	55.84	56
Lime	35.23	38.81	41
Water	14.38	5.35	00
	100.00	100.00	100

Anhydrous Sulphate of Lime.

This is a variety of the sulphate of lime found native in different places, which, as the name imports, contains no water of crystallization. It is found crystallized. The primitive form of the crystal is a rectangular prism, having two of its bases broader than the other two. The specific gravity is 2.950. It has a pearly lustre, considerable hardness, phosphoresces when it is heated, is transparent, and insoluble in water. The component parts are, according to the analysis of Mr Chenevix,

Acid	44.88
Lime	55.12
	100.00

2. Sulphate of Lime.

1187 Preparation. 1. This salt may be prepared by passing a current of sulphurous acid gas into a bottle of distilled water, in which is suspended pure carbonate of lime in powder. A brisk effervescence takes place; the sulphite, as it forms, falls to the bottom in the state of powder; and if the gas be continued to be added after the effervescence has ceased, the sulphite of lime in the state of powder is completely re-dissolved; the liquid becomes warm; and as it cools, it affords crystals.

1188 Properties. 2. This salt is either in the state of white powder, or in the form of six-sided prisms, terminated by long, six-sided pyramids. At first it has no taste, but when it is kept in the mouth for some time, it becomes sulphureous. It effloresces slowly when exposed to the air, and is converted into sulphate of lime on the surface. It is less soluble in water than the sulphate of lime, requiring 800 parts of water to dissolve it.

1189 Action of heat. 3. When it is exposed to heat, it is deprived of some water, becomes white, and is reduced to powder. A strong heat separates some sulphur, and it is then converted into sulphate of lime.

1190 Composition. 4. The component parts of this salt are,

Sulphurous acid	48
Lime	47
Water	5
	100

3. Nitrate of Lime.

1191 History. 1. This salt, which is the compound of nitric acid and lime, has been long known under the names of *calcareous nitre*, *mother water of nitre*, Baldwin's phosphorus. It always accompanies nitre, and as one of its names imports, remains in the solution from which nitre has been obtained.

1192 Preparation. 2. This salt may be prepared by dissolving carbonate of lime in nitric acid, evaporating to the consistence of syrup, and allowing the solution to cool slowly. It is thus obtained in the state of crystals.

3. The crystals of nitrate of lime are in the form of six-sided prisms, terminated by long pyramids. Sometimes they are in the form of long striated needles, grouped together, of a silvery whiteness. The taste is acid, hot, and bitter. The specific gravity is 1.6207. 1193 Properties.

4. This is one of the most deliquescent salts. Exposed to the air for a few hours, it is totally melted. It is sometimes employed in chemistry on account of this property of attracting moisture, to deprive gases of the vapour of water with which they may be combined. For this purpose, the gases are made to pass through tubes which contain dried nitrate of lime. It is owing to a mixture of this salt, that nitre is sometimes deliquescent in the air. The nitrate of lime is extremely soluble in water. One part of cold water dissolves four of this salt. Boiling water dissolves still more. 1194 Action of water.

5. When heated, this salt is very fusible. It melts like oil, and after it becomes dry, it often acquires, during calcination, the property of becoming luminous in the dark. Hence the origin of one of its names. More strongly heated, it is decomposed; gives out red vapours of nitrous gas, oxygen and azotic gases, and there remains behind pure lime. 1195 Of heat.

6. This salt is decomposed by the sulphuric acid, partially by the phosphoric, and by potash and soda. By double affinity it is decomposed by the sulphates of potash, of soda, and ammonia. Sulphate of lime, which is an insoluble salt, is always precipitated. 1196 Of acids.

7. By the analysis of Bergman, the constituent parts of nitrate of lime are the following, 1197 Composition.

Acid,	43
Lime,	32
Water.	25
	100

By the analysis of Mr Kirwan, when it is well dried in the air,

Acid,	57.44
Lime,	32.00
Water,	10.56
	100.00

This salt has not been applied to any use. It is recommended by Fourcroy as a substitute for nitre in the extraction of nitric acid *.

* Fourcroy Connaiss. Chim. ii. p. 151.

4. Nitrite of Lime.

When the nitrite of lime is exposed to heat, till it give out some bubbles of oxygen gas, there remains behind a calcareous nitrite, which converts vegetable blues to green, and gives out a great quantity of red vapour by the action of acids. It seems to be in the state of nitrite of lime, that this compound possesses the phosphorescent property †.

† Ibid. p. 159.

5. Muriate of Lime.

1198 Names. 1. The compound of muriatic acid and lime has been known by the names of *calcareous marine salt*, *fixed sal ammoniac*, and *Homberg's phosphorus*. This salt

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Lime, &c. salt is frequently found in solution in some mineral waters.

1199 Preparation. 2. It is prepared by saturating muriatic acid with carbonate of lime, and evaporating the solution to the consistence of syrup. It crystallizes on cooling.

1200 Properties. 3. The muriate of lime crystallizes in six-sided prisms, terminated by six-sided pyramids. The taste is acrid, bitter, and disagreeable. It is extremely deliquescent in the air. Cold water dissolves nearly double its weight. In a perfectly dry state, it is chloride of calcium. See N° 956. Its specific gravity is 1.76.

1201 Action of heat. 4. Exposed to heat, it becomes soft, melts, and swells up, and then is deprived of its water of crystallization. At a very high temperature it is also deprived of part of its acid. In this state, with an excess of lime, it acquires the property of shining in the dark, from which it has been called *the phosphorus of Homberg*.

1202 Of acids. 5. This salt is decomposed by the sulphuric acid, by the nitric acid, which converts it into the oxymuriatic, and partly by the phosphoric and fluoric acids.

1203 Composition. 6. According to the analysis of Bergman, the constituent parts of this salt are,

Muriatic acid,	31
Lime,	44
Water,	25
	100.

But, according to Mr Kirwan, when it is dried in a red heat, it is composed of

Acid,	42
Lime,	50
Water,	8
	100

1204 Uses. 7. This salt is only employed for chemical experiments, and particularly for the production of artificial cold, by mixing it with snow or pounded ice. Of all the salts employed for this purpose, it seems to have the greatest effect, in consequence of the rapid transition from the solid to the liquid state. To prepare the salt for this purpose, it is most convenient to evaporate it to the consistence of a pretty thick syrup; and then by stirring it constantly as it cools, it is obtained in a dry granulated state, which should be reduced to powder in the cold, and put up in bottles secured with ground stoppers.

6. Hyperoxymuriate or Chlorate of Lime.

1205 Preparation. This salt, which is the compound of hyperoxymuriatic acid and lime, is prepared by putting a quantity of pure white marble, reduced to powder, into one of the bottles of Woulfe's apparatus, half filled with water, and by passing a current of oxymuriatic acid gas into the liquid, till the effervescence ceases, and the powder has nearly disappeared. It acquires a pungent styptic taste, with a reddish colour. It exhales the odour of oxymuriatic acid, and not of the hyperoxymuriatic acid. When ammonia is added to this solution, it is decomposed, and there remains ordinary muriate of lime, from which circumstance it seems doubtful whether there is at all formed a hyperoxymuriate of lime. According to Mr Chenevix this salt is extremely deliquescent, melts at a low heat, in its water of crystallization, and is very soluble in alcohol. The component parts of this salt are, 1206 Composition.

Acid,	55.2
Lime,	28.3
Water,	16.5
	100.0†

† Philos. Trans. 1802, p. 147.

This salt has been successfully employed in the process of bleaching. 1207 Uses.

7. Fluate of Lime.

1. The compound of fluoric acid and lime has been long known under the names of *fluor spar*, *cubic spar*, and *phosphoric spar*, from the figure of its crystals, or from some of its properties. This salt exists in great abundance in nature, and in a state of considerable purity. 1208 History.

2. It may be artificially prepared, by combining fluoric acid with lime in solution in water. The salt is deposited in the form of powder in the bottom of the vessel; and when it is taken out, it is to be well washed and dried. 1209 Preparation.

3. When the fluate of lime is found native, it is generally crystallized in the form of cubes, the angles of which, and sometimes the edges, are truncated. The primitive form of the crystal is the regular octahedron. The form of its integrant particle is the regular tetrahedron. It has frequently a considerable degree of transparency, and exhibits a great variety of colours. The specific gravity is 3.15. It has no taste, is not altered by exposure to the air, and it is insoluble in water. 1210 Properties.

4. When it is exposed to heat, it decrepitates and becomes luminous in the dark; but when it has once given out this light, it cannot be restored, either by exposing it to the sun's rays, or by calcination with charcoal or any other combustible substance. From this circumstance it appears, that this phosphorescent property is owing to some volatile principle which has been a constituent part of the salt. The artificial fluate of lime also possesses the same property, and even, according to Scheele, in a higher degree. When it is strongly heated, it melts into a transparent glass. 1211 Action of heat.

5. This salt is decomposed by the sulphuric, nitric, and muriatic acids, by the carbonates of potash and soda, and by most of the phosphates. It is by decomposing it by means of the sulphuric acid, that the fluoric acid is obtained. 1212 Of acids.

6. The fluate of lime is much employed in small pieces of sculpture, and for ornamental purposes in the formation of cups, vases, and pyramids. It is employed also as a flux for mineral substances. 1213 Uses.

8. Borate of Lime.

This salt, which is a compound of boracic acid and lime, is prepared by pouring a solution of boracic acid into lime water, or by decomposing the soluble alkaline borates by means of lime water. A precipitate is thus formed, of a salt nearly insoluble, which is insipid, and in the form of a white powder. Little is known of the properties of this salt.

9. Phosphate of Lime.

1. The compound of phosphoric acid and lime, known

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known under the name of *calcareous phosphoric salt*, is one of the most interesting discoveries of modern chemistry.

1214 History and preparation. This was made by Scheele and Gahn in 1774, when they proved that it formed the basis of bones. To obtain this salt in a state of purity, a quantity of bones is calcined to whiteness, reduced to powder, and well washed with water to separate the carbonate of soda and other soluble salts which are generally combined with it. The phosphate of lime is thus procured in the form of an insipid white powder. In this state it is generally mixed with a little carbonate of lime, which may be separated by diluted acetic acid, and afterwards washing it with water.

1215 Properties. 2. By this process the phosphate of lime is procured in a state of purity from the solid matter of bones. It has no taste, and does not change the colour of vegetable blues. When it is prepared artificially, it is in the form of white powder, but as it exists in nature, it is found regularly crystallized. This is known to mineralogists under the name of *apatite*, of which there are several varieties. The primitive form of its crystal is the regular six-sided prism; the primitive form of the integrant molecule is a three-sided prism, whose bases are equilateral triangles. It remains unaltered by exposure to the air, and it is soluble in water.

1216 Action of heat. 3. When this salt is exposed to heat, it scarcely undergoes any change; but when it is exposed to the strong heat of a glasshouse furnace, it is converted into a semitransparent porcelain.

1217 Of acids. 4. The phosphate of lime is decomposed by the sulphuric, nitric, muriatic, and other acids; but this decomposition is only partial. Part of the lime only is abstracted, and the salt is converted into an acidulous phosphate of lime.

1218 Composition. 5. The component parts of phosphate of lime, according to Fourcroy and Vauquelin, are,

Acid,	41
Lime,	59
	100

1219 Uses. 6. The phosphate of lime is of great importance in chemistry, for the purpose of extracting phosphoric acid, to be decomposed to obtain phosphorus. It is also employed for making cupels, for polishing metals and precious stones, and for removing spots of grease from linen, paper, and silk. It is used in medicine as a remedy for rickets, to correct the supposed effects of acids in softening the bones.

Superphosphate of Lime.

1220 History. 1. This salt, with an excess of acid, was discovered by Fourcroy and Vauquelin in 1795. Scheele had remarked, that the phosphate of lime was dissolved by an acid in human urine; but he had not ascertained that this combination between the phosphoric acid and the phosphate of lime constituted a permanent salt.

1221 Preparation. 2. It may be obtained artificially by the partial decomposition of the phosphate of lime by means of any acid, or by dissolving this salt in phosphoric acid. This last process, Fourcroy observes, is the most certain; and when the phosphoric acid has dissolved as much as it can take up of the phosphate of lime, the salt is in the state of acidulous phosphate, or superphosphate.

3. This salt crystallizes in small silky threads, or in brilliant plates of a pearly lustre, which are attached to each other, and seem to have the consistence of honey or glue. 1222 Properties. It has a strong acid taste. Exposed to the air, it is slightly deliquescent. It is soluble in water, and the solution produces cold. It is more soluble in boiling water, and crystallizes by cooling.

4. When this salt is exposed to heat, it first melts, 1223 Action of heat. and then swells up and dries. If the temperature be increased, it undergoes the igneous fusion, and is converted into a transparent glass. The phosphoric acid in this salt is more readily decomposed by charcoal than in the neutral phosphate of lime. It is not decomposed by any of the acids, excepting the oxalic. The proportions of its constituent parts are the following: 1224 Composition.

Acid,	54
Lime,	46
	100 *.

* Fourcroy Connaiss. Chim. iii. p. 247.

10. Phosphite of Lime.

1. This salt, composed of phosphorous acid and lime, 1225 Preparation. is formed by the direct combination of the acid with the earth, and when they are saturated, it falls to the bottom in the form of white powder. This powder is re-dissolved with an excess of acid, and in this state of acidulous phosphite of lime, crystallizes by evaporating the solution.

2. When thus obtained, it is in the form of a white 1226 Properties. powder, if it is just neutralized; but with an excess of acid, it forms small prisms or needles. This salt has no taste; it is not changed by exposure to the air; and it is insoluble in water.

3. When it is exposed to heat, it gives out a phos- 1227 Action of heat. phoric light, yields a small quantity of phosphorus, and is converted into a phosphate. By the action of the blow-pipe it melts into a transparent globule.

4. The neutral phosphite of lime is soluble in acids, 1228 Of acids. without being decomposed. The proportions of its con- 1229 Composition. stituent parts are,

Phosphorous acid,	34
Lime,	51
Water,	15
	100

11. Carbonate of Lime.

1. This salt exists in great abundance in nature; 1230 Names. and it is known by great variety of names, as *limestone*, 1231 Preparation. *marble*, *chalk*. It may be prepared artificially, by directly combining carbonic acid with lime; but in this process the proportions of the acid and earth must be accurately adjusted; for, if there is too little acid, the first precipitate which is formed is re-dissolved in the water, and seems to form carbonate with excess of lime. If there be too much acid, the carbonate first precipitated is also re-dissolved, and disappears in this excess of carbonic acid.

2. The carbonate of lime is perfectly tasteless. The 1232 Properties. specific gravity is 2.7. It is frequently found crystallized, and exhibits a great variety of forms. When it is transparent and in the rhomboidal form, it has the property

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Lime, &c. property of double refraction. The primitive form of its crystals is an obtuse rhomboid, whose angles are about $101\frac{1}{2}°$ and $78\frac{1}{2}°$. The integrant molecule has the same form.

3. When it is exposed to the air it undergoes no
1233 change. It is insoluble in water.

Action of heat. 4. Exposed to a strong heat, it decrepitates, and is deprived of its water of crystallization. It becomes white, opaque, and friable. If the heat be increased and continued, the whole of the carbonic acid is dri-
1234 ven off in the state of gas.

Of acids. 5. The carbonate of lime is readily decomposed by all the acids with effervescence, owing to the disen-
1235 gagement of the carbonic acid in the state of gas.

Combination. 6. The component parts of carbonate of lime, as they have been ascertained by the analyses of Bergman and Kirwan, are the following.

	Bergman.	Kirwan.
Acid,	34	45
Lime,	55	55
Water,	11	00
	100	100

12. Arseniate of Lime.

1236
Preparation. This salt, which is a compound of arsenic acid and lime, is prepared by dropping the acid into lime water. A precipitate is formed, which is soluble either with an excess of the base, or the acid. Or it may be formed by dissolving carbonate of lime in arsenic acid. The acidulous arseniate of lime, when it is evaporated, af-
1237 fords small crystals. When this salt is heated, it melts, but is not decomposed *.

Action of heat.

* Fourcroy Connaiss. Chim. x. p. 83.

13. Tungstate of Lime.

1238
Found native. The compound formed by tungstic acid and lime is found native. It is from the mineral called tungsten,
1239 that the metallic substance is obtained which bears this name. When the solution of tungstic acid is added to lime water, a precipitate of tungstate of lime is formed, similar to the native compound tungsten. This mineral is found crystallized. The primitive form of the crystal is the octahedron, which is composed of two four-sided pyramids, applied base to base. It is of a yellowish colour, with some degree of transparency and considerable hardness. It is insoluble in water, and
1240 is scarcely altered by the action of heat. The specific gravity is about six. The component parts of this salt are,

Preparation. Composition.

Tungstic acid,	70
Lime,	30
	100

14. Molybdate of Lime.

15. Acetate of Lime.

1241
Preparation. 1. The compound of acetic acid and lime is formed by dissolving the carbonate of lime in the acid, till it is saturated. By evaporating the solution till a pellicle
1242 forms on the surface, it crystallizes on cooling.

Properties. 2. The crystals of acetate of lime are in the form of small prisms, with a shining silky lustre. The taste is bitter and sour. It is not changed by exposure to the air, but is soluble in water. The specific gravity is 1.005. Lime, &c.

3. When it is exposed to heat, it is decomposed, 1243
partly by the separation of the acid, and partly by its Action of heat.
decomposition. The component parts of this salt, ac- 1244
cording to Dr Higgins, are, Composition.

Acetic acid and water,	64.3
Lime,	35.7
	100.0 †

† Experiments, p. 47.

16. Oxalate of Lime.

The oxalic acid saturated with lime forms an insoluble salt, which may be formed by dropping oxalic acid into any of the acid solutions of lime. The oxalate of lime, thus formed, is a white powder, which converts the syrup of violets to a green. This salt cannot be decomposed by any other acid, the affinity of oxalic acid for lime is so strong. It is on this account that oxalic acid is employed as a test for lime, whether it is in a state of combination or uncombined. This salt may be decomposed by exposing it to heat. The acid itself is driven off, and undergoes decomposition.

The component parts of this salt, according to Bergman, are,

Acid,	48
Lime	46
Water	6
	100

17. Tartrate of Lime.

The compound of tartaric acid and lime may be form- 1245 Preparation.
ed, by dissolving lime in the acid; or by adding a solution of lime in powder to a solution of tartar in boiling water, till it ceases to effervesce, and to redden vegetable blues. The salt precipitates in the form of a white powder, which is insoluble, excepting with an excess of acid. This salt is decomposed by the sulphuric, nitric, and muriatic acids.

18. Citrate of Lime.

This salt, which is a compound of citric acid and 1246 Preparation.
lime, may be formed by the direct combination of the acid and the earth. Small crystals are formed, which are precipitated, and are scarcely fusible in water, excepting with an excess of acid, and from this solution
it may be obtained crystallized. The component parts 1247 Composition.
of this salt are,

Citric acid	62.66
Lime.	37.34
	100.00 ‡

‡ Fourcroy vii. p. 207.

19. Malate of Lime.

1. The compound of malic acid and lime may be 1248 Preparation.
formed by combining the acid with the earth, and neutralizing them. Small irregular crystals are thus obtained, which are scarcely soluble in boiling water,
but become very soluble with an excess of acid. In 1249 Exists in plants.
this state it is the supermalate of lime. This salt is found

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ready formed in some vegetables, as in house-leek and similar succulent plants.

1250 Properties. 2. This acidulous malate of lime has an acid taste. When it is evaporated, it forms a solid, shining substance, analogous to varnish. It is decomposed by the sulphuric and oxalic acids, and also by the alkalies. Lime water added to a solution of this salt, combines with excess of acid, and precipitates the malate of lime.

20. Gallate of Lime.

The gallic acid combined with lime forms a yellowish coloured, insoluble salt, which, with an excess of base, becomes soluble.

21. Benzoate of Lime.

The compound of benzoic acid and lime forms a salt which is very soluble in water. This salt crystallizes in an arborescent form on the sides of the vessel which contains the solution. It is decomposed by the sulphuric, nitric, and muriatic acids. It exists in great abundance in the urine of graminivorous quadrupeds.

22. Succinate of Lime.

The compound of succinic acid and lime forms salts which are not very soluble in water, and are not altered by exposure to the air.

23. Saccolate of Lime.

Saclactic acid and lime form an insoluble salt.

24. Camphorate of Lime.

1251 Preparation. 1. This salt, which is a compound of camphoric acid and lime, is formed by adding lime-water to crystallized camphoric acid. The solution is then to be boiled, filtered, and evaporated to three-fourths of its quantity. As it cools, the salt is deposited.

1252 Properties. 2. The camphorate of lime has no regular shape, unless the evaporation has been properly managed, when it is found in the form of plates lying on each other. It is of a white colour, and has a slightly bitter taste.

1253 Action of water and heat. 3. It effloresces in the air, and falls down into powder. It is scarcely soluble in cold, and requires about 200 parts of boiling water for its solution. When it is exposed to heat, if it be moderate, it melts and swells, but if thrown on red-hot coals, or heated in close vessels, the acid is decomposed and sublimed, and the lime remains pure.

4. It is decomposed by the sulphuric, nitric, and muriatic acid. With the sulphuric acids there is formed an insoluble precipitate. The nitric and muriatic acids precipitate the camphoric acid. This salt is also decomposed by the carbonate of potash, and the phosphate of soda.

5. The component parts of this salt are,

Camphoric acid	50
Lime	43
Water	7
	100 *

* Ann. de Chim. xxvii. 23.

25. Suberate of Lime.

1254 Properties. This salt, which is a compound of suberic acid and lime, does not crystallize, is perfectly white, has a slight saline taste, and does not redden the tincture of turnsole. It is scarcely soluble in cold water. Boiling water dissolves it more abundantly, but as it cools, a part of it is precipitated. When it is placed upon burning coals, it swells up, the acid is decomposed, and the lime remains in the state of powder. This salt is decomposed by the sulphuric, nitric, and muriatic acids, by potash and soda, and their carbonates, and by the phosphate and borate of soda †.

1255 Action of heat.

† Ibid. xxiii. p. 54.

26. Mellate of Lime.

The mellitic acid dropt into lime-water forms a precipitate which is re-dissolved by adding nitric acid. Or when the mellitic acid is mixed with a solution of sulphate of lime, a precipitate is formed of small, gritty crystals, which do not affect the transparency of the water.

27. Lactate of Lime.

The compound of lactic acid and lime forms a deliquescent salt, which is soluble in alcohol.

28. Prussiate of Lime.

The compound of prussic acid and lime is formed by dissolving the lime in the acid. The solution is then to be filtered, and the lime which has not combined with the acid is to be separated by adding carbonic acid in water, in the proportion necessary to precipitate the lime from the same bulk of lime-water. The solution, after a second filtration, must be preserved in close vessels. By distillation the prussic acid is driven off, and the pure lime remains behind. This salt is decomposed by all the other acids, and also by the alkalies.

29. Sebate of Lime.

When sebacic acid is dropped into lime-water the transparency of the water is not disturbed, so that the compound of this acid with lime is soluble in water.

IV. Compounds of Lime with Inflammable Substances.

Lime does not enter into combination with alcohol or ether; but it forms compounds with the fixed oils, which are known by the name of soaps. Lime combines also in small quantity with the volatile oils, forming a similar compound.

Sect. II. *Of Barytes and its Combinations.*

1. For the knowledge of this earth we are indebted to modern chemistry. It was discovered by Scheele in 1774; and its properties were investigated by him, and in the following year by Gahn, who analyzed a mineral which had been distinguished by the name of *ponderous spar*, on account of its weight, and found that it was composed of sulphuric acid and the new earth. It received the name of *terra ponderosa* from Bergman, who also examined its properties, and confirmed the experiments of Scheele and Gahn. Mr Kirwan gave it the name of *barytes*, from the Greek word βαρυς, which signifies heavy. Its properties were farther investigated by Dr Hope, in 1793 *, and by Pelletier, Fourcroy, and Vauquelin, in 1797 †. 1256 History.

2. This earth may be obtained in a state of purity

* Edin. Trans. iv. 36.

† Annal. de Chim. xxi. 113.

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rity by the following process: A quantity of sulphate of barytes, a mineral found in considerable abundance in nature, is first reduced to a fine powder.
1257 Preparation. Mix it with $\frac{1}{8}$th of its weight of charcoal powder, and expose the mixture in a crucible to a strong heat, for several hours. The sulphuric acid, by this process, is decomposed, by being deprived of its oxygen, which combines with the carbon of the charcoal, and forms carbonic acid, which is driven off. The sulphur remains in combination with the earth, forming a sulphuret of barytes. This sulphuret is to be dissolved in water, and nitric acid poured into the solution. The nitric acid combines with the barytes, and forms nitrate of barytes, while the sulphur is precipitated. The solution is to be filtered, and slowly evaporated till it crystallize. The crystals thus formed are then put into a crucible, and exposed to a strong heat. The nitric acid is decomposed, and driven off, and the earth remains behind in a state of purity.

Dr Hope has recommended another process, which is more economical. By this process the sulphate of barytes is decomposed as in the former. The sulphuret which is obtained is thrown into water, that all soluble matters may be dissolved. To the solution, after filtration, a solution of carbonate of soda is to be added. A precipitate takes place in the form of a white powder. This powder is to be washed with water, made up into balls with charcoal, and exposed to a strong heat in a crucible. The balls are afterwards to be thrown into boiling water, when part of the barytes is found dissolved, and, as the water cools, it crystallizes.

1258 Properties and composition. 3. Barytes, as it is obtained by decomposing the nitrate in the first process, is in the form of small, gray, porous masses, which are easily reduced to powder. It has a hot, burning taste; and when introduced into the stomach, is a deadly poison. Its specific gravity is 4.00. It destroys the texture of all animal substances. It converts vegetable blues to a green colour. In many of its properties it is perfectly analogous to the fixed alkalies. It is decomposed by the same process as lime. Its base is called barium. It is a dark grey metal, more than twice the weight of water. Barium is susceptible of a higher degree of oxidation by simply heating barytes in contact with oxygen.

1259 Action of water. 4. When it is exposed to the air, especially if the atmosphere be loaded with moisture, it swells up in a few minutes, becomes hot, and at last falls into a white powder. It is then deprived of part of its acrimony, and is increased in weight 0.22. This is owing to the absorption of water from the atmosphere. If a small quantity of water be thrown upon barytes, it boils up, is strongly heated, is enlarged in volume, and gives out a great quantity of heat. After being slaked in this manner, it is diluted with water, the earth crystallizes, and assumes the appearance of needle-formed crystals, which, at the end of some time, if exposed to the air, spontaneously fall to powder. With a greater quantity of water the barytes is completely dissolved. Cold water takes up about $\frac{1}{20}$ of its weight. This solution changes the syrup of violets to green, and at last destroys the colour. When this liquid is exposed to the air, a thick pellicle is formed on the surface, which is owing to the absorption of carbonic acid from the atmosphere. Boiling water dissolves $\frac{1}{2}$ its weight of pure barytes. The solution affords crystals as it cools. They are in the form of long, four-sided prisms, transparent and white, which effloresce in the air; but the form of the crystals varies according to the rapidity of the evaporation and crystallization. 1260

Of heat. 5. Light has no action on barytes. Heated on charcoal with the blowpipe, it melts into an opaque, gray globule, which soon penetrates the charcoal. Exposed to heat in a crucible, it melts, and attaches itself to the sides of the vessel, to which it adheres strongly, forming a kind of greenish covering. Less strongly heated, it hardens, and internally assumes a bluish green shade. There is no action between barytes and oxygen, azote, hydrogen, or carbon.

I. Phosphuret of Barytes.

1261 Preparation. 1. Barytes enters into combination with phosphorus, forming the compound called *phosphuret of barytes.* This is prepared by introducing a mixture of barytes and phosphorus into a glass tube closed at one end, and exposing the mixture to the heat of burning coals. The two substances rapidly combine together. 1262

Properties. 2. The phosphuret of barytes, thus obtained, is of a dark or shining brown colour, having a metallic appearance, very fusible, and exhaling, when it is moistened, a strong fetid odour: in the dark it is luminous. When it is thrown into water, it is decomposed, giving out phosphorated hydrogen gas, and is gradually converted, by the action of the air and the water, into *phosphate of barytes* *.

* *Fourcroy Connaiss. Chim.* ii. p. 191.

II. Sulphuret of Barytes.

1263 Preparation. 1. A similar combination also takes place between barytes and sulphur. The combination may be formed by introducing barytes and sulphur well mixed together, into a crucible, and exposing them to a red heat. At that temperature the mixture melts, and the compound which is formed is the sulphuret of barytes. 1264

Properties. 2. This substance is very soluble in water, which it instantly decomposes; and, when it is saturated with the sulphurated hydrogen which is formed, it is converted 1265 Hydrogenated sulphuret. into a hydrogenated sulphuret of barytes, which deposits by cooling, crystals of different forms, sometimes in that of small needles, sometimes in that of large six-sided prisms, sometimes in the form of octahedrons, and often in that of small, brilliant, hexagonal plates, which are crystals of sulphurated hydrogen and barytes, denominated by Berthollet, *hydrosulphuret of barytes.* When the sulphuret of barytes is dissolved in water, it instantly exhales the fetid odour of sulphurated hydrogen gas. The liquid which has deposited crystals of hydrosulphuret of barytes, retains a hydrogenated sulphuret in solution. When it is exposed to the air, this solution becomes of an orange yellow. Crystals of hydrosulphuret of barytes, with spots or yellowish plates, are often observed in the midst of the white masses.

3. The sulphuret of barytes is most remarkable for the great rapidity with which it decomposes water, and the great quantity of the sulphurated hydrogen with which it combines, forming the hydrosulphuret of barytes; which latter is slowly, and with difficulty, decomposed by the air, and the great proportion of sulphurated hydrogen gas which is disengaged by the action of acids, without any precipitation of sulphur.

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1266 Three compounds. 4. Thus there are three different combinations of sulphur with barytes. In the first, the sulphur is directly combined with the barytes, as when they are exposed to heat in the state of dryness, which is the simple sulphuret of barytes. In the other, the sulphur combined with the hydrogen, is in the state of hydrosulphuret of barytes. This compound is prepared by passing sulphurated hydrogen gas into water holding barytes in solution, which, as it combines with the gas, becomes more soluble, and is condensed and absorbed by the water. The distinctive character between the latter combination and that of the sulphuret of barytes is, that the first, by the action of acids, only gives out sulphurated hydrogen gas, without any deposition of sulphur; and the second, exposed to heat, is deprived of its sulphur, which is sublimed, without affording sulphurated hydrogen gas. Between these two states, there is an intermediate combination, in which the sulphuret of barytes holds in solution more or less sulphurated hydrogen; so that, by the action of acids, it affords sulphurated hydrogen gas, with a deposition of sulphur at the same time. To this intermediate compound, Berthollet has given the name of *hydrogenated sulphuret of barytes* *.

* Fourcroy *Connaiss. Chim.* ii. p. 191.

III. Compounds of Barytes with the Acids.

1267 Affinities. Barytes enters into combination with the acids, and forms with them compounds, which are distinguished by the name of *salts*. The order of the affinities of barytes for the acids, according to Bergman, is the following:

Sulphuric acid,
Oxalic,
Succinic,
Fluoric,
Phosphoric,
Saclactic,
Nitric,
Muriatic,
Suberic,
Citric,
Tartaric,
Arsenic,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Prussic.

1. Sulphate of Barytes.

1268 Found native. 1. This salt, which is a compound of sulphuric acid and barytes, was formerly distinguished by the name of *heavy spar*, *phosphoric spar*, or *Bolognian stone*. It exists in great abundance in nature, particularly accompanying metallic veins; from which circumstance, probably, and from its great weight, it was supposed to contain a metallic substance. It is rarely formed artificially, as that found in nature is sufficiently pure.

1269 Properties. 2. The sulphate of barytes is the heaviest of all the salts, the specific gravity being 4.4. It has neither taste nor smell. Sometimes it is found crystallized, and sometimes compact. There is a considerable variety among the forms of its crystals. The primitive form of sulphate of barytes is a rhomboid, with right angles at the bases, whose angles are $101\frac{1}{2}°$ and $78\frac{1}{2}°$ The integrant molecule is the same.

3. This salt remains unchanged in the air, and it is insoluble in water. When it is suddenly heated, it decrepitates. By the action of a strong heat, it melts with difficulty; and before the blow-pipe it fuses, and is converted into a white opaque globule. It is decomposed at a red heat by hydrogen and charcoal, and is converted into a sulphuret which is phosphoric. This was formerly called, from an accident, *Bolognian phosphorus*. A piece of the sulphate of barytes was found in the neighbourhood of Bologna, by a shoemaker of that city, who, suspecting that it contained silver, put it into the fire to separate the metal. He found no metal, but he observed that by heating it acquired the property of shining in the dark, and thence it obtained the name of Bolognian stone or phosphorus. 1270 Action of heat.

This salt is decomposed by the carbonates of potash and soda, either by exposing them to a strong heat in a crucible, or by boiling them together in solution.

According to the different analyses which have been made to ascertain the constituents of this salt, it appears that there is a considerable difference between the natural and artificial sulphate of barytes, as in the following table: 1271 Composition.

	Native.	Artificial.
Acid	13	33
Barytes	84	64
Water	3	3
	100	100*.

* Fourcroy *Connaiss. Chim.* iii. p. 25.

By another analysis, when the artificial sulphate was heated to redness, the component parts were found, according to

	Thenard †.	Chenevix ‡.
Acid	25.18	24
Barytes	74.82	76
	100.00	100

† *Ann. de Chim.* xxxii. p. 266.
‡ *Nichol. Jour.* ii. 8vo. p. 196.

2. Sulphite of Barytes.

1. This compound of sulphurous acid and barytes is formed by passing sulphurous acid gas into water, in which is mixed, or suspended, carbonate of barytes in the state of fine powder; or by the direct combination of sulphurous acid and barytes, either solid or in solution. In whatever way it is prepared, the salt is deposited in the form of powder, or crystallized. 1272 Preparation.

2. The crystals of sulphite of barytes are sometimes in the form of small, brilliant, and opaque needles, or very hard transparent crystals in the form of tetrahedrons, with truncated angles. It has little taste. The specific gravity is 1.6938. It is scarcely altered when exposed to the air, and is insoluble in water. When it is exposed to heat, sulphur is driven off, and there remains a sulphate of barytes. It is decomposed by the sulphuric and muriatic acids, with the disengagement of sulphurous acid. 1273 Properties.

3. This salt has been applied to no use, excepting 1274 Uses.
for

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for the chemical purpose of ascertaining the purity of sulphurous acid. It is employed in this way by Fourcroy. If there be any mixture of sulphurous acid with the sulphuric, it may be detected by this salt; for as there is a stronger affinity between sulphuric acid and barytes than between sulphurous acid and the same earth, the sulphuric acid, if any be present, combines with the barytes, and forms with it an insoluble salt, which is precipitated.

1275 Composition. 4. The following are the proportions of the constituent parts of this salt.

Sulphurous acid	39
Barytes	59
Water	2
	100 *.

* Fourcroy Connaiss. Chim. iii. p. 75.

3. Nitrate of Barytes.

1276 Preparation. This compound of nitric acid and barytes is prepared by saturating the acid with native carbonate of barytes; or, by the decomposition of sulphuret of barytes, by nitric acid. By filtration and evaporation this salt crystallizes.

1277 Properties. 2. The crystals of nitrate of barytes are in the form of regular octahedrons, or in small brilliant plates. The specific gravity is 2.9149. It has a hot, acrid, and austere taste, and is little changed by being exposed to the air. It is soluble in 12 parts of cold, and in about three or four parts of boiling water. When placed upon burning coals, it decrepitates, boils up, and becomes dry, and gives out sparks round the points where it comes in contact with the burning coal. When it is heated in a retort, it gives out a little water, oxygen gas, and azotic gas; and there remains behind, the barytes in the form of a solid, gray, porous mass.

1278 Composition. The constituent parts of this salt, according to Fourcroy, Vauquelin, and Kirwan, are the following:

	Fourcroy and Vauquelin †.	Kirwan ‡.
Nitric acid	38	32
Barytes	50	57
Water	12	11
	100	100

† Ibid. iii. p. 106.
‡ Nichol. Jour. iii. p. 115.

This salt is only employed for detecting sulphuric acid in nitric acid, and to be decomposed for the purpose of obtaining pure barytes.

4 Nitrite of Barytes.

Nothing farther is known of this salt, than that it is formed when the nitrate of barytes is decomposed in a retort by means of heat. If the operation be stopped at the time that a third part of the oxygen gas has been disengaged, the nitrite of barytes remains.

5. Muriate of Barytes.

1279 History. 1. This salt, which is a compound of muriatic acid and barytes, was first investigated by Scheele and Bergman, and little more has been since added by the experiments and researches of other chemists.

1280 Preparation. 2. It is prepared by the direct combination of muriatic acid with the carbonate of barytes; or, by decomposing the sulphuret of barytes by the muriatic acid, filtering the solution, and evaporating till a pellicle appear on the surface. If it be allowed to cool slowly, crystals of muriate of barytes are formed. But the sulphate of barytes, which is employed, sometimes contains iron: so that a muriate of this metal is formed along with the muriate of barytes. To separate the iron, the mixture is to be calcined, by which the acid is driven off, and the iron remains behind in the state of oxide, which is insoluble in water.

3. The primitive form of the crystals of this salt is a four-sided prism with square bases. The form of the integrant particles is the same. It crystallizes in tables, or in eight-sided pyramids. The taste is acrid, astringent, and metallic. The specific gravity is 2.8257. When dried, it is converted into a chloride of barium. 1281 Properties.

4. It undergoes no change by exposure to the air. It is soluble in five or six parts of cold water, but boiling water dissolves more; and, on cooling, the salt crystallizes. 1282 Action of water.

5. When exposed to heat, it decrepitates, loses its water of crystallization, dries, falls down to powder, and at last melts; but no heat that can be applied decomposes it. 1283 Of heat.

6. This salt is decomposed by the sulphuric and nitric acids, and a precipitation of nitrate or of sulphate of barytes is formed. 1284 Of acids.

7. The constituent parts of this salt, according to Mr Kirwan, are, 1285 Composition.

		When dried.
Acid,	20	23.8
Barytes,	64	76.2
Water,	16	00.0
	100	100.0

8. This is one of the most delicate tests for detecting sulphuric acid in any solution. Water, which holds 0.0002 parts of sulphuric acid, exhibits a visible precipitate by a single drop of the solution of muriate of barytes. Nay, there is a slight cloud in a few minutes produced by the addition of a solution of this salt to water which holds 0.00009 parts of sulphuric acid in solution. The muriate of barytes has been proposed and recommended as a cure for scrophula; and it is said, in some cases in which it has been used, with good effect; but it ought to be administered with the utmost caution. The carbonate of barytes is one of the most active poisons, and probably all the salts of this earth are possessed of similar properties. The dose should not exceed five or six drops of the solution at first *. 1286 Uses.

* Fourcroy Connaiss. Chim. iii. p. 267.

6. Hyperoxymuriate, or Chlorate of Barytes.

1. The compound of hyperoxymuriatic acid and barytes was formed by Mr Chenevix. The process which he followed was, to cause a current of oxymuriatic acid gas to pass through a solution of a large quantity of barytic earth in warm water. This salt he found soluble in four parts of cold, and less of warm water; but as it crystallizes like the muriate of this earth, and has the same degree of solubility, he could not separate the hyperoxymuriate from the muriate, which was formed at the same time. He therefore thought of obtaining it by double affinity, as in the following process. 1287 Preparation.

2.

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Barytes, &c.

2. When phosphate of silver is boiled with muriate of barytes, a double decomposition takes place; muriate of silver and phosphate of barytes are formed, both of which being insoluble, are precipitated. But the phosphate of silver does not decompose the hyperoxymuriate of barytes. When therefore the muriate and hyperoxymuriate of barytes are boiled with phosphate of silver, the muriate of barytes only is decomposed. The muriate of silver and the phosphate of barytes are precipitated, and the hyperoxymuriate of barytes remains in solution. When this salt is decomposed by the stronger acids, it is accompanied with a flash of light, which Mr Chenevix conjectures, is owing to the relative proportionate affinities, and consequently the greater rapidity of the disengagement.

1288 Composition. The proportions of this salt are,

Hyperoxymuriatic acid,	47.0
Barytes,	42.2
Water,	10.8
	100.0 *

* Phil. Trans. 1802. p. 147.

7. Fluate of Barytes.

This compound of fluoric acid and barytes may be formed, by pouring fluoric acid into a solution of nitrate or muriate of barytes. A precipitate is formed, which is the fluate of barytes. This salt is decomposed with effervescence by the sulphuric acid, and it is precipitated by lime water. Of the proportions of its constituent parts and other properties, nothing is known.

8. Borate of Barytes.

The compound of boracic acid and barytes is formed by pouring a solution of boracic acid into a solution of barytes. An insoluble white powder is precipitated, which, according to Bergman, may be decomposed, even by the weak vegetable acids.

9. Phosphate of Barytes.

1289 Preparation. 1. The compound of phosphoric acid and barytes has been only examined by Vauquelin. It is prepared, either by the direct combination of phosphoric acid with barytes, or the carbonate of barytes; or by precipitating a solution of nitrate or muriate of barytes, by means of an alkaline phosphate. The phosphate of barytes is precipitated in the form of powder.

1290 Properties. 2. This salt is in the form of white powder, without any appearance of crystallization. It is not altered by exposure to the air, and is insoluble in water. The specific gravity is 1.2867.

1291 Action of heat. 3. This salt at a high temperature is fusible. It is converted into a vitreous matter or gray enamel. Before the blow-pipe, on charcoal, it gives out a yellow phosphoric light. The vitreous globules become opaque on cooling. It is decomposed by the sulphuric acid. The phosphoric and phosphorous acids, when added in excess, have the property of re-dissolving the salts which they form with barytes.

10. Phosphite of Barytes.

1292 Preparation. 1. This compound of phosphorous acid and barytes, is formed by the direct combination of the acid with the earth; or by precipitating the soluble phosphites by a solution of barytes. By the last process the salt is obtained in the greatest purity.

2. The phosphate of barytes is in the form of a white powder, which is insipid, not altered by exposure to the air, not very soluble in water without an excess of acid, by which means it is converted into the acidulous phosphite. 1293 Properties.

3. The phosphite of barytes melts under the blow-pipe into a globule, which is surrounded with a most brilliant light. The vitreous globule becomes, on cooling, white and opaque. 1294 Action of heat.

4. This salt is decomposed by most of the acids; by lime and lime water. The other alkaline and earthy bases combine with the excess of phosphorous acid, when it is in the state of acidulous phosphate, and there remains behind a neutral phosphite. 1295 Of acids.

5. The component parts of this salt are, 1296 Composition.

Phosphorous acid,	41.7
Barytes,	51.3
Water,	7.0
	100.0 *

* Fourcroy Connaiss. Chim. ii. p. 251.

11. Carbonate of Barytes.

1. This compound of carbonic acid and barytes has been known by the names of *aërated heavy spar*, *aërated baroselenite*, and *witherite* from the name of Dr Withering, who first discovered that it is a natural production. Its nature and properties were first investigated by Scheele and Bergman, about the year 1776, and since that time by Kirwan, Hope, Klaproth, Pelletier, Fourcroy and Vauquelin. 1297 Names.

2. The carbonate of barytes is found native in striated, lamellated, semitransparent masses. The primitive form of its crystals is the six-sided prism. The specific gravity is 4.331. 1298 Native.

3. The carbonate of barytes may be prepared artificially, by exposing a solution of pure barytes to the air, or by passing carbonic acid gas into the solution. It may be prepared also in the dry way, by mixing together sulphate of barytes and carbonate of potash or soda, and exposing the mixture to strong heat; or by decomposing, by means of carbonate of potash, soda, or ammonia, the nitrate or muriate of barytes in solution in water. By whatever processes the carbonate of barytes is obtained, it is in the form of a white tasteless powder. When thus prepared, the specific gravity is 3.763. 1299 Prepared by art.

4. It undergoes no change by exposure to the air. Cold water dissolves $\frac{1}{4304}$; boiling water $\frac{1}{2304}$ part. 1300

5. The carbonate of barytes undergoes little change when it is exposed even to the strongest heat. The artificial carbonate loses about 0.28 of its weight by calcination, while the native carbonate becomes white and opaque, and is converted into a bluish green colour, without any perceptible loss of weight; but if it be heated in a black lead crucible, or if it be formed into a paste, with 100 parts of the salt to 10 of charcoal, the carbonic acid is separated. Action of heat.

6. The component parts of the carbonate of barytes are the following: 1301 Composition.

Native

Barytes, &c.

Native Carbonate.

	Withering.	Fourcroy.
Acid	20	10
Barytes	80	90
	100	100

Artificial Carbonate.

	Bergman.	Pelletier.
Acid	7	22
Barytes	65	62
Water	28	16
	100	100

When both the natural and artificial are exposed to a red heat, the component parts, as ascertained by Mr Kirwan, are,

Acid	22
Barytes	78
	100

1302 Uses. 7. This salt has been found native only in small quantity, otherwise it is supposed, that it might be of great use for the preparation of barytic salts, which promise great service in several arts and manufactures. It has been proposed to employ it in medicine; but in experiments on animals, it has been found to act as a most deadly poison. Great caution, therefore, should be observed in employing it as an internal remedy *.

* *Fourcroy* iv. 20.

12. Arseniate of Barytes.

The compound of arsenic acid and barytes is formed by dissolving the earth in the acid. It is an insoluble, uncrystallized salt; but with an excess of acid it becomes soluble, and is decomposed by sulphuric acid. It melts when exposed to a strong heat, but is not decomposed.

13. Tungstate of Barytes.

With the tungstic acid, barytes forms an insoluble salt.

14. Molybdate of Barytes.

Barytes with the molybdic acid forms a salt which has very little solubility.

15. Chromate of Barytes.

It is little known, but said to be insoluble in water.

16. Columbate of Barytes.

17. Acetate of Barytes.

1303 Preparation. 1. This salt, which is a compound of acetic acid and barytes, may be prepared by directly combining the acid with the earth; or by decomposing sulphuret of barytes by means of acetic acid. By evaporating the solution, it may be obtained crystallized.

1304 Properties. 2. The crystals of the acetate of barytes are in the form of fine transparent prisms. The specific gravity is 1.828. This salt has an acid bitter taste, effloresces in the air, is very soluble in water, is decomposed by the carbonates of the alkalies, but not by the alkalies themselves, or the pure earths.

3. This salt may be employed to detect the presence and quantity of sulphuric acid in solutions, particularly in vinegar, which may be adulterated with the addition of this acid †. 1305 Uses.

† *Fourcroy* viii. 196.

18. Oxalate of Barytes.

1. The compound of oxalic acid and barytes is formed by adding the acid to a solution of barytes in water. A white powder precipitates, which is oxalate of barytes; it is insoluble in water. With an excess of oxalic acid, this precipitate is dissolved, and small angular crystals are formed. 1306 Preparation.

2. If these crystals are dissolved in boiling water, they become opaque, and fall down in the form of an insoluble powder, for the water combines with the excess of acid, which held them in solution. 1307 Action of heat.

19. Tartrate of Barytes.

The compound of tartaric acid and barytes forms a salt in the state of white powder, which has little solubility, excepting with an excess of acid. It is decomposed by the sulphuric, nitric, muriatic, and oxalic acids.

20. Citrate of Barytes.

1. The compound of citric acid and barytes forms a salt, by adding the earth to a solution of the acid. A flocculent precipitate at first appears, which is dissolved by agitation. The precipitate afterwards becomes permanent when the acid is saturated. 1308 Preparation.

2. This salt, which is at first deposited in the form of powder, shoots out afterwards into a kind of vegetation, of a silvery whiteness, with great brilliancy and beauty. It is soluble in a great proportion of water. This salt is composed of

Acid	50
Barytes	50
	100

21. Malate of Barytes.

The compound of malic acid and barytes is formed by adding the acid to a solution of the earth in water. A crystallized, soluble salt is precipitated.

22. Gallate of Barytes.

The compound of gallic acid and barytes is formed by the direct combination of the acid with the earth. A salt is thus formed, which is not very soluble, but with an excess of the base.

23. Benzoate of Barytes.

Benzoic acid combines with barytes, and forms a salt which is soluble in water, crystallizes, undergoes no change by exposure to the air, and is decomposed by heat and the stronger acids.

24. Succinate of Barytes.

Barytes forms, with succinic acid, a salt which has little solubility.

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25. Saccolate of Barytes.

This salt is insoluble in water.

26. Camphorate of Barytes.

1309 Preparation. 1. The compound of camphoric acid and barytes is formed by adding the crystallized acid to the solution of the earth, and then boiling the mixture. It is afterwards to be filtered and evaporated to dryness. What remains is camphorate of barytes.

1310 Properties. 2. This salt does not crystallize; but when it is slowly evaporated, small plates are deposited, which seem transparent in the liquid, but become opaque when exposed to the air. It has scarcely any taste; but an impression remains on the tongue, which is slightly acid and bitter.

3. This salt undergoes no change by exposure to the air. It is only soluble in 600 parts of water at the boiling temperature.

1311 Action of heat. 4. When exposed to the action of the blow-pipe, the acid is volatilized, and the earth is converted into a vitreous substance. The camphoric acid, as it burns, first exhibits a blue, then a red, and at last a white flame.

5. This salt is decomposed by the sulphuric, nitric, and muriatic acids, and by the oxalic, tartaric, and citric *.

* *Ann. de Chim.* xxvii. p. 28.

27. Suberate of Barytes.

This salt does not crystallize, and is only soluble in water with an excess of acid; when exposed to heat, it swells up and melts, and is decomposed by the sulphuric, nitric, muriatic, and oxalic acids †.

† *Ibid.* xxiii. 52.

28. Mellate of Barytes.

By adding mellitic acid to a solution of acetate of barytes, there is formed a flaky precipitate, which is re-dissolved with the addition of more acid. When the acid is poured into a solution of muriate of barytes no precipitate is formed; but a short time afterwards a group of transparent needle-formed crystals is deposited.

29. Lactate of Barytes.

Barytes forms with lactic acid, a deliquescent salt.

30. Prussiate of Barytes.

Prussic acid and barytes form a salt which is very little soluble in water, and is decomposed, not only by the sulphuric acid, but even by carbonic.

31. Sebate of Barytes.

Sebacic acid, added to a solution of barytes in water, forms no precipitate; from which it is inferred that the sebate of barytes is insoluble in water.

Sect. III. *Of Strontites and its Combinations.*

1312 History. 1. This earth was not discovered till about the year 1791 or 1792. Dr Crawford, indeed, previous to this period, in making some experiments on what he supposed was a carbonate of barytes, and observing a striking difference between this mineral and the carbonate of barytes which he had been accustomed to employ, conjectured that it might contain a new earth; and he sent a specimen to Mr Kirwan for the purpose of analyzing it. This conjecture was fully verified by the experiments of Dr Hope ‡, Mr Kirwan, and M. Klaproth, who were all engaged in the same analysis nearly about the same time. Strontites is found native in combination with carbonic and sulphuric acids. With the former it is found in considerable quantity in the lead mines of Strontian in Argyleshire, from which it has derived its name *strontites*, or *strontian* as it is called by others. The nature and properties of this earth have been still farther investigated by Pelletier, Fourcroy, and Vauquelin.

‡ *Edin. Trans.* iv. 3.

2. This earth may be obtained in a state of purity, 1313 Preparation. either by exposing the carbonate of strontites, mixed with charcoal powder, to a strong heat, by which the carbonic acid is driven off; or, by dissolving the native salt in nitric acid, and decomposing the nitrate of strontites thus formed, by heat. Strontites obtained by either of these processes, is in small porous fragments of a greenish white colour. It has an acrid, hot, 1314 Properties. alkaline taste, and converts vegetable blues to green. The specific gravity is 1.647. It is decomposed by the same process as lime. Strontium, its base, bears a very near resemblance to barium.

3. Light has no perceptible action upon this earth. 1315 Action of heat. When it is exposed to heat, it may be kept a long time, even in a red heat without undergoing any change, or even the appearance of fusion. By the action of the blow-pipe it is not melted, but is surrounded with a very brilliant white flame.

4. When a little water is thrown on strontites, it 1316 Of water. exhibits the same appearance as barytes. It is slaked, gives out heat, and then falls to powder. If a greater quantity of water be added, it is dissolved. According to Klaproth it requires 200 parts of water at the ordinary temperature of the atmosphere for its solution. Boiling water dissolves it in greater quantity, and when the solution cools, it affords transparent crystals. These crystals are in the form of rhomboidal plates, or in that of flattened silky needles, or compressed prisms. The specific gravity is 1.46. These crystals effloresce in the air, and have an acrid hot taste. The solution of this earth in water is acrid and alkaline, and converts vegetable blues to green. It is soon covered with a pellicle, by absorbing carbonic acid from the atmosphere.

5. Strontites has the property of communicating a purple colour to flame.

6. The order of the affinities of strontites is the following: 1317 Affinities.

Sulphuric acid,
Phosphoric,
Oxalic,
Tartaric,
Fluoric,
Nitric,
Muriatic,
Succinic,
Acetic,
Arsenic,
Boracic,
Carbonic.

L

I. Phosphuret of Strontites.

The phosphuret of strontites is prepared in the same way as the phosphuret of barytes.

II. Sulphuret of Strontites.

1318 Preparation. The sulphuret of strontites is formed by exposing sulphur and the earth in a crucible, to heat. This sulphuret is soluble in water, by means of sulphurated hydrogen, which is disengaged by the decomposition of the water. The strontites thus combined with sulphurated hydrogen, forms a hydrosulphuret of strontites; and if this solution be evaporated, the hydrosulphuret of strontites may be obtained in crystals, and the hydrogenated sulphuret remains, as in similar compounds, in solution. When the hydrogenated sulphuret is decomposed by means of an acid, the sulphurated hydrogen gas which is disengaged, burns with a beautiful purple flame, on account of holding in solution a small quantity of the earth, which communicates this property.

III. Compounds of Strontites with the Acids.

1. Sulphate of Strontites.

1. The compound of sulphuric acid with strontites may be formed by adding sulphuric acid to a solution of strontites in water, and it is obtained in the state of a white powder. It is found native in different places, crystallized in fine needle-formed prisms. It has no taste, and is scarcely soluble in water. It suffers no change in the air. By the action of the blow-pipe it gives out a yellowish purple light. It is not decomposed by any of the acids; but it is decomposed by the carbonate of potash and soda, by the barytic salts, by the sulphates of potash and of soda, the phosphates of potash, soda, and ammonia, and by the borate of ammonia.

2. The component parts of this salt, according to Vauquelin, are,

Acid	46
Strontites	54
	100

But according to Klaproth, Kirwan, and others,

Acid	42
Strontites	58
	100

2. Sulphite of Strontites.

This salt is yet unknown.

3. Nitrate of Strontites.

1. The compound of nitric acid and strontites, is formed by precipitating, by means of nitric acid, the sulphuret of strontites, obtained from the decomposed sulphate, or by dissolving the carbonate of strontites in the acid. By evaporation it may be obtained in crystals.

2. The crystals of nitrate of strontites are in the form of octahedrons. The taste of this salt is cool and pungent. It is not altered by exposure to the air. The specific gravity is 3.0061. It is soluble in 15 parts of cold water, and much more soluble in boiling water, in which it crystallizes on cooling. Exposed to sudden heat it decrepitates. When it is subjected to heat in a crucible, it swells up, gives out oxygen and nitrous gas, and there remains behind pure earth. This salt has the property of communicating a purple flame to combustible substances with which it is mixed; as when a little of the salt in powder is thrown on the wick of a candle.

3. The component parts of this salt are, according to

	Vauquelin.	Kirwan.
Acid	48.8	31.7
Strontites	47.6	36.21
Water,	4.0	32.72
	100.0	100.00

4. Nitrite of Strontites.

The properties of this salt have not been examined.

5. Muriate of Strontites and Chloride of Strontium.

1319 Preparation. 1. The compound of muriatic acid and strontites is prepared by dissolving carbonate of strontites in the acid. By evaporating the solution, the salt is obtained crystallized. When perfectly dry, it becomes a chloride of strontium.

1320 Properties. 2. This salt crystallizes, in long, slender, hexagonal prisms. The taste is cooling and pungent. The specific gravity is 1.4402. It is not altered by exposure to the air. It is very soluble in water. Three parts of the salt are dissolved in two parts of cold water. These crystals, which are soluble in alcohol, communicate a purple colour, which is the distinguishing characteristic of this salt. When heated, it melts, and parts with its water of crystallization, without being decomposed, and there remains behind a semitransparent enamel. This salt is decomposed by a very strong heat. It is decomposed also by the sulphuric, nitric, and phosphoric acids; and by potash, soda, and barytes.

1321 Composition. 3. The constituent parts of this salt are, according to

	Vauquelin.	Kirwan.
Acid	23.6	18
Strontites	36.4	40
Water	40.0	42
	100.0	100

6. Hyperoxymuriate, or Chlorate of Strontites.

1322 Preparation. 1. This combination of hyperoxymuriatic acid and strontites was prepared by Mr Chenevix, by a similar process to that which he employed in the formation of barytes with the same acid: and in many of its properties it is analogous.

2. The crystals of this salt are in the form of needles.
1323 Composition. They melt in the mouth, and give the sensation of cold. It is composed of

Acid	46
Strontites	26
Water	28
	100 *

* Phil. Trans. 1802.

7.

Strontites, &c.

7. Fluate of Strontites.

The properties of this salt have not yet been investigated.

8. Borate of Strontites.

This compound of boracic acid and strontites is in the form of a white powder, and requires 130 parts of water for its solution. It converts the syrup of violets to a green colour, from which it is inferred, that it contains an excess of the earth.

9. Phosphate of Strontites.

1324 Preparation. 1. The compound of phosphoric acid and strontites, is formed by dissolving the carbonate of the earth in acid; or by mixing together the solutions of muriate of strontites with those of the alkaline phosphates.

1325 Properties. 2. It is thus obtained in the form of white powder, which is perfectly tasteless. It is not altered by exposure to the air. It is insoluble in water, without an excess of acid. It melts under the blow-pipe into a white enamel, and gives out a purple, phosphorescent light.

3. The constituent parts of this salt are,

Acid	41.24
Strontites	58.76
	100.00

10. Phosphite of Strontites.

The name of this salt is unknown.

11. Carbonate of Strontites.

1326 Found native. 1. This salt is found native; and, as we have already mentioned, was pointed out by Dr Crawford as different from the carbonate of barytes, with which it had been formerly confounded.

1327 Preparation. 2. It may be prepared artificially, by saturating a solution of strontites in water with carbonic acid; or, by precipitating soluble salts with a base of this earth, by means of alkaline carbonates. The carbonate of barytes crystallizes in needles, or in six-sided prisms. It has no taste. The specific gravity is 3.6750. It is

1328 Properties. not changed by exposure to the air, and it is nearly insoluble in water. When it is strongly heated in a crucible, to produce fusion, it is deprived of part of its carbonic acid. When heated under the blow-pipe, it melts into an opaque, vitreous globule, and gives out a purple flame.

1329 Composition. 3. The component parts of this salt, according to different chemists, are,

	Hope.	Klaproth and Kirwan.	Pelletier.
Acid	30.2	30.	30
Strontites	61.2	69.5	62
Water	8.6	0.5	8
	100.0	10.00	100

12. Arseniate of Strontites.

When arsenic acid is dropped into a solution of strontites in water, a copious precipitate is formed, which is redissolved when there is an excess of acid. When the arseniate of strontites is neutralized, it is only in a slight degree soluble in water *.

13. Tungstate of Strontites.	Unknown.
14. Molybdate of Strontites.	Unknown.
15. Cromate of Strontites.	Unknown.
16. Columbate of Strontites.	Unknown.

17. Acetate of Strontites.

1330 Preparation. 1. This compound of acetic acid and strontites is formed by dissolving the carbonate in the acid. By evaporation the salt may be obtained crystallized.

1331 Properties. 2. The crystals remain unaltered by exposure to the air. They change vegetable blues to green, and are equally soluble in hot and cold water †.

18. Oxalate of Strontites.

The compound of oxalic acid and strontites is formed by the direct combination of the acid with the earth in solution. A precipitate appears in the form of a white powder, which is nearly insoluble in water. It is decomposed by heat.

The component parts of this salt are,

Acid	40.5
Strontites	59.0
	100.0

19. Tartrate of Strontites.

1. This salt is formed by dissolving the earth in the acid. The crystals are in the form of small triangular tables; they are not altered by the air, are insipid to the taste, and soluble in 320 parts of boiling water.

2. The constituent parts of this salt are,

Acid and water	47.12
Strontites	52.88
	100.00

20. Citrate of Strontites.

1. This combination of citric acid with strontites may be formed by mixing together a solution of nitrate of strontites and citrate of ammonia. A double decomposition takes place, but no precipitate is formed. By slow evaporation, crystals of citrate of strontites may be obtained.

2. This salt is soluble in water.

21. Malate of Strontites.

This salt is scarcely known.

22. Gallate of Strontites.

Little known also.

23. Benzoate of Strontites.

Unknown.

24. Succinate of Strontites.

Succinic acid combines with strontites, and forms crystals, which may be obtained by slow evaporation.

12.

* Edin. Trans. iv. 17.

† Edin. Trans. iv. p. 14.

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25. Camphorate, suberate, mellate, lactate, prussiate, and sebate of strontites. Unknown.

Sect. IV. *Of Magnesia and its Combinations.*

1332 History. 1. Magnesia was first known about the beginning of the 18th century, when it was sold by a Roman canon, under the name of *magnesia alba* or *white magnesia*, and *the powder of the count of Palma*, as a cure for diseases; and like many new remedies, it was considered as universal. In the year 1707, Valentini discovered that this boasted *panacea* was the produce of the calcined ley which remains after the preparation of nitre. He gave it the pompous name of *the laxative powder of many virtues*. In the year 1709, Slevogt described the method of obtaining it by precipitation, from the mother ley of nitre. Lancisi and Hoffmann examined some of its properties in 1717 and 1722; and although the latter discovered that it formed different combinations with acids from those of lime, it was generally confounded with this latter substance.

But the nature of magnesia was not fully known, till Dr Black, in 1755, entered upon his celebrated investigations of the different properties of this substance, lime and the alkalies, in the mild and caustic state. Margraaf published the result of his experiments and researches on it in 1759, in which he gave many distinctive characters of this earth, and of its combinations; and, at last, by the observations of Bergman, published in 1775, and those of Butini of Geneva in 1779, the nature and properties of magnesia were fully demonstrated.

1333 Preparation. 2. Magnesia, although it exists in great abundance in combination with other substances, has never been found perfectly pure in nature. The process by which it may be obtained in greatest purity, is the following. A quantity of Epsom salt, which is a compound of sulphuric acid and magnesia, is to be dissolved in water, and then precipitated by potash. The precipitate which is formed is to be well washed and dried, both with cold and hot water, to separate any saline matters with which it may be mixed. The nature of this process is obvious. The potash has a stronger affinity for sulphuric acid than magnesia. It therefore combines with the acid, and the magnesia is precipitated.

1334 Properties and analysis. 3. Magnesia, when it is obtained pure, is in the form of a fine white powder, or in white friable cakes resembling starch. It has no smell, and no sensible taste; but becomes dry, and leaves on the tongue a slight sensation of bitterness. Its specific gravity, according to Kirwan, is 2.330. It gives a slight tinge of green to syrup of violets, or other delicate vegetable blues. It is decomposed by the same process as lime; and an amalgam of magnium, its base, is obtained. This base itself, however, has never been procured in a separate state.

1335 Action of heat. 4. Magnesia is not acted upon by light. It is not melted when exposed to the greatest heat. By strong calcination it becomes finer, whiter, and more friable. When it is exposed to heat in the form of paste with water, it contracts its dimensions, and acquires a phosphorescent property; for when it is strongly rubbed on a hot iron plate, it becomes luminous in the dark. It is not altered by the action of the blow-pipe on charcoal, but gives out a flame of a slight yellow colour.

5. There is no action between magnesia and oxygen or azote. When exposed to the air, it attracts a little moisture from the atmosphere, but this goes on very slowly. 1336 Of air.

Butini exposed a quantity of magnesia for the space of two years in a porcelain cup slightly covered with paper, and he found that it had acquired only $\frac{1}{71}$ part of its weight in addition, during that time.

6. There is no action between magnesia and hydrogen or carbon, and very little between it and phosphorus.

7. Magnesia is very little soluble in water. According to Mr Kirwan it requires near 8000 times its weight of cold water to dissolve it. Butini found, that water boiled with this substance, and left in contact with it for three months, had scarcely acquired $\frac{1}{10000}$ part of its weight; but water combines with magnesia in the solid state. One hundred parts of magnesia, according to Bergman, thrown into water, and taken out and dried, acquired 18 parts of additional weight. 1337 Of water.

8. Magnesia enters into combination with the acids, and forms with them peculiar salts. The order of its affinities is the following, according to Bergman. 1338 Affinities.

Oxalic acid,
Phosphoric,
Sulphuric,
Fluoric,
Arsenic,
Saclactic,
Succinic,
Nitric,
Muriatic,
Tartaric,
Citric,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Prussic.

9. Magnesia does not enter into combination with the fixed alkalies; but in combination with some of the earths, it becomes fusible by means of a strong heat. With lime in certain proportions, it forms a greenish yellow glass. 1339 Of earths.

10. Magnesia is much employed in medicine as a gentle laxative, and as an absorbent to destroy the acidity in the stomach. It is used in pharmacy to suspend or aid the solution of resinous and gummy substances, such as camphor and opium, in water, which are otherwise little soluble. 1340 Uses.

I. Of Sulphuret of Magnesia.

1. Magnesia enters into combination with sulphur, either in the dry or humid way. Two parts of magnesia and one of sulphur, put into a crucible, and exposed to heat, form an orange yellow mass, which is not very soluble in water, but emits the odour of sulphurated hydrogen gas, when it comes in contact with that liquid, and which is very readily decomposed by means 1341 Preparation.

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means of heat. The heat that is applied to obtain this sulphuret, must be very moderate, otherwise the sulphur is driven off.

2. The sulphuret of magnesia is formed with more difficulty in the humid way. When two parts of magnesia and one of sulphur in powder, with 20 parts of water, are exposed to heat on a sand bath, the liquid becomes of a pale yellow colour, which is slightly fetid, but has nothing of the strong odour of the other sulphurets. There is formed very little of the sulphuret of magnesia; for the greatest part of the sulphur and magnesian earth remains uncombined. There is very little sulphureted hydrogen produced, the water scarcely exhaling the odour of this gas.

1342 Properties. 3. The solid sulphuret of magnesia decomposes rapidly when exposed to the air. It seems to absorb very little sulphureted hydrogen gas; so that the properties of the hydrosulphuret of magnesia are yet unknown *.

* Fourcroy Connaiss. Chim. iii. 160—167.

II. Compounds of Magnesia with Acids.

1. Sulphate of Magnesia.

1343 History. 1. The compound of sulphuric acid and magnesia was formerly known under the name of *Epsom* and *Seidlitz salts*, because it exists in the water of these springs, and *sal catharticus amarus, bitter purging salt*, on account of its properties. It was long confounded with sulphate of soda, till its properties were investigated by Black, Macquer, and Bergman, and its nature and composition fully ascertained.

1344 Preparation. 2. This salt exists abundantly in nature. It is found in many mineral springs, and it forms a considerable proportion of the saline ingredients of sea water. The bittern or mother water of common salt, that is, the water which remains after the crystallization, consists chiefly of sulphate of magnesia. It is therefore rarely prepared by art, by the direct combination of its constituent parts. It is easily purified by dissolving the salt in water, and by evaporation and crystallization.

1345 Properties. 3. The sulphate of magnesia, thus prepared, is crystallized in four-sided prisms, terminated by four-sided pyramids. There is, however, some deviation from this form. The primitive form of the crystal is a quadrangular prism with square bases. The integrant molecule is a triangular prism, whose bases are right-angled isosceles triangles. It has a cool, bitter taste. The specific gravity is 1.66.

1346 Action of water and heat. 4. Exposed to the air it effloresces. It is soluble in its own weight of cold water: boiling water dissolves more than two-thirds of its weight. Exposed to heat, it undergoes the watery fusion, and being deprived of its water of crystallization, it does not melt, nor is it decomposed by the strongest heat. By the action of the blow-pipe it melts with difficulty into an opaque, vitreous globule.

1347 Of alkalies. 5. The sulphate of magnesia is decomposed by the fixed alkalies, but with ammonia it forms a triple salt.

1348 Composition. The component parts of this salt are, according to

	Bergman.	Kirwan. In crystals.	Kirwan. Dry.
Sulphuric acid	33	29.35	63.32
Magnesia	19	17.00	36.68
Water	48	53.65	00.00
	100	100.00	100.00 *

* Nichol. Journ. iii. p. 225.

6. The sulphate of magnesia is employed in medicine as a purgative. From this salt, too, the earth of magnesia is usually extracted.

1349 Uses.

2. Sulphate of Ammonia and Magnesia.

1350 Preparation. 1. This is a triple combination of sulphuric acid with ammonia and magnesia. It is prepared by the partial decomposition of the sulphate of magnesia by means of ammonia. By evaporating the solution, the triple salt is obtained in crystals.

1351 Properties. 2. This salt crystallizes in octahedrons. It has a bitter acrid taste, does not effloresce in the air, is less soluble in water than either of the salts of which it is composed, but it is more soluble in hot than in cold water, and it crystallizes on cooling. By heat it undergoes the watery fusion. It then dries and is decomposed. The component parts of this salt are,

Sulphate of magnesia	64
of ammonia	32
	100 †

† Fourcroy Connaiss. Chim. ii. 49.

3. Sulphite of Magnesia.

1352 Preparation. 1. The compound of sulphurous acid and magnesia is formed by passing sulphurous acid gas into two parts of water, with one of carbonate of magnesia. A violent effervescence takes place, with the evolution of heat. The sulphite of magnesia is formed, and precipitated to the bottom in the state of powder; but with an excess of acid it is re-dissolved, and crystallizes.

1353 Properties. 2. The crystals of sulphite of magnesia are in the form of depressed transparent tetrahedrons. It has a mild earthy taste, which soon becomes sensibly sulphureous; it has no smell. Its specific gravity is 1.3802.

1354 Action of air, &c. 3. It effloresces in the air, and is slowly converted into sulphate of magnesia. It is soluble in 20 parts of cold water. Boiling water dissolves a greater proportion, and from this it crystallizes on cooling. Exposed to heat, this salt becomes viscid, and by calcination it loses 0.45 of its weight. If the heat be increased, it is decomposed; the acid is driven off, and the pure earth remains behind.

The component parts of this salt are,

Sulphurous acid	39
Magnesia	16
Water	45
	100

4. Sulphite of Ammonia and Magnesia.

1355 Preparation. 1. This triple salt is formed by decomposing the sulphite of ammonia by magnesia, or the sulphite of magnesia by ammonia, in solution in the cold; or, by mixing together the solutions of the two salts.

1356 Properties. 2. This salt is in transparent crystals, the form of which has not been determined. When it is exposed to the air, it is converted into sulphate of ammonia and magnesia. 1357 Action of heat. It is less soluble in water than either of the two sulphites of which it is formed. By the action of heat, sulphurous acid is given out, acidulous sulphite of ammonia is sublimed, and there remains behind pure magnesia †.

† Ibid. p. 89.

5. Nitrate of Magnesia.

1. This compound of nitric acid and magnesia was formerly

formerly called *nitre with base of magnesia*, and magnesian *saltpetre*. It is formed by the direct combination of the acid with the earth. By evaporation it is

1358 History and preparation. crystallized.

1359 Properties. 2. This salt crystallizes in four-sided rhomboidal prisms, whose summits are oblique or truncated. Sometimes it is in the form of small needles combined in groups. The taste is penetrating and bitter. The specific gravity is 1.736.

1360 Action of water. 3. It is deliquescent in the air, and is soluble in its own weight of cold water. It is more soluble in boiling water, in which it crystallizes on cooling; but it can only be obtained in regular crystals by slow evaporation from its solution in cold water.

1361 Of heat. 4. By the action of heat it undergoes the watery fusion; the water is driven off, and it becomes dry. It is decomposed in a strong heat, gives out a little oxygen gas, then nitrous gas, and at last the nitric acid.—The pure earth remains behind.

1362 Composition. The component parts of this salt are, according to

	Bergman.	Kirwan.
Acid	43	46
Magnesia	27	22
Water	30	32
	100	100

6. Nitrate of Ammonia and Magnesia.

1363 Preparation. 1. This triple salt is formed, either by the direct combination of the solutions of nitrate of ammonia, and nitrate of magnesia, by which the salt is obtained pure and crystallized; or, by partially decomposing the nitrate of ammonia by magnesia, or the nitrate of magnesia by ammonia.

1364 Properties. 2. The crystals of this salt are in the form of fine prisms. It has a bitter, acrid, and ammoniacal taste. It is less deliquescent in the air than either of the constituent salts, and less soluble in water. It requires 11 parts of cold water to dissolve it, but less of boiling water. It crystallizes on cooling.

1365 Action of heat. When it is rapidly heated, it inflames spontaneously. When slowly heated in close vessels, it gives out oxygen gas, azotic gas, a greater proportion of water than it contains, nitrous gas, and nitric acid, without the smallest trace of ammonia; which shows that it is decomposed, that the hydrogen combines with the oxygen of the acid, and forms water.

1366 Composition. The component parts of this salt are,

Nitrate of magnesia	78
——— ammonia	22
	100*.

7. Nitrite of Magnesia.

Nothing is known of the properties of this salt.

8. Muriate of Magnesia.

1367 Found native. 1. This compound of muriatic acid and magnesia was formerly called *marine salt of magnesia*, and was confounded with the muriate of lime, with which it is frequently accompanied. The difference between these two salts was first pointed out by Dr Black, and Bergman afterwards examined the nature and properties of muriate of magnesia. The salt is obtained by dissolving magnesia in muriatic acid till they are saturated, and then evaporating the solution. Small irregular crystals are obtained. This salt exists in the waters of the ocean, and in mineral waters, along with the muriates of soda and lime.

2. It is extremely difficult to obtain the muriate of magnesia in any regular form. It is either in the state of powder, or very small regular needles, or in a kind of jelly. It has a disagreeable bitter taste. The specific gravity is 1.601. 1368 Properties.

3. It is very deliquescent in the air. Cold water readily dissolves its own weight, and it is still more soluble in boiling water.

4. It is completely decomposed by heat; the acid is driven off, and the pure earth remains behind *. 1369 Action of heat.

1370 Composition.

	Bergman.	Kirwan.
Acid	34	34.59
Magnesia	41	31.07
Water	25	34.38
	100	100.04†.

* Fourcroy iii. 204.

† Nicholson's Journ. iii. 215.

9. Muriate of Ammonia and Magnesia.

This triple salt is formed by mixing the solutions of muriate of magnesia and muriate of ammonia; and by evaporating the solution the salt crystallizes in the form of small polyhedrons. It has a bitter, ammoniacal taste. It is little altered by exposure to the air, and is soluble in six parts of cold water. It is decomposed by heat. The muriate of ammonia is sublimed, and the muriate of magnesia is deprived of its acid. 1371 Preparation. 1372 Properties.

The component parts of this salt are, 1373 Composition.

Muriate of magnesia	73
——— ammonia	27
	100

10. Hyperoxymuriate of Magnesia.

This is similar in its chemical and physical properties to the hyperoxymuriate of lime, and it is prepared in the same way. It is precipitated by lime and ammonia.

The component parts are, 1374 Composition.

Acid	60
Magnesia	25.7
Water	15.3
	100.0*.

* Phil. Trans. 1802, p. 149.

11. Fluate of Magnesia.

1. This salt is formed by combining together fluoric acid and magnesia. According to Scheele, it precipitates in the form of a gelatinous mass; but Bergman observes that great part of the salt is deposited as the saturation approaches. By evaporating the solution, crystals in the form of six-sided prisms, terminated by a low pyramid composed of three rhomboidal sides, are obtained. 1375 Preparation. 1376 Properties.

2. This salt is not decomposed by the strongest heat, or by any acid.

12. Fluate of Ammonia and Magnesia.

This triple salt is formed, by mixing the solutions of the fluate of ammonia and magnesia. A precipitation is formed, which is the triple salt in crystals. The properties of this salt are unknown †.

* Fourcroy Connais. Chim. iii. p. 244.

† Fourcroy, iii. 308.

13. Borate

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Magnesia, &c.

13. Borate of Magnesia.

1377 Preparation. 1. This salt is formed by the direct combination of boracic acid with magnesia. The earth is slowly dissolved, and when the solution is evaporated, crystals are obtained.

1378 Properties. 2. The crystals of this salt are very small and irregular. It melts when exposed to heat, without being decomposed; but it may be decomposed, it is said, by alcohol ‡.

‡ *Ib.d* 319.

14. Borate of Magnesia and Lime.

1379 Found native. 1. This salt, which has been lately discovered native, is called by mineralogists *cubic quartz*. It was analyzed by Westrumb in 1788. It is an insipid salt, and is regularly crystallized in polyhedrons of 22 faces. The specific gravity is 2.566.

1380 Properties. 2. It is not altered by exposure to the air, nor is it soluble even in boiling water. Exposed to a strong red heat, the crystals lose their lustre; and with a white heat they decrepitate, and at last melt into a yellow coloured glass.

1381 Composition. 3. The component parts of this salt are,

Acid	73.5
Magnesia	14.6
Lime	11.9
	100.0

15. Phosphate of Magnesia.

1382 Preparation. 1. This salt may be obtained by the direct combination of phosphoric acid and carbonate of magnesia; for, it may be prepared by mixing together phosphate of soda and sulphate of magnesia in solution. In a few hours, large, transparent crystals are formed in the solution.

1383 Properties. 2. This salt crystallizes in six-sided prisms with unequal sides, but it is frequently in the form of powder. It has a cooling, sweetish taste. The specific gravity is 1.5489.

1384 Action of water. 3. It effloresces in the air, is not very soluble in cold water, and requires about 50 parts of boiling water for its solution, and part of it crystallizes on cooling.

1385 Of heat. When it is heated, it is easily deprived of its water of crystallization, and if the heat be moderate, it melts and falls down into a white powder. With a stronger heat, it is melted into glass.

16. Phosphate of Ammonia and Magnesia.

1386 Found native. 1. This triple salt was discovered by Fourcroy in a calculous concretion, found in the colon of a horse. The results of his experiments on this substance have been confirmed by Berthollet and Vauquelin.

1387 Composition. 2. It may be prepared artificially, by mixing together a solution of phosphate of magnesia with a solution of phosphate of ammonia.

1388 Properties. 3. The crystals are in the prismatic form, but cannot be accurately ascertained. This salt has no taste. In the concrete form, it is found in the cavities of animal bodies, and sometimes it is crystallized, but most frequently lamellated and semitransparent.

1389 Action of heat. 4. It is not changed by the action of the air, and is scarcely soluble in water. When it is heated moderately, it falls to powder. With a strong heat it is deprived of the ammonia, and under the blow-pipe it melts into a transparent globule. It is decomposed by the sulphuric, nitric, and muriatic acids.

The component parts of this salt found in the intestine of the horse are, 1390 Component salt.

Phosphate of ammonia	33.3
——— magnesia	33.3
——— water	33.3
	100.0

17. Phosphite of Magnesia.

1. This salt may be prepared by directly combining phosphorous acid with magnesia. Or it may be obtained in a purer state, and crystallized, by mixing together solutions of phosphites of soda or of potash, and sulphate of magnesia, by which means it is obtained in brilliant milky flakes. 1391 Preparation.

2. This salt, which has no sensible taste, sometimes crystallizes in the form of tetrahedrons. It effloresces in the air, and is soluble in 400 parts of cold water. When exposed to heat, it suddenly swells up, and melts into a glass. Under the blow-pipe it gives out a phosphoric light, and becomes opaque on cooling. 1392 Properties.

The component parts of this salt are,

Acid	44
Magnesia	20
Water	36
	100

18. Phosphite of Ammonia and Magnesia.

This salt is formed by the partial decomposition of phosphite of ammonia by means of magnesia, or by mixing together the solutions of the two phosphites. If the solutions be sufficiently concentrated, the triple phosphite is readily deposited. It forms crystals, and has little solubility in water. Its other properties are unknown.

19. Carbonate of Magnesia.

1. This salt, which was first distinguished by Dr Black, has been called *mild magnesia*, *aërated magnesia*. It is formed by mixing together sulphate of magnesia and carbonate of potash in solution. Or it may be obtained by dissolving pure magnesia in water saturated with carbonic acid. The salt, as the solution is evaporated, crystallizes. 1393 Names &c. preparation.

2. The magnesia of commerce, which is in the state of powder, or light friable cakes, is not fully saturated with the acid. But when it is crystallized by the above processes, it is in the form of transparent six-sided prisms, terminated by a hexagonal plane. This salt has little taste. The specific gravity is 0.2941. 1394 Properties.

3. When it is crystallized, it soon loses its transparency in the air. It is soluble in 48 parts of cold water. Exposed to heat in a crucible it slightly decrepitates, is deprived of its water and acid, and falls down into a powder. It is decomposed by all the acids. The component parts of this salt are, according to 1395 Action of water and heat. 1396 Composition.

	Bergman.	Butini.	Fourcroy.
Acid	30	36	50
Magnesia	45	43	25
Water	25	21	25
	100	100	100

The

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Magnesia, &c.

The magnesia of commerce is composed of

	Fourcroy.	Kirwan.
Carbonic acid	48	34
Magnesia	40	45
Water	12	21
	100	100

20. Carbonate of Ammonia and Magnesia.

This triple salt is prepared by decomposing carbonate of ammonia by means of magnesia; or by precipitating a solution of carbonate of magnesia by means of pure ammonia. This salt, however, has not been particularly examined.

21. Arseniate of Magnesia.

When arsenic acid is saturated with magnesia, a thick matter forms towards the point of saturation, which is soluble in excess of acid; but when it is evaporated, it does not crystallize. It assumes the form of a jelly. It is decomposed by the alkaline arseniates.

22. Tungstate of Magnesia.

This acid, in combination with magnesia, forms a salt which appears in the form of brilliant scales. It is not altered by exposure to the air, and it is soluble in water. It is decomposed by acids, and a white powder is precipitated.

23. Molybdate of Magnesia.
24. Chromate of Magnesia.
25. Columbate of Magnesia. } Unknown.

26. Acetate of Magnesia.

This salt is formed by the direct combination of magnesia with acetic acid. It does not crystallize, but a viscid mass remains when the solution is evaporated. It has a sweetish taste, leaving afterwards an impression of bitterness. The specific gravity is 1.378. It deliquesces in the air, is very soluble in water, and is decomposed by heat.

27. Oxalate of Magnesia.

This salt is formed by combining oxalic acid with magnesia, and evaporating the solution. A salt is obtained in the form of white powder, which is scarcely soluble in water. It is decomposed by heat. The component parts of this salt are,

Acid and water	65
Magnesia	35
	100

28. Tartrate of Magnesia.

This compound of tartaric acid and magnesia forms a salt which is insoluble in water, without an excess of acid. When this is the case, it crystallizes by evaporation. The crystals are in the form of hexangular truncated prisms. It is first melted, and then decomposed by heat.

29. Citrate of Magnesia.

This salt is obtained by dissolving carbonate of magnesia in citric acid. From the thick solution of this salt there is no crystallization; but after some days, by a slight agitation, it assumes the form of a white opaque mass, which remains soft, as it separates from the edges of the vessel. The component parts of this salt are,

Acid	66.66
Magnesia	33.34
	100.00*

* Fourcroy, vii. 208.

30. Malate of Magnesia.

This is a deliquescent salt, and very soluble in water.

31. Gallate of Magnesia.

Magnesia boiled with an infusion of nut galls, affords a clear liquid, which assumes a green colour. By evaporation to dryness the green colour vanishes, and the acid is decomposed.

32. Benzoate of Magnesia.

The combination of benzoic acid with magnesia affords plumose crystals which are easily soluble in water. This salt has a bitter taste.

33. Succinate of Magnesia.

This salt, which is formed by the combination of succinic acid and magnesia, does not crystallize. It is a white glutinous mass, which is deliquescent in the air.

34. Saccolate of Magnesia.

This salt is insoluble in water.

35. Camphorate of Magnesia.

1. This salt is formed by mixing carbonate of magnesia with water, and adding crystallized camphoric acid. A slight effervescence takes place. The temperature should be increased, to drive off the carbonic acid. The solution is filtered while it is hot, and evaporated to dryness. The mass is dissolved in distilled water, filtered and evaporated by a gentle heat, till a pellicle appears on the surface. By cooling, there are deposited small plates, which are heaped upon each other. 1397 Preparation.

2. This salt, which does not crystallize, is white and opaque, and has a bitter taste. In the air it is slightly efflorescent. It is not very soluble in water. Boiling water dissolves a little, but it is precipitated in cooling. When it is thrown on red-hot coals, the acid is volatilized, and pure magnesia remains behind. By the action of the blow-pipe it gives out a bluish flame. It is decomposed by sulphuric, nitric, and muriatic acids *. 1398 Properties.

* Ann. de Chim. xxvii. p. 37.

36. Suberate of Magnesia.

The compound of suberic acid and magnesia is in the form of powder. It has a bitter taste, is deliquescent in the air, and soluble in water. It reddens the tincture of turnsole. Exposed to heat, it swells up and melts. By the action of the blow-pipe, the salt is decomposed, the acid is driven off, and pure magnesia remains behind. The sulphuric, nitric, and muriatic acids, decompose it. It is also decomposed by the alkalies, barytes, and lime †.

† Ibid. xxiii. p. 56.

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37. Mellate of Magnesia.

Unknown.

38. Lactate of Magnesia.

A salt in small deliquescent crystals.

39. Prussiate of Magnesia.

This salt may be prepared by directly combining prussic acid with pure magnesia; but the magnesia is precipitated when the solution is exposed to the air. It is also decomposed by the alkalies and lime.

Sect. V. *Of Alumina and its Combinations.*

1399 *History.*

1. *Alumina*, which is now employed to signify one of the simple earths, is derived from the word *alum*, of which this earth forms a constituent part, and from which it is obtained in greatest purity. It was formerly denominated *argil* and *argillaceous earth*. Pott and Margraaf were the first who distinguished this earth from the calcareous earth or lime, and proved that this latter earth could not be obtained from it by calcination. In the year 1739, Hellot shewed, that the basis of alum, separated from this salt by an alkali, was pure argil, or alumina. In 1758 and 1762 Macquer examined this earth, and detailed its characteristic properties. These were afterwards farther elucidated and confirmed by the experiments and researches of Bergman and Scheele, so that the nature and characters of this earth were completely developed, and it was universally admitted as distinct from all others hitherto known.

1400 *Preparation.*

2. Although alumina exists in great abundance in nature, yet it is rarely found in a state of perfect purity. It may be obtained pure by the following process.

Dissolve a quantity of common alum in water, and add to the solution, a solution of potash or carbonate of potash, or, what is supposed to be still better, liquid ammonia. An abundant white precipitate is immediately formed. Continue the addition of the alkali as long as any precipitate appears. When the whole of the precipitate has collected at the bottom of the vessel, pour off the fluid part, and wash the precipitate repeatedly with large quantities of water, to free it from all saline matters which it may have retained. Dry the precipitate in a moderate heat, and the substance thus obtained is alumina in a state of tolerable purity. If this precipitate retain any portion of sulphuric acid, it may be separated by adding muriatic acid in small quantities at a time, till the whole is dissolved. Evaporate the solution till a drop of it, when suffered to cool on a plate of glass, yields minute crystals. Then set by the solution till it cool, and crystals will be deposited. Let these crystals be removed by pouring off the fluid, and continue the evaporation till no more crystals are formed. In this way the alum which the earth retained may be separated. The liquid which remains is to be mixed with ammonia as long as any precipitate appears. This precipitate, well washed and dried, is pure alumina.

1401 *Properties and composition.*

3. The alumina obtained by this process, is either in the form of friable fragments, or of very fine white powder, soft to the touch, and insipid to the taste. It has a peculiar odour, which is distinguished by the name of *earthy smell*, and is only perceptible when it is breathed upon, or moistened (o). It adheres to the tongue in consequence of its rapidly absorbing moisture. The specific gravity is 2. It has never been decomposed, but is, from analogy, concluded to be a compound of a metallic base (alumium) with oxygen.

1402 *Spongy alumina.*

4. Saussure has observed, that alumina exhibits two different appearances, according to the quantity of water which has been employed in the solution of the aluminous salt. If the quantity of water does not exceed what is necessary for the solution of the salt, we obtain a light friable white earth, which is very spongy, and adheres to the tongue. This he calls *spongy alumina*. But when the salt is dissolved in a large quantity of water, we obtain, after drying the precipitate in the same temperature, a yellowish brittle transparent mass, which splits into small fragments, when held in the hand, like solid sulphur. It has a smooth conchoidal fracture, no earthy appearance, does not adhere to the tongue, and does not swell up when put into water. It occupies 10 or 12 times less volume than in the spongy state, and has some resemblance to gum arabic, or a dried jelly. This he distinguishes by the name *gelatinous alumina* *.

1403 *Gelatinous.*

1404 *Action of water.*

5. Alumina undergoes no change by being exposed to light. When it is exposed to heat, it is diminished in bulk, in consequence of being deprived of the water with which it is combined. Accordingly, Saussure has observed, that the spongy alumina, exposed to the same temperature, loses a greater quantity of moisture than the gelatinous alumina. The former, when exposed to a red heat, loses 0.58 part of its weight; but the latter only 0.43 part. When they are both exposed to a very strong heat, the spongy alumina is deprived of no more water than what it gives out with a red heat, while the gelatinous parts with only 0.4825. On this property of the contraction of bulk of alumina when exposed to heat, depends the principle of the thermometer, or pyrometer, of Wedgwood, of which we shall immediately give a short description.

When alumina is exposed to a very strong heat suddenly applied, as by means of the blow-pipe, with a stream of oxygen gas, it is susceptible of a kind of fusion; and, when it is cooled, it appears under the form of an enamel, of a greenish colour, and so hard as to cut glass.

1405 *Of water.*

6. Alumina is not soluble in water, but it absorbs and retains that fluid in considerable quantity. With a greater quantity of water it is diffused in it, and may be

* Journ. de Physique, lii. p. 290.

(o) This smell, however, as it has been justly observed by Saussure, is owing to the oxide of iron, with which the alumina, in its ordinary state of purification, is contaminated; for when it is perfectly pure, and no traces of oxide of iron can be detected, it has no perceptible smell. To alumina which was perfectly inodorous, he communicated this smell, by triturating it with oxide of iron. *Journal de Physique*, lii. p. 287.

be formed into a paste, in which state it is moulded with great facility into any form.

7. There is no action between alumina and oxygen, azote, hydrogen, or phosphorus; and very little between it and sulphur, except when they are in a state of minute division, or in combination with some other substances. Carbone combines with alumina, of which

1406 Of carbone. there are many natural compounds, among the class of bituminous fossils; but even in these compounds, the carbon and alumina are mixed with other earths, and with the oxide of iron.

1407 Of acid. 8. Alumina enters into combination with almost all the acids, and forms salts which are more or less soluble and susceptible of crystallization. Some are insoluble in water, and others require an excess of acid.

1408 Affinities. 9. The order of its affinity for the acids is the following:

Sulphuric acid,
Nitric,
Muriatic,
Oxalic,
Arsenic,
Fluoric,
Tartaric,
Succinic,
Saclactic,
Citric,
Phosphoric,
Lactic,
Benzoic,
Acetic,
Boracic,
Sulphurous,
Carbonic,
Prussic.

1409 Of alkalies. 10. Alumina combines with the fixed alkalies. When they are heated together, an opaque mass, which has little coherence, is formed. Fixed alkali dissolved in water, with the assistance of heat, has the property of dissolving alumina; but from this solution it may be precipitated by means of an acid, and then it is obtained in great purity. Liquid ammonia also holds a small quantity of alumina in solution, if it has been recently precipitated.

1410 Of earths. 11. Alumina enters into combination with many of the earths, and particularly with lime and silica. These compounds form the chief basis of all kinds of pottery and porcelain. Alumina combines with lime, and enters into fusion with it by means of heat. A compound is also formed with alumina and barytes, or strontites, by exposing them together in a crucible to a strong heat; or, by boiling them together in water. Magnesia and alumina alone do not enter into combination by means of the strongest heat; but a porcelain is obtained from a mixture of lime, magnesia, and alumina. But in the proportions that are employed, it is necessary that the alumina be greatest. The following table shews the results of experiments on these earths in different proportions †.

† *Kirwan Mineral.* i. p. 61.

Alumina,	3	A porcelain.
Lime,	2	
Magnesia,	1	

Alumina,	3	A porcelain.
Magnesia,	2	
Lime,	1	

Alumina,	3	Porous porcelain.
Magnesia,	3	
Lime,	1	

Alumina,	3	Porous porcelain.
Magnesia,	3	
Lime,	2	

Alumina,	3	Porcelain.
Lime,	2	
Magnesia,	2	

12. This is one of the most important of the earths, Uses. 1411
on account of the variety of purposes to which it is applied. It forms the bases of all kinds of earthen ware, from the coarsest brick to the finest china. It is also chiefly employed in the pots or crucibles which are exposed to very strong heat, as in glass manufacture and cast iron. It is employed also in dyeing and calico-printing, and in the cleaning or scouring of woollen stuffs. It has been applied to a valuable use by the late Mr Wedgwood, in the construction of an instrument capable of ascertaining high degrees of temperature, to which the common thermometer cannot reach.

13. This instrument is constructed on the principle Wedgwood's pyrometer. 1412
of the contraction of pure clay, when it is exposed to heat. Mr Wedgwood took a very pure clay, and formed it into small short cylinders, exactly of the same size. These are baked in a low red heat, to expel the whole of the air and moisture which adhere to the clay. The cylinders are thus prepared for the measurement of strong heats. For this purpose, one of the cylinders is introduced between two rulers, to which a scale is attached, and its bulk is exactly measured. It is then introduced into the furnace whose heat is to be tried, and the temperature is to be estimated according to the diminution of bulk which the cylinder has sustained. The quantity of contraction is measured by means of two metallic rulers, which are fixed upon a plate. These rulers are 24 inches in length, and are divided into 240 parts. The distance between the rulers at the upper extremity of the scale is 0.5 of an inch, and at the lower extremity 0.3 of an inch. The size of the clay cylinder, before it is introduced into the furnace, nearly fits the upper part of the scale; or at least the degree at which it stands, before it is introduced into the furnace, is marked. After being heated, the clay cylinder is again applied to the scale, and the diminution of bulk is measured by the distance at which it stands between the rulers from the top of the scale, or from the degree at which it stood before it was exposed to the heat.

Mr Wedgwood connected the scale of his pyrometer Scale of it. 1413
with Fahrenheit's thermometer. The first degree of his scale which marks a red heat, corresponds to the 947° Fahrenheit; but to make this instrument better understood, we may state a few of the corresponding degrees of the two instruments.

Alumina, &c.

	Wedgwood.	Fahrenheit.
Red heat	0 =	947
Fine silver melts	28	4717
Fine gold melts	32	5237
Welding heat of iron	95	13427
Cast iron melts	130	17977
Greatest heat in an air furnace eight inches square	160	21877
Extremity of the scale, or highest temperature observed	240	32277

This instrument has been of considerable importance in some arts and manufactures, and it is undoubtedly fitted to give some information concerning those intense heats which can be measured by no other instrument which has yet been contrived. But as the same kind of clay cannot always be obtained, and as it is probable that the contractions of the cylinders are not proportional to the temperatures, their estimation by this instrument can only be considered as an approximation to certainty.

I. Compounds of Alumina with Acids.

1. Sulphate of Alumina.

1414 Preparation. 1. This is a compound of sulphuric acid and alumina. It may be formed by the direct combination of the acid with the earth. But in the preparation of this salt, the earth and the acid must be in a state of purity, and must be saturated with each other. The solution is then evaporated to dryness; the salt is again dissolved in distilled water, and evaporated slowly till it crystallizes.

1415 Properties. 2. The crystals of this salt are in the form of thin plates, soft and pliant, with a brilliant pearly lustre, and of an astringent taste. It is not altered by exposure to the air; it is very soluble in water, but it does not crystallize readily.

1416 Action of heat, &c. When it is heated, it is infusible; but by long calcination, it dries and falls down to powder. At a high temperature it is decomposed, and the acid is driven off.

3. The sulphuric acid readily combines with this salt, and forms with it an acidulous sulphate of alumina. This salt has a more acid taste than the former; it crystallizes with more difficulty, and the crystals have more brilliancy. It reddens vegetable blues, and frequently assumes the form of a thick gelatinous mass.

4. All the alkaline and earthy bases, except silica and zirconia, decompose either of these two salts. The saturated sulphate of alumina, according to Bergman, is composed of

1417 Composition.

Sulphuric acid	50
Alumina	50
	100

2. Acidulous Sulphate of Alumina and Potash, or Alum.

1418 History. 1. The alum of commerce, now of such extensive utility in many of the arts and manufactures, was imported into Europe from Asia, previous to the 15th century, during which it was begun to be manufactured in Italy. Alum works were erected in Spain and Germany in the 16th century; and towards the end of it, a manufactory of this salt was established in Yorkshire in England. But the true nature of alum has been only of late understood. It is to the experiments and researches of Vauquelin that we are indebted for the knowledge of its component parts. 1419

Preparation. 2. Alum is generally obtained by exposing to the weather for some time aluminous schistus, or what are called *aluminous ores*, which are natural productions sometimes found in the neighbourhood of volcanoes, and sometimes, as in Britain, dug out of coal mines which abound with pyrites or sulphuret of iron. When these substances, which are also mixed with a considerable proportion of clay, are exposed to air and moisture, the sulphur combines with the oxygen of the air, or with that of the water, by decomposing it, and is thus converted into sulphuric acid. This combines with the alumina, and thus there is formed a sulphate of alumina. The salt, thus formed, is dissolved in water, and must be purified by repeated boilings and crystallizations. This aluminous schistus is generally mixed with a considerable proportion of sulphate of iron. From this it is to be separated during the process, and the potash or ammonia, which is necessary to constitute the triple salt, must be added. Even before the component parts of alum were discovered, the addition of potash or ammonia was found to be necessary to complete the process. This was well known to the manufacturers, who supposed that it was necessary to take up a quantity of acid, which being in excess, prevented the granulation, as it was called, or the crystallization of the alum. 1420

Properties. 3. Alum crystallizes in regular octahedrons; but this form is subject to considerable variety, according to the difference of proportion which is found to take place among its component parts. The primitive form of the crystal is the regular octahedron, and the integrant molecule the regular tetrahedron. It has a very astringent, styptic, and somewhat sweetish taste. It usually reddens vegetable blues. The specific gravity is 1.7109. 1421

Action of water and heat. 4. It is little changed by exposure to the air. By long contact there is a slight efflorescence on the surface. Alum is soluble in 16 or 20 parts of cold water. Boiling water dissolves a greater proportion. When exposed to heat, it melts in its water of crystallization. It then swells up, enlarges in volume, and there remains behind a light, porous, dry mass, which has a sharp acid taste, and reddens more strongly vegetable blues. In this state it is called *burnt* or *calcined alum*. When it is exposed to a stronger heat, the acid is driven off. 1422

Varieties. 5. According to the experiments of Vauquelin, there are three kinds or varieties of alum, which, although they possess nearly the same properties, have different constituent parts, or different proportions of the same constituents. The first is sulphate of alumina and potash with an excess of acid; which indeed is necessary to constitute alum. The second consists of alumina and ammonia, also with an excess of acid. The third variety, which is most frequently found among the alum of commerce, is a mixture of both. It contains

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Alumina, &c. tains both potash and ammonia. When an additional quantity of potash is added, the alum crystallizes, not in its usual form, but in the form of cubes, and hence it has been denominated *cubic alum*. If a still greater quantity of potash be added, the crystallization is nearly interrupted; and it then appears in the form of flakes.

1423 Composition. The component parts of alum are, according to

	Vauquelin.		Kirwan.
Sulphate of alumina	49	Acid	17.66
——— potash	7	Base	12.00
Water	44	Water	70.34
	100		100.00

1424 Action of charcoal. 6. The three varieties of alum are nearly decomposed in the same way, by combustible substances. If alum be exposed to a moderate heat with charcoal, it is converted into the state of neutral salt, because the charcoal acts on the excess of acid, before it can effect the decomposition of the salt; but when it is strongly heated, there is formed with the sulphate of alumina and potash a black substance, which spontaneously takes fire in the air. This substance has been distinguished by the name of *pyrophorus*; and it is called *Homberg's pyrophorus*, because it was discovered by that chemist.

1425 Pyrophorus. Pyrophorus is prepared by mixing together three parts of alum, and one of flour or sugar, in an iron ladle, and exposing the mixture to heat till it ceases to swell, and becomes black. It is then to be reduced to powder, put into a glass phial, and again exposed to heat, till a blue flame proceeds from the mouth of the phial. After it burns for a minute, it is allowed to cool, and must be kept in a well-closed bottle.

1426 Properties. 7. The pyrophorus thus formed, contains a hydrogenated sulphuret of potash and alumina, mixed with charcoal in a state of minute division. It kindles more readily in humid than in dry air. The oxygen gas of the atmospheric air is absorbed. Part is converted into carbonic acid, and part combines with the sulphur, and forms sulphuric acid; so that when the pyrophorus is burnt, it no longer contains the hydrogenated sulphuret as before, but sulphate of alumina and potash; not in the state of alum, because it has been deprived of the excess of acid, which gives alum its peculiar character.

8. Pyrophorus gives out a very fetid odour, when it is thrown into water, and leaves behind a sulphuret of potash, and of hydrogenated alumina. It is inflamed by nitrous gas, and by oxymuriatic acid gas *.

* *Fourcroy*, iii. p. 59.

1427 Uses of alum. 9. The uses of alum are very numerous. It is employed in medicine as an astringent and styptic. It is also employed in the arts of bleaching, of tanning, dyeing, calico-printing, and others. It is sometimes used in preserving animal matters from putrefaction, and it might be employed for the purpose of securing wood from catching fire.

1428 Preparation. *Sulphate of alumina and potash.*—1. If a solution of crystallized alum be boiled with a solution of pure alumina, the saturated sulphate of alumina and potash is formed. The excess of acid, it is obvious, in this process, enters into combination with the alumina. The alum, as the earth is added, is gradually precipitated in the solution, in the form of a white powder.

2. This salt, saturated with alumina, never assumes any regular form. It has no taste, is not changed by exposure to the air, is not soluble in water, and when it is exposed to heat, it is not altered, except at a very high temperature. This salt is less easily decomposed than any of the other varieties of sulphate of alumina. By the action of some of the acids it is converted into alum, which is owing to the acid combining with the additional portion of alumina that saturated the excess of acid existing in the alum. This salt has been applied to no use. 1429 Properties.

3. Sulphite of Alumina.

1. The compound of sulphurous acid and alumina is prepared by passing sulphurous acid gas into water in which pure alumina is mixed or suspended. 1430 Preparation.

2. The sulphite of alumina, thus formed, is in the state of a white, soft powder, which has at first an earthy taste, and becomes afterwards sulphureous. When it is exposed to the air for a long time, it is converted into the sulphate of alumina, and more rapidly if it be combined with an excess of sulphurous acid. It is insoluble in water. Exposed to heat, the acid is driven off, and partially decomposed, for there remains behind a small quantity of sulphur. The component parts of this salt are 1431 Properties. 1432 Composition.

Sulphurous acid	32
Alumina	44
Water	24
	100

4. Nitrate of Alumina.

1. This salt was formerly known under the names of *nitre of argil*, and *nitrous alum*. It is formed by the direct combination of the nitric acid with alumina. It has been found impossible to neutralize the acid; and it cannot be obtained crystallized, excepting in the form of thin plates, and often only in a gelatinous mass. 1433 Preparation.

2. This salt has an austere and acid taste. The specific gravity is 1.645. It is deliquescent in the air, and extremely soluble in water. When it is heated, the acid is driven off, and the pure earth remains behind. It is readily decomposed by the sulphuric acid, which disengages the nitric acid; and by the muriatic acid, which is converted into the oxymuriatic acid. 1434 Properties.

5. Nitrate of Alumina.

This salt is unknown.

6. Muriate of Alumina.

1. This salt, which is a compound of muriatic acid and alumina, is formed by the direct combination of the acid with the earth; but is never neutralized. The acid is always in excess. 1435 Purification.

2. This salt is rarely crystallized, but most frequently in the form of white powder, or in that of a gelatinous mass. It has an astringent, acid, and sharp taste. It reddens the tincture of turnsole and of violets. It is extremely deliquescent in the air, and very soluble in water. When it is exposed to heat it melts, and is decomposed. 1436 Properties.

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composed. The acid is separated, and the pure alumina remains behind. It is decomposed in the same way as the other muriates.

7. Hyperoxymuriate of Alumina.

1. This salt is prepared by passing oxymuriatic acid gas through water in which newly precipitated alumina is suspended. The alumina disappears, and when sulphuric acid is poured into the solution, a strong smell of hyperoxymuriatic acid gas is perceived.

2. This salt is deliquescent, and it is soluble in alcohol. Mr Chenevix could not ascertain the proportion of its principles*.

* Philos. Trans. 1802. p. 149.

8. Fluate of Alumina.

The combination of fluoric acid and alumina affords a salt which cannot be crystallized, but which is in the form of a jelly. It has always an excess of acid, and an astringent taste. It is decomposed by all the earthy and alkaline bases. With the latter it forms triple salts.

9. Borate of Alumina.

It is extremely difficult to form a compound of alumina and boracic acid by direct combination. This salt may be formed by mixing together a solution of borate of soda, with a solution of sulphate of alumina. Its properties have not been examined.

10. Phosphate of Alumina.

This salt is little known. By saturating phosphoric acid with alumina, a white powdery mass is obtained, which has little tate, except there be an excess of acid, and then it seems to form an acidulous salt. It melts under the blow-pipe into a transparent globule, without decomposition. It is decomposed by the alkalies, some of the earths, and the acids.

11. Phosphite of Alumina.

1. This salt is formed by the direct combination of phosphorous acid with alumina. The solution is to be evaporated to a proper consistence.

2. The phosphite of alumina does not crystallize, but forms a thick, viscid, gummy mass, which becomes dry and solid in the air. It has an astringent taste, is very soluble in water, swells up when it is heated, and gives out a phosphoric light. It is decomposed by all the alkaline and earthy bases.

12. Carbonate of Alumina.

1437 This compound little known.

Little is known of the combination of carbonic acid and alumina. Bergman had observed, when alum was precipitated by an alkaline carbonate, that very little or no effervescence took place; he therefore concluded, that the carbonic acid, not being driven off, must have combined with the alumina which was precipitated. And besides, he found that the liquid contained a portion of carbonate of alumina, which is deposited some hours or some days afterwards by the evaporation of the carbonic acid, which held it in solution.

Common clay, which is a mixture of alumina and silica, contains a certain portion of carbonic acid, which is disengaged by the application of strong heat. He obtained from one species of clay several times its volume of this acid, mixed with a small portion of hydrogen gas. It is owing to the same combination of carbonic acid, that clays, treated with acids, effervesce, without containing any carbonate of lime.

According to Saussure, alumina is dissolved in water, which is saturated with carbonic acid; but when the solution is exposed to the air, it is decomposed. 1438 The acids combined with water.

13. Arsenic of Alumina.

This salt is formed by dissolving alumina in arsenic acid, and evaporating the solution to dryness. A thick mass is thus obtained, which is insoluble in water. It is decomposed by the sulphuric, nitric, and muriatic acids, as well as by the earthy and alkaline bases.

14. Tungstate of Alumina.

This salt has not been examined.

15. Molybdate, chromate, and columbate. Unknown.

18. Acetate of Alumina.

The acetic acid enters into combination with alumina, and forms with it small needle-shaped crystals, which are soft, deliquescent, and have an astringent taste. The specific gravity of this salt is 1.245. Its other properties are unknown.

19. Oxalate of Alumina.

Oxalic acid very readily combines with alumina. When the solution is evaporated, a yellowish, soft, transparent mass is obtained, but it does not crystallize. 1439
This salt has an astringent taste, is deliquescent, and reddens the tincture of turnsole. When it is heated, it swells up, is deprived of its acid, and the alumina remains behind, slightly coloured. It is decomposed by the stronger acids. (Properties.)

The component parts of this salt are, 1440 Composition.

Acid and water	56
Alumina	44
	100

20. Tartrate of Alumina.

Alumina enters into combination with tartaric acid, and forms an uncrystallized, gelatinous mass, which has an astringent taste, is not deliquescent in the air, but is soluble in water.

21. Citrate of Alumina.

The properties of this salt have not been examined.

22. Malate of Alumina.

When malic acid is added to a solution containing alumina, a precipitate is formed, which is scarcely soluble in water.

23. Gallate of Alumina.

If pure alumina be added to a solution of nut-galls, an insoluble compound is formed with the tannin and extract. The liquid remained clear and white, and it afforded by evaporation, small crystals, which are gallate of alumina with excess of acid*.

* Phil. Trans. 1803. p. 244.

24. Benzoate of Alumina.

The compound of benzoic acid and alumina affords a salt, Silica, &c. salt, which crystallizes in an arborescent form. It has a bitter taste, is deliquescent in the air, soluble in water, is decomposed by the action of heat, and even by most of the vegetable acids.

25. Succinate of Alumina.

The compound of succinic acid and alumina affords salts which crystallize in the form of prisms, and are easily decomposed by heat.

26. Saccolate of Alumina.

This compound of saclactic acid and alumina forms a salt which is insoluble in water.

27. Camphorate of Alumina.

1441 Preparation. 1. The compound of camphoric acid and alumina is formed by precipitating alumina by means of ammonia, washing the precipitate, and diluting it with distilled water. Crystals of camphoric acid are then to be added. The mixture is to be heated, filtered, and evaporated.

1442 Properties. 2. A white powder is then obtained, which has a bitter, acid, and astringent taste. It reddens vegetable blues. This salt is scarcely altered by exposure to the air. Water dissolves about $\frac{1}{200}$ part of its weight. Boiling water dissolves it more readily; but on cooling, a precipitate is formed. When it is exposed to heat, it swells up, and the acid is volatilized. By the action of the blow-pipe, a blue flame is produced, the salt is decomposed, and the pure alumina remains behind. This salt is decomposed by the mineral acids, and even by some of the vegetable acids. It is also decomposed by the nitrates of lime and barytes *.

* *Annal. de Chim.* xxvii. p. 34.

28. Suberate of Alumina.

The compound of suberic acid and alumina may be formed by evaporating the solution with a very moderate heat, in a large open vessel.
1443 Properties. This salt does not crystallize; but the dried matter which is obtained is transparent, of a yellowish colour, and has a styptic, bitterish taste. When too much heat is employed, the salt melts and blackens. It reddens the tincture of turnsole, and is slightly deliquescent in the air. Exposed to the action of the blow-pipe, the acid is volatilized and decomposed, and the alumina remains behind. It is decomposed by the mineral acids, the earths, and the alkalies †.

† *Ibid.* xxiii. p. 56.

29. Mellate of Alumina.

The properties of this salt are unknown.

30. Lactate of Alumina.

This is a deliquescent salt.

SECT. VI. *Of Silica and its Combinations.*

1444 History. 1. Silica has been distinguished by the names of *siliceous earth*, or *quartzy earth*, because it is obtained from *silex*, or flint, and from the stone called *quartz*. This earth exists in great abundance in nature, and it constitutes the bases of some of the hardest stones of which the nucleus of the globe consists; and, on account of its great abundance, it has been regarded as the primitive or elementary earth, the base of all the other earths. Silica forms one of the constituent parts of most stony bodies; but it exists in greatest abundance in agates, jasper, flints, quartz, and rock crystal; in the latter it is nearly in a state of purity.

2. But to obtain it perfectly pure, a quantity of quartz or rock crystal may be exposed to a red heat. 1445 Preparation. When it is taken from the fire, and while it is yet hot, it is suddenly immersed in cold water. It is then to be reduced to powder; and, if transparent rock crystal has been employed, it is then in a state of tolerable purity. To have it perfectly pure, mix one part of the pounded stone with three parts of potash, and expose them in a crucible to heat which is sufficient for the fusion of the mixture. The mass thus obtained is soluble in water. Add a sufficient quantity of water for its solution, and drop in muriatic acid, as long as there is any precipitate. Let this be repeatedly washed with water, and dried. The substance thus obtained is pure silica.

3. It is in the form of a very fine white powder, 1446 Properties and composition. which has neither taste nor smell. The particles are rough and harsh to the feel, as when they are rubbed between the fingers, or touched with the tongue. The specific gravity is 2.66. Though never hitherto decomposed, it is assumed to be an oxide of silicium. It may now be observed, once for all, that the remaining earths are in the same situation, with respect to the present state of chemical knowledge.

4. Light has no action on silica; and it is one of the 1447 Action of heat, &c. peculiar characters of this earth, that it resists, unchanged, the greatest degree of heat.

5. There is no action between silica and oxygen, azote or hydrogen, nor is it changed by exposure to the air. It is not acted upon by carbon, phosphorus, or sulphur. It is insoluble in water; but in a state of minute division, it absorbs a considerable portion, and forms with this liquid a transparent jelly. When it is exposed to the air, the whole of the moisture is evaporated.

6. Silica is frequently found in nature in the crystal- 1448 Crystals. lized form, and then it is distinguished by the name of *rock crystal*. It is most commonly in hexagonal prisms, terminated by hexagonal pyramids. Crystals of silica have also been formed artificially. In a solution of silica in fluoric acid which had remained at rest for two years, Bergman found crystals, some of which were cubes, and some had truncated angles, at the bottom of the vessel. Crystals of silica have also been formed, by diluting largely with water the combination of silica and potash, and allowing it to remain for a long time. Professor Seigling of Erfurt obtained crystals from a solution which had been kept eight years in a glass vessel. A crust was formed on the top, composed of carbonate of potash and crystallized silica. The crystals of the latter were in the form of tetrahedral pyramids, perfectly transparent, and so hard as to strike fire with steel.

7. Silica is only acted on by a very few of the acids. 1449 Action of acids. These are, the phosphoric and boracic, which combine with it by fusion, and the fluoric, which dissolves silica either in the gaseous or liquid state. When silica is held in solution in water by means of an alkali, it is also dissolved by the muriatic acid.

8. The alkalies have a very powerful action on this 1450 Of alkalies. earth.

earth. In the preparation of the pure earth, it was combined with potash by means of fusion. This compound is different in its nature and properties, according to the proportions of the silica and the alkali. Two or three parts of potash with one of silica form a compound which is deliquescent in the air, and soluble in water. This was formerly distinguished by the name *liquor silicum*, or *liquor of flints*. It is now called *silicated alkali*. When this solution is long exposed to the air, the earth is deposited in a flaky gelatinous form. It is decomposed by acids, which combine with the alkali, and the pure earth falls to the bottom in the state of fine powder. When the solution is largely diluted with water, and if a greater quantity of the acid be added than is sufficient to saturate the alkali, the silica remains in solution. This is particularly the case when muriatic acid is employed. When the silica is in greater proportion than the potash, a compound is formed which is possessed of very different
1451 Glass. properties. The substance thus obtained is glass.

9. This earth also enters into combination with some of the earths. If to a solution of the liquor of flints lime water be added, a precipitate is formed,
1452 Of earths. which is found to be a compound of silica and lime. Silica also combines with lime by means of heat, and in certain proportions a glass is formed.

The following table, drawn up by Mr Kirwan, exhibits the effects of heat on these earths in different proportions *.

* *Mineral.* i. p. 56.

Proportions.	Wedgw.	Effect.
50 Lime 50 Silica	150°	Melted into a mass between porcelain and enamel, of a white colour, semitransparent at the edges, and which gave feeble sparks with steel.
80 Silica 20 Lime	156°	Not melted, but formed a brittle mass.
80 Lime 20 Silica	156°	Formed a yellowish-white loose powder.

10. Silica enters into combination with barytes. The following table will shew the effect of different proportions of these earths, as they were ascertained by Mr Kirwan †.

† *Ibid.* 57.

Proportions.	Wedgw	Effect.
80 Silica 20 Barytes	155°	Formed a white brittle mass.
75 Silica 20 Barytes	150°	A brittle hard mass, semitransparent at the edges.
66 Silica 33 Barytes	150°	Melted into a hard, somewhat porous, porcelain mass.
50 Silica 50 Barytes	148°	A hard mass not melted.

Proportions.	Wedgw.	Effect.
80 Barytes 20 Silica	148°	The edges melted into a pale greenish mass, between a porcelain and an enamel.
75 Barytes 25 Silica	150°	Melted into a somewhat porous porcelain mass.
66 Barytes 33 Silica	150°	Melted into a yellowish, and partly greenish white, porous porcelain.

11. Silica also enters into combination with strontites. Three parts of strontites and one of silica, strongly heated in a silver crucible for an hour, afforded a gray, sonorous, vitreous mass, which has no taste, and is insoluble in water.

12. Siliceous earth enters with difficulty into combination with magnesia; but if equal parts of silica and magnesia be exposed to very strong heat, they melt into a white enamel.

13. But the most important compounds of all the earths are those of silica and alumina. These earths may be combined together, as appears from the experiments of Guyton, in the humid way. He mixed together equal parts of alumina dissolved by means of potash, and of silica held in solution by the same alkali. When the solutions came into contact, a brown zone was immediately formed, which spread by agitation through the whole mass, and communicated to it a yellowish colour. The mixture was no farther changed during the space of an hour, although it was occasionally stirred by a glass rod; but at the end of that time the whole mass assumed the appearance of a thick, opaque, white jelly *. When the silica and alumina are mixed together, and formed into a paste with water, and exposed to heat, they strongly cohere, 1453 Porcelain.
and assume a considerable degree of hardness. This compound forms the basis of all kinds of pottery and porcelain.

* *Annal. Chim.* iii. p. 14.

I. Compounds of Silica with Acids.

1. Muriate of Silica.

When muriatic acid is poured upon a solution of silicated potash, part of the silica remains in the solution combined with the acid. To this compound 1454 Preparation.
Fourcroy has given the name of *muriate of silica*. This solution, which is perfectly transparent, is always acid. When it is concentrated by slow evaporation, it assumes the form of a transparent jelly. But if the solution be boiled, it is decomposed, and the silica is precipitated in the form of small crystalline particles, so that it is totally separated from the water and the acid †. 1455 Properties.

† Fourcroy, iii. 115.

2. Fluate of Silica.

Fluoric acid combines with silica, either in the gaseous or liquid state. When it is disengaged from lime in the state of gas, by means of an acid, if the process be performed in glass vessels, they are corroded. The fluoric acid in the state of gas combines with the 1456 Preparation.
silica,

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Yttria, &c. silica, and retains it, even when it is condensed by water. This earth may be precipitated from the liquid solution by means of an alkali. When fluoric acid gas is condensed by water, part of the silica with which it was combined is precipitated; but this portion is at last dissolved by new additions of the acid, so that the salt is in the state of an acidulous fluate. If this solution be evaporated, a quantity of silica, corresponding to the portion of acid disengaged, is deposited, and the liquid which remains contains a portion in proportion to that of the acid which is left in the solution ‡.

‡ *Ibid.* iii. p. 310.

3. Fluate of Potash and Silica.

This triple salt is formed, when a solution of fluate of potash is exposed to heat in glass vessels; or, when the fluoric acid which has been prepared in glass vessels is combined with potash. But the nature of this triple salt has not been examined.

4. Fluate of Soda and Silica.

This triple salt is formed in the same way as the former.

5. Borate of Silica.

Boracic acid and silica combine together by means of a strong heat, and form a transparent glass. To this Fourcroy has given the name of *borate of silica*. This compound has no taste, is not altered by the air, nor is it soluble in water.

6. Phosphate of Silica.

This compound of phosphoric acid and silica is formed by means of fusion; and the compound is a hard, dense, transparent glass. When it is exposed to strong heat, it combines with the alkalies, and forms a triple salt. It is not decomposed by any of the acids. This substance is employed in the fabrication of artificial gems.

Sect. VII. *Of Yttria and its Combinations.*

1457 History. 1. This earth was discovered by Gadolin in 1794; and the account of his analysis of the mineral from which it is obtained, was published in the memoirs of the Swedish academy, and in Crell's Annals for the year 1796. In 1797 Ekeberg analyzed the same mineral, and confirmed the results of Gadolin. To the new earth found in this mineral, Ekeberg gave the name of *yttria*, derived from *Ytterby*, a place in Sweden where the stone is found. The same mineral was afterwards analyzed by Vauquelin and Klaproth, about the year 1800. The mineral from which this earth is obtained has received the name of gadolinite, is of a black colour, has a vitreous fracture, and its specific gravity is 4.0497. It is magnetic. When it is heated with borax, it melts, and communicates to the salt a yellowish colour inclining to violet. The component parts of this mineral are,

Yttria	.47
Silica	.25
Oxide of iron	.18
Alumina	.04
	.94

2. Yttria is obtained from this mineral, by reducing it to powder, and adding a mixture of nitric and muriatic acids, till the whole is decomposed. The solution is then to be filtered and evaporated to dryness. 1458 Preparation. If then it be diluted with water, the silica will remain behind. The liquid which passed through the filter is also to be evaporated to dryness, and what remains is to be exposed to a red heat in a close vessel. It is afterwards dissolved in water, and filtered. The liquid which passes through the filter is transparent and colourless. By adding a solution of ammonia, a precipitate is formed, which being collected, is pure yttria.

3. This earth is in the state of a white powder. It 1459 Properties. has neither taste nor smell. It is not fusible. It is not soluble in water, or in any of the caustic fixed alkalies; but it readily dissolves in carbonate of ammonia. The specific gravity of this earth is 4.842.

4. This earth undergoes no change by the action of light. It is not acted on by oxygen, azote, or hydrogen, nor does it combine with sulphur. It forms compounds with the acids. These salts have a sweetish, austere taste, and some of them have a red colour.

I. Compounds of Yttria with the Acids.

1. Sulphate of Yttria.

1. Sulphuric acid combines readily with yttria, and 1460 Preparation. during the combination there is an evolution of caloric; and as the union goes on, the salt which is formed crystallizes in small brilliant grains.

2. These crystals are sometimes irregular, but often 1461 Properties. have the form of six-sided prisms, terminated by four-sided summits, and are of an amethyst red colour. This salt has a sweetish astringent taste, something like the salt of lead. The specific gravity is 2.791. It undergoes no change by exposure to the air. It is soluble in about 50 parts of cold water, but less so where there is not an excess of acid. This salt is partially decomposed when exposed to a red heat.

2. Sulphite of Yttria.

Unknown.

3. Nitrate of Yttria.

Nitric acid combines with yttria by dissolving the 1462 Preparation. earth in the acid. This salt crystallizes with difficulty. When it is evaporated by heat, if too much be applied, in place of becoming solid as other salts, it becomes soft, and assumes the appearance of a thick, transparent honey. When it cools, it becomes hard and brittle. It deliquesces in the air. When sulphuric acid is poured into a solution of nitrate of yttria, a precipitate is formed which crystallizes. These are crystals of sulphate of yttria *.

* *Ann. de Chim.* xxxvi. 143.

4. Muriate of Yttria.

This salt, which is a compound of muriatic acid and yttria, resembles the nitrate in many of its properties. It dries with difficulty, is fusible with a moderate heat, and is deliquescent in the air. This salt is decomposed by ammonia.

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Yttria, &c.

5. Fluate of Yttria. } Unknown.
6. Borate of Yttria. }

7. Phosphate of Yttria.

1463 Preparation. Phosphoric acid does not precipitate yttria from its combination with the other acids; but the phosphate of soda decomposes the salts of yttria, and forms a phosphate of yttria, which is precipitated in white, gelatinous flakes †.

† *Ibid*, 158.

8. Phosphite of Yttria.

Unknown.

9. Carbonate of Yttria.

1464 Preparation. This compound of carbonic acid and yttria was formed by Klaproth, by precipitating the earth by means of an alkaline carbonate, from its solution in acids. The carbonate of yttria is in the form of an insipid white powder. It is insoluble in water.

The component parts of this salt are,

Acid	18.
Yttria	55.
Water	27.
	100

10. Arseniate of Yttria.

This salt is formed by boiling the earth in the acid. A white powder is precipitated, which is arseniate of yttria.

11. Tungstate, Molybdate, Chromate, and Columbate of Yttria. Unknown.

15. Acetate of Yttria.

This salt is formed by the direct combination of the earth with the acid. By evaporating the solution, a salt is obtained in crystals. These crystals, which are of a red colour, are in the form of six-sided plates obliquely truncated. This salt undergoes no change by exposure to the air.

16. Oxalate of Yttria.

This salt is formed by adding oxalic acid to the solution of yttria in acids. A precipitate is formed in the state of a white powder, which is insoluble in water. It may be obtained also by employing the oxalate of ammonia.

17. Tartrate of Yttria.

This compound is formed by precipitating yttria from its solution in acids by means of tartrate of potash. This salt is soluble in water.

18. Citrate, Malate, Gallate, and Benzoate of Yttria. Unknown.

22. Succinate of Yttria.

If the succinate of soda be added to a concentrated solution of muriate or acetate of yttria, a precipitate is formed, which is the succinate of yttria in the state of cubic crystals.

Glucina, &c.

23. Saccolate, Camphorate, Suberate, Mellate, and Lactate of Yttria. Unknown.

28. Prussiate of Yttria.

The prussiate of potash crystallized and re-dissolved in water, causes a precipitate in the solution of yttria in acids. This is in the form of a white, gritty matter *.

* Ann. de Chim. xxv. p. 158.

Sect. VIII. *Of Glucina and its Combinations.*

1. This earth was discovered by Vauquelin in the year 1789. He was requested by Haüy to analyze the beryl, to ascertain whether its constituent parts were the same with those of the emerald, which the latter had conjectured in observing a perfect correspondence in structure, hardness, and specific gravity. In the course of this analysis, Vauquelin discovered the new earth, to which, from its properties, he gave the name of *glucina*, from the Greek word γλυκυς, which signifies sweet. The same experiments were repeated by Klaproth and Bindheim, and the results obtained by Vauquelin were confirmed. 1465 History.

2. This earth is obtained by the following process. One hundred parts of the beryl or emerald, reduced to a fine powder, are fused with 300 parts of caustic potash. The fused mass is then diluted with distilled water, and dissolved in muriatic acid. The solution is to be evaporated to dryness, taking care to stir it towards the end of the evaporation. Dilute the residuum with a large quantity of water, and filter it. The silica is thus separated by means of the first process. The filtered solution, which contains the muriates of alumina and glucina, is precipitated by carbonate of potash. The precipitate is to be well washed, and dissolved in sulphuric acid. Add to this solution, a quantity of sulphate of potash, and evaporate to obtain crystallized alum. When by a new addition of sulphate of potash, and by a new evaporation, the solution yields no more alum, add to it a solution of carbonate of ammonia in excess, and agitate it well. The glucina, after being deposited, is dissolved by means of the excess of this salt, and the small quantity of alumina which may remain is precipitated without being dissolved. After some hours, when the aluminous precipitate is not diminished in volume by a new addition of carbonate of ammonia and agitation, the solution is to be filtered, and boiled in a glass matrass, and as the carbonate evaporates, there is precipitated a white, gritty powder, which is carbonate of glucina. The carbonic acid may be driven off, by exposing the powder in a crucible to a red heat †. 1466 Preparation.

† Fourcroy, ii. p. 157.

3. Glucina prepared by this process is in the form of a soft powder, or light white fragments, which are insipid to the taste, and adhere to the tongue. The specific gravity is 2.967 ‡. It is altogether infusible in the fire, and it neither contracts nor becomes harder, like alumina. It has no effect on vegetable colours. 1467 Properties.

‡ Ann. de Chim. lix. 177.

4. There is no action between glucina and oxygen, azotic, or hydrogen gases. It is not changed by exposure to the air, nor is it acted on by carbon, phosphorus, or sulphur. It combines with sulphurated hydrogen. When sulphurated hydrogen gas is made to pass into water in which this earth is suspended, it combines 1468 Hydrosulphuret.

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Zirconia, &c. combines with it, and forms a hydrosulphuret, whose properties are similar to those of the other hydrosulphurets.

1469 Action of water. 5. Glucina is insoluble in water; but it forms with this liquid, in small quantity, a paste which is slightly ductile, but has less tenacity than that of alumina.

1470 Of acids. 6. Glucina combines readily with all the acids, and forms with most of them soluble salts, which are distinguished by a sweet and slightly astringent taste. Its affinities are in the following order.

Sulphuric acid,
Nitric,
Muriatic,
Phosphoric,
Fluoric,
Boracic,
Carbonic.

1471 Of alkalies. 7. This earth is soluble in solutions of the fixed alkalies. It is also soluble in carbonate of ammonia, but it is insoluble in pure ammonia.

1472 Characteristic properties. 8. The characteristic properties of this earth are, according to Vauquelin, the following.

a. It forms with acids sweetish and slightly astringent salts.

b. It is soluble in sulphuric acid when a little in excess.

c. It decomposes aluminous salts, by separating the earth when it is boiled in their solutions.

d. The salts of glucina are completely precipitated by ammonia.

e. It is soluble in the liquid carbonate of ammonia.

f. The affinity of this earth for the acids is between that of magnesia and alumina ‡.

‡ *Fourcroy* ii. p. 161.

I. Compounds of Glucina with Acids.

1. Sulphate of Glucina.

1473 Preparation. 1. This salt, which was first discovered by Vauquelin, is prepared by the direct combination of sulphuric acid with the earth, either in the pure state or in that of carbonate. The solution is to be evaporated to the consistence of syrup, and crystals are obtained on cooling.

1474 Properties. 2. This salt crystallizes with difficulty in the form of small needles; but their form has not been accurately ascertained. It has a sweet, and somewhat astringent taste. It is not perceptibly altered by exposure to the air, and is very soluble in water.

1475 Action of heat. 3. When it is exposed to heat, it melts, swells up, and then dries. With a red heat it is entirely decomposed, the acid is driven off in the state of vapour, and the pure earth remains behind.

1476 Of acids, &c. 4. This salt is not decomposed by any of the acids, but it is decomposed by the alkaline and most of the earthy bases. The infusion of nut-galls added to a solution of this salt produces a yellowish white precipitate, which is characteristic of the salt *.

* *Fourcroy Connaiss. Chim.* iii. p. 49.

2. Sulphite of Glucina.

This salt is yet unknown.

3. Nitrate of Glucina.

1477 Preparation. 1. The compound of nitric acid and glucina is formed by the direct combination of the acid and earth in a state of purity. The solution is evaporated by a moderate heat to dryness, and then the salt is obtained in the state of powder.

2. The nitrate of glucina does not crystallize. It is either in the form of powder, or in that of a soft ductile mass. The taste is sweetish and astringent. 1478 Properties.

3. It is extremely deliquescent in the air, and is very soluble in water. It readily melts when exposed to heat, and if the heat be increased it is decomposed; the acid is driven off in the gaseous form, and the earth remains behind. It is only decomposed by sulphuric acid †. 1479 Action of heat.

† *Ibid.* 146.

4. Nitrite of Glucina.

Unknown.

5. Muriate of Glucina.

This salt, according to Vauquelin, by whom only it has been described, comes very near the nitrate of glucina in its properties. It seems to crystallize with more facility, but the crystals are so small that the form cannot be determined. It does not deliquesce in the air. When it is dissolved in alcohol, and diluted with water, it affords a very agreeable sweet liquor.

It is decomposed by heat, by the sulphuric acid, the nitric, and by the phosphoric, by the assistance of heat.

6. Fluate of Glucina. } Unknown.
7. Borate of Glucina. }

8. Phosphate of Glucina.

1. Vauquelin procured this salt by adding the phosphate of soda to the solution of the nitrate, the sulphate, or muriate of glucina. A copious mucilaginous matter is instantly precipitated. Or it may be obtained by heating together the muriate of glucina and phosphoric acid in the state of glass. 1480 Preparation.

2. This salt does not crystallize, but is in the form of mucilage or of white powder. It has no perceptible taste. It is not altered by exposure to the air, and it is insoluble in water without an excess of acid. It is not decomposed by strong heat. It melts under the blow-pipe into a transparent vitreous globule. It is decomposed by the sulphuric, nitric, and muriatic acids. 1481 Properties.

9. Phosphite of Glucina.

Unknown.

10. Carbonate of Glucina.

1. The compound of carbonic acid and glucina, which was discovered by Vauquelin, and only examined by him, is prepared by exposing the earth to the air, from which it attracts the acid, or by precipitating some of the soluble salts of glucina by means of an alkaline carbonate. The precipitate is to be washed with water, and dried in the air. 1482 Preparation.

2. This carbonate is in the state of a white powder, soft and greasy to the touch. It has not the sweet taste of the other salts of glucina. It is not changed by exposure to the air, and is insoluble in water. When exposed to heat, the acid is driven off, and the pure earth remains behind. It is decomposed by all the acids with a brisk effervescence. 1483 Properties.

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Zirconia, &c.

11. Carbonate of Ammonia and Glucina.

This triple salt is formed by adding the earth of glucina to a solution of carbonate of ammonia. It is soluble in the same quantity of water which holds the carbonate of ammonia in solution. Its other properties are unknown.

12. Arseniate, tungstate, molybdate, chromate, and columbate of glucina. Unknown.

17. Acetate of Glucina.

Glucina readily dissolves in acetic acid. This salt does not crystallize; but by evaporation it is reduced to a gummy substance, which becomes slowly dry and brittle. For a long time it retains a kind of ductility. The taste is sweet and strongly astringent.

18. Oxalate, tartrate, citrate, malate, gallate, and benzoate of glucina. Unknown.

24. Succinate of Glucina.

This salt, according to Ekeberg, is formed by precipitating the earth from its solutions, by means of the succinates. It is therefore nearly insoluble.

25. Saccolate, camphorate, suberate, mellate, lactate, prussiate, and sebate of glucina. Unknown.

Sect. IX. *Of Zirconia and its Combinations.*

1484 History. 1. The name of this earth is derived from a stone, called *zircon* or *jargon*, which is found in the island of Ceylon. It was from this stone that Klaproth extracted the earth, some time before the year 1793. He soon after found the same earth in the oriental hyacinth. By this discovery, Guyton was led to analyze the hyacinths of France; and in those which were collected in the river of Expailly, he detected the same earth. The experiments of Klaproth and Guyton were repeated by Vauquelin, and their results were confirmed, so that the nature and properties of this earth have been fully developed.

1485 Preparation. 2. Zirconia is extracted from this mineral, in which alone it has been found, by the following process. A quantity of the mineral is to be reduced to fine powder, and fused with five or six times its weight of pure potash, in a silver crucible. The fused mass is then dissolved in water, by which means the alkali is separated. The residuum is then dissolved in muriatic acid, which is to be heated, to separate the silica; and when no farther precipitate appears by means of heat, add a caustic fixed alkali. Another precipitate is formed, which is to be well washed and dried. This is pure zirconia.

1486 Properties. 3. Zirconia, thus prepared, is in the state of fine white powder, which is nearly soft to the touch, and without taste or smell. When it retains water, it assumes the form of a jelly, and is semitransparent. The specific gravity is 4.3.

1487 Action of heat. 4. Light has no action on this earth. When it is exposed to the heat of the blow-pipe, it remains infusible, but gives out a yellowish, phosphoric light. Heated in a charcoal-crucible, and surrounded with powdered charcoal, it undergoes a kind of fusion, but without becoming transparent, or assuming a vitreous form. It becomes extremely hard, strikes fire with steel, and scratches glass.

5. There is no action between zirconia and oxygen or azotic gases, nor is it changed by exposure to the air. It is not acted on by hydrogen, carbon, phosphorus, or sulphur.

1488 Of water. 6. This earth is insoluble in water; but it mixes with a considerable portion of this fluid, and forms with it a transparent jelly. If in this state it be slowly dried, it retains the water, and assumes a yellowish colour, and something of the transparency of gum arabic *. When it is dried in a very high temperature, it loses more than one-third of its weight. After having been exposed to a red heat, it becomes of a gray colour, harsh to the feel, and less soluble in acids.

1489 Of acids. 7. Zirconia combines with the acids, and forms with them peculiar salts. Many of these are insoluble in water, and are distinguished by an astringent taste.

1490 Affinities. The order of the affinities of this earth is the following:

Vegetable acids,
Sulphuric,
Muriatic,
Nitric.

1491 Action of alkalies. 8. Zirconia does not combine with the alkalies by fusion, and is insoluble in liquid alkalies. It may be dissolved, however, by the alkaline carbonates.

I. Compounds of Zirconia with Acids.

1. Sulphate of Zirconia.

1492 Preparation and properties. 1. This salt is formed by the direct combination of the earth with sulphuric acid. The solution is to be evaporated to dryness. The salt thus obtained is in the form of a white powder, which is very friable. Sometimes it is in the form of crystals like small needles. It has no taste, is not changed by exposure to the air, and is insoluble in water.

1493 Action of heat. 2. This salt is readily decomposed by heat, the acid is driven off, and the earth remains behind. When it is boiled in water, the earth is precipitated, and the acid remains in the liquid. At a high temperature it is decomposed by charcoal, and converted into a sulphuret which is soluble in water, and the solution furnishes by evaporation crystals of hydrosulphuret of zirconia †.

2. Sulphite of Zirconia.

Unknown.

3. Nitrate of Zirconia.

1494 Preparation. 1. This salt is formed by the direct combination of zirconia with concentrated nitric acid; and by evaporation it is obtained in the form of a yellow, transparent viscid mass, which dries with difficulty.

1495 Properties. 2. This salt has a styptic and astringent taste, and leaves on the tongue a thick matter, which proceeds from a decomposition of the salt by means of the saliva.

1496 Action of water and heat. 3. When nitrate of zirconia, after being evaporated, is put into distilled water, a very small quantity only is dissolved. The greatest part remains under the form of

* Annal. de Chim. xx. 197.

† Ibid. 199.

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Zirconia, &c. of gelatinous and transparent flakes. This salt is very readily decomposed by heat.

1497 Of acids, &c. 4. It is also decomposed by sulphuric acid, which forms in the solution a white precipitate soluble in excess of acid; by carbonate of ammonia, which produces a precipitate, soluble in an excess of this salt; and by an infusion of nut galls in alcohol, which affords a white precipitate, soluble in an excess of this infusion. But if the zirconia contains iron, the colour of the precipitate is bluish gray, of which a part remains in the solution, communicating to the liquor a pure blue colour. When this liquid is mixed with carbonate of ammonia, it affords a purple matter, by the refracted rays, but of a violet colour by reflected light. Crystallized gallic acid also precipitates the nitrate of zirconia, of a bluish gray colour. Most of the other vegetable acids also decompose this salt, and form combinations with the earth which are insoluble in water *.

* Ann. de Chim. xxii. p. 199.

4. Nitrate of Zirconia.

Unknown.

5. Muriate of Zirconia.

1498 Preparation. 1. Of all the acids, the muriatic combines most readily with zirconia, when the latter is in the state of carbonate. This salt was first formed by Klaproth, and its properties were afterwards more particularly investigated by Vauquelin.

1499 Properties. 2. The muriate of zirconia has no colour, but possesses a very astringent taste, is very soluble in water, and also in alcohol. By slow evaporation, it affords small transparent needle-formed crystals, whose figure has not been determined. When muriate of zirconia contains any portion of silica, the crystals are cubical, have little consistence, and resemble a jelly. These crystals, exposed to the air, gradually lose their transparency, and are diminished in volume. There are formed, in the middle of the mass, white silky crystals in the shape of needles, which arise from the cubes.

1500 Action of heat, acids, &c. 3. Muriate of zirconia is decomposed by heat, which drives off the acid. It is even decomposed in the mouth by means of the saliva.

4. *a.* It is also decomposed by sulphuric acid, which forms a precipitate with the earth in heavy white flakes, while another part is retained in solution by the muriatic acid. But by the assistance of heat, the latter is dissipated, and the remaining part of the sulphate of zirconia is deposited. If the evaporation be stopped before it is brought to a state of dryness, it assumes the appearance of a jelly by cooling. The sulphate of zirconia is then soluble in muriatic acid.

b. This salt is also decomposed by the phosphoric, citric, tartaric, oxalic, and saclactic acids, which forming with its base insoluble compounds, precipitate in the form of white flakes.

c. The gallic acid precipitates the muriate of zirconia in the form of white matter, if the salt has been pure, but of a grayish green if it contain iron. In the latter case, the precipitate becomes, when dry, of a shining black colour, which has the same appearance as china ink. The liquid, in which are formed the gallates of zirconia and iron, preserves a green colour; and although new portions of gallic acid are added, no farther precipitation is produced. But the carbonate of ammonia throws down a copious flaky matter, which has a purple colour, and nearly resembles that of lees of wine. Thus it appears that the gallic acid has a greater affinity for zirconia than the muriatic, and that the gallates of zirconia and iron are soluble in muriatic acid.

d. The carbonate of potash, when fully saturated, decomposes the muriate of zirconia; and although this solution is attended with effervescence, the precipitate, washed and dried in the air, retains a large proportion of carbonic acid; for when this earth is afterwards dissolved in acids, it produces a brisk effervescence. The carbonate of ammonia at first forms a precipitate in the solution of muriate of zirconia. This precipitate is in great part redissolved by new additions of the ammoniacal salt, and there is produced a triple salt, which may be decomposed by heat.

e. A solution of sulphurated hydrogen gas in water, mixed with a solution of muriate of zirconia containing iron, becomes turbid, and produces a reddish colour; but there is no real precipitate. Hydrosulphuret of ammonia, instantly precipitates this earth of a fine green colour, which appears black when it is dry. When this precipitate is placed on burning coals, it emits the odour of sulphurated hydrogen gas, and becomes of a purple blue colour when reduced to powder.

f. Pure alumina decomposes the muriate of zirconia, with the aid of heat. The alumina is dissolved, the liquid becomes milky, and assumes the form of a jelly as it cools. It has been remarked, when the muriate of zirconia contains iron, it remains in solution with the alumina; and the zirconia, which has been precipitated in this way, contains no perceptible portion of this metal.

g. The prussiate of mercury produces in the solution of muriate of zirconia a copious white precipitate, which is soluble in muriatic acid.

h. A plate of zinc introduced into a solation of muriate of zirconia, produces a slight effervescence. The liquid becomes milky, and assumes the appearance of a white semitransparent jelly in a few days *.

* Ann. de Chim. xxxii. p. 201.

6. Fluate of zirconia, borate, phosphate, and phosphite of zirconia. Unknown.

10. Carbonate of Zirconia.

When an alkaline carbonate in solution is added to a solution of muriate of zirconia, the earth is precipitated without effervescence; and when this precipitate is exposed to heat in close vessels, it gives out carbonic acid gas. It also enters into combination with the alkaline carbonates, and forms with them triple salts. This, Vauquelin observes, is one of the remarkable characters of this salt.

The component parts of carbonate of zirconia, according to the same chemist, are, 1501 Composition.

Acid and water	44.5
Zirconia	55.5
	100.0

11. Arseniate, tungstate, molybdate, chromate, and columbate of zirconia. Unknown.

16.

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Metals.

16. Acetate of Zirconia.

1502 Properties. Acetic acid combines with zirconia, and forms with it a salt which does not crystallize. When the solution is evaporated to dryness, the acetate of zirconia remains in the state of powder. This salt has an astringent taste, is not altered by exposure to the air, and is very soluble in water and in alcohol. This salt seems to have less tendency to be decomposed by heat than the nitrate of zirconia *.

* Ann. de Chim xxii, p. 206.

17. Oxalate, tartrate, citrate, and malate of zirconia. Unknown.

21. Gallate of Zirconia.

Gallic acid, added to a solution of muriate of zirconia, it has been already mentioned, produces a precipitate of a white matter, which is the gallate of zirconia. The properties of this compound have not been examined.

22. Benzoate, succinate, saccolate, camphorate, suberate, mellate, lactate, prussiate, and sebate of zirconia. Unknown.

Sect. X. *Of Thorina.*

1503 General account. This earth, which was found by Berzelius in gadolinite, and some other minerals found in the neighbourhood of Fahlun, differs from alumine and glucine by its insolubility in potash; from yttria, by its solutions being astringent to the taste and destitute of sweetness, and precipitated at a boiling heat; from zirconia, by remaining soluble in acids after being ignited, and by being precipitated by oxalate of ammonia.

Chap. XIV. Of METALS.

1504 Importance of metals. 1. The metals, on account of their importance and utility, have always greatly occupied the attention of mankind. Indeed such is their importance, that man could not take a single step in the improvement even of the simplest of the arts of life, without the assistance of some of the metals. In this view, the origin and improvement of many arts, and the knowledge of metallic substances, may be, in some measure, considered as coeval. The metals, therefore, became very early, and were probably the first objects of chemical investigation. In the extraordinary pursuits of the alchemists, they were the subjects of their eager researches, in the discovery of the means of converting the more abundant and baser metals, as they were called, into those which were more valued, on account of their durability and scarcity. They failed of their purposes; but their labours were not in vain. The facts which they discovered, in the progress of their investigations, were of no small importance to science.

1505 Characters. 2. The metals are distinguished from other substances by a number of characteristic properties. These are, brilliancy, colour, opacity, density, hardness, elasticity, ductility, malleability, tenacity, fusibility, power of conducting caloric and electricity.

1506 Brilliancy. 3. Lustre or brilliancy is one of the most striking characteristic properties of metallic substances, and hence it has been denominated *metallic lustre.* This is owing to the reflection of a great proportion of the rays of light by metallic surfaces. On account of this property, metals are employed in the construction of mirrors. Other substances, indeed, exhibit the appearance of this brilliancy, which is the case with the mineral called *mica;* but in this substance, as well as every other which is not metallic, it is merely superficial, and it entirely disappears when the surface is broken, or scratched with a sharp-pointed instrument. But the metal, treated in the same way, becomes more brilliant. The following is the order in which the metals possess this lustre:

Platinum,
Steel,
Silver,
Mercury,
Gold,
Copper,
Tin,
Zinc,
Antimony,
Bismuth,
Lead,
Arsenic,
Cobalt; and the other brittle metals.

4. Colour is one of the constant properties of metallic substances, while it is only accidental and variable in other minerals. And as the metals are the most opaque, and the densest bodies in nature, colour in them is very intense, or rather confounded with their brilliancy. The prevailing colour of metals is white; some however are yellow, and others reddish. Those of a white colour were formerly distinguished by the name of *lunar metals*, because silver, which was called *luna*, being placed at the head of these metals, has a white colour. Gold, which was distinguished by the name of *sol*, having a yellow colour, gave the name of solar metals to such as resembled it. The colour of metals is permanent, while they remain unaltered; but it is often totally lost when they enter into new combinations. 1507 Colour.

5. It is generally admitted, that all metallic substances are perfectly opaque. Newton indeed observed, that gold-leaf when reduced to $\frac{1}{180000}$ of an inch thick, appeared of a green colour, from which he concluded that it transmits the green rays; and he supposed that other metals might also transmit light, if they were sufficiently thin. But no metal has yet been found so malleable as to be reduced to that state of thinness to permit light to pass through it. Silver-leaf, so thin as to be only $\frac{1}{100000}$ part of an inch, is quite opaque. 1508 Opacity.

6. The metals are particularly distinguished from other substances by their density. Metallic substances have a greater specific gravity than any other bodies in nature; that is, the quantity of matter contained in a given bulk, is greater in the metals than in other substances. Even the lightest of the metals possess a greater density than the heaviest bodies known of any other kind of matter. The particles of which they are composed must therefore be in closer contact than in any other body. To this greater density is owing their superior lustre. 1509 Density.

7. The metals differ from each other greatly in degrees of hardness. In general, metallic substances are not 1510 Hardness.

Metals. not so hard as many other natural bodies. The degree of hardness does not depend on the density, for the hardest metals are by no means the heaviest. This property, therefore, must be owing to the nature of the particles of which the metal is composed, or to some peculiar disposition or arrangement of these particles. It is found that some of the metals can be hardened by art, merely by hammering, or by sudden cooling after being heated. The hardness of metals, too, is greatly increased by being combined with each other, or with other substances; as, for instance, when copper and tin are combined together, or iron and carbon in the formation of steel, the utility of which latter, as it is applied for cutting instruments, depends on its hardness. Metallic substances, in comparing their different degrees of hardness, have been divided into eight classes, which are arranged in the following order.

1st, Iron and manganese.
2d, Platinum and nickel.
3d, Copper and bismuth.
4th, Silver.
5th, Gold, zinc, and tungsten.
6th, Tin and cobalt.
7th, Lead and antimony.
8th, Arsenic.

Mercury being always fluid at the ordinary temperature of the atmosphere, cannot be compared with regard to this property; and the degree of hardness which some of the other metals possess has not been ascertained.

1511 Elasticity. 8. The elasticity of metals seems to follow the same order in which they possess the property of hardness. The elasticity of some metals can be increased in the same way as their hardness, either by mechanical means, as by hammering, or by new combinations.

1512 Ductility. 9. One of the most important physical properties of the metals is ductility. By this is meant that peculiar property which some metals possess, of being drawn out into wire, without destroying or diminishing the cohesive power of their particles. Some metals possess this property in a great degree, while others are entirely deprived of it; and some metals are extremely ductile, while they possess in a very small degree another property, namely, malleability. Iron is one of the most ductile metals, but is much less malleable than many others.

1513 Malleability. 10. Malleability is also one of the most valuable properties of metallic substances. By this property they can be reduced to any form or shape which may be wanted, for those purposes to which they are to be applied. The property of malleability is supposed to depend on the form of the particles, or on the mode of their aggregation. Those metals which possess this property of malleability or laminability, seem to be composed of small plates, while the ductile metals seem to have their particles arranged in a fibrous form. When metallic substances are hammered, they become harder, denser, and more elastic, which is owing to their particles being brought into closer contact.

1514 Tenacity. 11. Tenacity is expressive of the power of cohesion between the particles of metallic substances. Different metals possess this property in very different degrees. The method which has been adopted to estimate the different degrees of tenacity, is by suspending wires of the same diameter of the different metals by one extremity, and attaching weights to the other, till the wires are broken. Iron, which has the greatest tenacity of all the metals, when formed into wire, $\frac{1}{10}$ of an inch in diameter, will support a weight of 500lb. without breaking, while a wire of lead of the same diameter, can only support about 29 lbs. The following is the order of the ductile metals, according to the degree of their tenacity.

Iron,
Copper,
Platinum,
Silver,
Gold,
Tin,
Lead.

12. Another property of the metals is fusibility. 1515 Fusibility. When they are exposed to a sufficient degree of heat, they melt, and are reduced to the state of liquidity. One of the metals, namely mercury, is always in the fluid state, at the ordinary temperature of the atmosphere. The different metals which are generally in the solid state, require very different temperatures for their fusion. Thus lead and tin require comparatively a lower temperature to be melted; while gold and platinum can only be brought to the state of fusion, by the greatest degree of heat that can be applied.

13. Metallic substances are the best conductors of caloric, but the comparative degrees of this property have not been ascertained. They are also found to be the best conductors of electricity. 1516 Conductors of caloric and electricity.

14. The metals possess some properties in common with other substances, as taste and smell, by which some of them are peculiarly distinguished; and in being susceptible of crystallization, which is the case with some, or of being volatilized, as happens to others.

15. But metallic substances are not only of vast importance in the arts of civilized life, on account of the properties which we have now detailed, which belong to them in the metallic state; but many of them are not less valuable in those changes which they undergo, by new combinations, and the new properties they acquire, in consequence of these changes. One of the first and most ordinary changes to which metallic substances are subject, is their combination with oxygen. This is called in chemical language, *oxidation*. When a metal, as for instance, a piece of iron, is exposed to the air, when it is moist, it soon undergoes a remarkable change. It loses its metallic lustre, and the surface is covered with a brownish powder, well known by the name of *rust*. This change is owing to the combination of oxygen with the metal, and the rust of the metal in this state is known in chemistry by the name of *oxide*. The process by which this compound of oxygen and a metallic substance is formed, is called *oxidation*, and the product is denominated an *oxide*. 1517 Oxidation in the air.

16. But this process of oxidation is effected more rapidly when metals are exposed to the action of heat; and indeed many metals require a very high temperature to produce the combination, while it cannot be accomplished in others by the greatest degree of heat that 1518 By heat.

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that can be produced. This process was formerly called *calcination*, or calcining the metal; and the product, now denominated an *oxide*, was distinguished by the name of *calx* or *calces*, from its being reduced to the state of powder, in the same way as limestone, by burning.

1519 Are oxidated in different circumstances.

17. Metals differ very much from each other in the circumstances in which this oxidation takes place, in the temperature which is necessary, the facility of the combination, the proportions of oxygen which combine, and the force of affinity between the constituent parts of the oxide. Some metals are oxidated in the lowest temperature, as, for instance, iron and manganese; while others require the greatest degree of heat that can be applied. Such are silver, gold, and platinum.

1520 In the air.

18. The facility with which oxidation takes place in some metals is so great, such as iron, tin, lead, copper, and manganese, that they must be completely defended from the action of oxygen; but in gold and platinum, no perceptible change is observed, for whatever length of time they are exposed to the atmosphere.

1521 Proportion of oxygen determinate.

19. This oxidation and the quantity of oxygen absorbed is proportional to the temperature. There are, however, many metals which combine with a determinate proportion of oxygen at certain temperatures, and from this may be estimated the quantity of oxidation from the degree of heat which has been applied. The rapidity of the oxidation is almost always increased by the elevation of temperature. In this way actual combustion or inflammation is produced. Thus filings of metals thrown upon a body in the state of ignition, give out brilliant sparks; and steel, struck upon a flint, burns with a vivid flame in the air, in consequence of the great heat which is communicated to it by percussion.

20. Metallic substances combine with very different proportions of oxygen; and this quantity varies according to the manner in which the process has been conducted, or the temperature to which the metal has been exposed.

1522 Different phenomena of oxidation.

21. In these different states and conditions of oxidation, different phenomena are exhibited. Sometimes the metal becomes red-hot and is inflamed; sometimes the oxidation takes place without fusion, or does not combine with oxygen till after it has been melted; sometimes it is covered with a brittle crust, or with a substance in the form of powder. At other times a pellicle, exhibiting different colours, forms on the surface; but, in all cases, the metal is tarnished, loses its brilliancy and its colour, and assumes another, which announces the change that has taken place.

1523 Different affinities.

22. Another difference which takes place among metals, is the different degrees of force with which the oxygen adheres to the metal. The knowledge of this, and the different degrees of affinity between oxygen and metallic substances, is of great importance in many operations and chemical results.

1524 Caloric given out during oxidation.

23. During the fixation of oxygen in metallic substances, it is absorbed by some in its solid state, and gives out a great deal of caloric. In others it is combined, without giving out the same quantity. This proportion of caloric given out corresponds to the facility with which oxides part with their oxygen, or are reduced to the metallic state. Those which have combined with oxygen with the greater proportion of caloric, are most easily reduced; but those, on the contrary, in which the oyxgen has been deprived of its caloric, are reduced to the metallic state by a great addition of caloric, and the greatest number of oxides requires the addition of substances whose affinity for oxygen is greater than that of the metal.

1525 Different oxides.

24. Metallic oxides are extremely different in different metals, and even in the same metal, according to the proportion of oxygen. They are, however, possessed of some commen properties. They are all in the form of powder or earthy substance, or so brittle as to be easily reduced to this state. They exhibit every shade of colour from pure white to brown and deep red, and they are heavier than the metals from which they have been obtained. Some oxides are revived, as it is called, or are reduced to the metallic state, merely by being in contact with light or caloric. Some require the addition of a combustible substance and a high temperature; while others have so strong an affinity for oxygen, that they cannot be deprived of it by the strongest heat, but become fusible in the fire, and afford a glassy matter more or less coloured, and even serve as a flux to the earths. Some oxides are volatile, but the greatest number are fixed. Some have an acrid and caustic taste, are more or less soluble in water, and even possess an acid quality; others are insoluble and insipid.

1526 Theory of Stahl.

25. Observing this remarkable change produced on metallic substances by the action of air or of heat, philosophers began early to account for it. According to Beecher and Stahl, the founders of chemical science, metals are composed of earths and phlogiston, and the process which takes place during the calcination of a metal, is merely depriving it of its phlogiston. This doctrine, which had undergone various modifications, from the difficulties which it presented in accounting for the phenomena of the calcination of metals, was finally overthrown by the celebrated experiments of Lavoisier. In one of these experiments he introduced eight ounces of tin into a glass retort, and having hermetically sealed it, after previous heating to expel some of the air, it was accurately weighed, and exposed to heat. The tin melted; and a pellicle appeared on its surface, which was soon converted into a gray powder. The heat was continued for three hours, but no farther change appeared upon the metal. When the retort was cooled, it was found to have the same weight as before the operation. The point of the retort was then broken off, and a quantity of air rushed in. This was equal to 10 grs. which was the

1527 Overturned.

additional weight required by the retort. The whole of the metallic substance in the retort was 10 grains heavier than when it was introduced, so that he concluded, that the 10 grains of air which had disappeared, had combined with the metal, and caused its increase of weight. The inference which he drew from this was, that the calcination of metals is not owing to their being deprived of any substance, but to their combination with air, and with the oxygen of the air; for it was found by future experiments, that the calcination or oxidation of metals could not be effected without

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Metals. without oxygen; and when it took place in a given quantity of common air, it was only the oxygen which was absorbed.

26. But as a still farther proof, that the calcination of metals is owing to the absorption of oxygen, they are reduced by those substances which have a greater affinity for oxygen. If charcoal in powder be mixed with a metallic calx or oxide, the oxygen combines with the carbon of the charcoal, forming carbonic acid, and the oxide is restored to the metallic state. If this process be performed in close vessels, the quantity of oxygen in the carbonic acid corresponds to the quantity which was absorbed by the metal during calcination.

27. From these observations, therefore, it appears that metallic substances combine with oxygen; and it has been observed, that not only different metals combine with it in different proportions, but the same

1528 Metals combine with carbon, &c.

metal forms compounds of one, two, and sometimes three different portions. No combination takes place between azote or hydrogen and metallic substances; but some of them enter into combination with carbon, phosphorus, and sulphur, forming carburets, phosphurets, and sulphurets. The metals also combine with the acids, and form salts, some of which are of the utmost importance, not only in chemistry, but also in the arts of life. They also enter into combination with each other, forming a class of bodies which are distinguished by the name of *alloys*.

1529 Division.

28. Metallic substances were formerly divided into *noble* or *perfect*, and *imperfect metals*. The noble or perfect metals were platinum, gold, silver, mercury; and the property on which this character was founded, was that of their being susceptible of being reduced by being exposed to heat. The other metals then known were called *imperfect metals*, because, to reduce them to the metallic state, the addition of some combustible substance was found to be necessary. They were also divided into *metals* and *semimetals*. Among the first were included those metals which were malleable and ductile; the semimetals comprehended those which possessed neither of these properties, and were therefore considered as less perfect. These distinctions, however, are now neglected, because they afford no well-founded or just marks of discrimination.

29. In the arrangement of the metals which we propose to follow, that of Fourcroy is adopted. He has divided them into five different classes, according to their ductility, and the proportions of oxygen with which they combine, or the facility with which that combination takes place. In the first class he includes those metals which are brittle, and in some of their combinations with oxygen have acid properties. These are,

Arsenic,
Tungsten,
Molybdena,
Chromium,
Columbium.

The second class comprehends those which are brittle, and simply susceptible of oxidation. These are the following:

Arsenic, &c.

Titanium,
Uranium,
Cobalt,
Nickel,
Manganese,
Bismuth,
Antimony,
Tellurium.

The third class comprehends those metals which have some degree of ductility, which are only two in number, viz.

Mercury,
Zinc.

The fourth class, which consists of three metals, includes such as are ductile, and easily oxidated. These are,

Lead,
Iron,
Copper.

The fifth class is composed of three metals, which are characterized by being very ductile, but oxidated with great difficulty. These are,

Silver,
Gold,
Platinum.

30. To these preliminary observations we have only to add, that metallic substances are found, either on the surface or in the interior of the globe, and either uncombined, or forming compounds with different substances. Some metals, as gold and platinum, are generally found in small grains, mixed with the soil. These, as well as the matters with which they are accompanied, have proceeded from the decomposition of the more solid parts of the globe. But metallic substances, which are met with in greater abundance, exist in the interior of the globe, in veins which traverse the other strata of the earth in different directions. The metals most commonly found in veins are, lead, copper, silver, zinc, mercury, and antimony. Some exist in detached masses. 1530 Natural history.

31. Metals, as they exist in the earth, are either in a state of purity, or the metallic state, when they are called *native* or *virgin metals*; or combined with each other, when they are said to be *alloyed*. They are found also combined with other substances, very frequently with sulphur; when they are said to be mineralized: or, they are combined with oxygen, when they come under the denomination of *oxides*; or they are combined with acids in the state of *salts*.

Sect. I. *Of Arsenic and its Combinations.*

1. It would appear that the ancients were acquainted with arsenic in its state of combination with sulphur, which is a reddish-coloured mineral, and was employed by them in painting; and although Theophrastus arranged it among metallic stones, probably on account of its weight, it was not known to possess a metallic substance 1531 History.

substance till the middle of the 17th century. Paracelsus, indeed, who lived at an earlier period, is said to have known it in the metallic state; but the process of obtaining it from orpiment and arsenic, was only first described by Schroeder in 1649. Lemery also published a process for extracting this metal in 1675. It was afterwards fully demonstrated by Brandt in 1733, and by Macquer in 1746, that arsenic possessed peculiar properties, and is totally distinct from all other metals. These facts were farther confirmed by Monnet in 1773, and by Bergman in 1777.

1532 Found native.

2. Arsenic is frequently found native, and is then in dark-coloured masses, which have little brilliancy, and exhibit no metallic lustre, except at the fracture. It is frequently found combined with other metals. In this state it is combined with iron, and is known by the name of *arsenical pyrites*, or *mispickel*. One of the most frequent combinations of arsenic is with sulphur, of which there are two principal varieties; the one is of a yellow colour, well known under the name of *orpiment*, and the other red, called *realgar*. It is also sometimes found in the state of white oxide, or arsenious acid; but this is a rare occurrence.

1533 Method of analyzing the ores.

3. In whatever state arsenic is found, it can easily be detected, by throwing a little of it on burning coals. The white fume which arises, and the garlic smell which is exhaled, are sufficiently characteristic of this metal. To obtain the metal from its oxide, it may be mixed with three times its weight of black flux. This mixture is put into a crucible, to which another crucible inverted is adapted. They are then to be luted together, to exclude the air. Apply heat to the lower crucible till it becomes red, defending the upper one as much as possible from the heat, by means of a plate of iron or copper, through which the lower crucible passes. When the apparatus has cooled, a crust of metallic arsenic is found in the upper crucible, in the form of crystals. This being detached and weighed, shows the quantity of pure metal in the mineral which has been tried.

In the humid way, Bergman recommends to treat native arsenic by dissolving it in four parts of nitromuriatic acid, concentrating the solution by evaporation, and precipitating the muriate of arsenic which is formed, by means of water. If there is any silver, it is first precipitated in the form of an insoluble muriate, and iron is sometimes found in the solution precipitated by water.

The sulphurets of arsenic are to be treated by muriatic acid, adding a small quantity of nitric acid, to separate the sulphur. The oxide of arsenic may then be precipitated by water. The pure metal may be obtained by immersing a plate of zinc in the solution, having previously added a quantity of alcohol.

1534 Properties.

4. Arsenic is in the form of small plates of a blackish gray, brilliant, and metallic colour, with considerable lustre where there is a fresh fracture. The specific gravity is 8.31. It is extremely brittle, and is therefore easily reduced to powder. It has neither smell nor perceptible taste when it is cold; but when it is heated, and in the state of vapour, it is remarkable for a strong fetid odour of garlic. It sublimes before it melts, so that its fusing point is not known. It is the most volatile of all the metals. When slowly sublimed, it crystallizes in the form of regular tetrahedrons, and sometimes in that of octahedrons. The tetrahedron is the form of its integrant molecule.

1535 Action of air.

5. When arsenic recently prepared is exposed to the air, it is soon tarnished, loses its lustre, becomes at first yellowish, and then passes to a black colour. It loses at the same time its hardness, and becomes extremely friable. When it is heated in contact with air, or if it be thrown into the state of powder on burning coals, it burns with a blue flame, and exhaling the strong odour of garlic, is sublimed in the form of a white, acrid, soluble mass, which has been called the *white oxide of arsenic*, or *white arsenic*. By this latter name it is well known in the shops. To this oxide of arsenic, because it possesses some acid properties, Fourcroy has given the name of *arsenious acid*. This acid bears the same relation to arsenic acid as the phosphorous and sulphurous acids do to phosphoric and sulphuric acids.

1536 Oxide or arsenious acid.

6. This oxide or acid is extremely volatile. When it is heated in close vessels, it is sublimed in transparent, regular tetrahedrons. It is extremely acrid and caustic, corroding and destroying the organs of animals, so that it is the most violent poison known. The specific gravity is between 4 and 5. It reddens vegetable blues, and, when exposed to the air, it is covered with a slight efflorescence.

1537 Properties.

7. The arsenious acid is decomposed by hydrogen, carbon, phosphorus, and sulphur. At a red heat the, hydrogen and carbon combine with the oxygen, and reduce it to the metallic state. Phosphorus and sulphur are partly converted into phosphoric and sulphuric acids, and partly combine with the arsenic, forming a phosphuret or sulphuret of arsenic.

8. This acid is very soluble in water. It requires about 15 parts of boiling water for its solution, from which it may be obtained crystallized on cooling, or by slow evaporation. The crystals are in the form of regular tetrahedrons. The solution in water is extremely acrid, reddens vegetable blues, combines with earthy bases, decomposes the alkaline sulphurets, and affords with them a yellow precipitate in which the arsenic returns to the metallic state. The component parts of arsenious acid are,

Arsenic	75.2
Oxygen	24.8
	100.0

1538 Arsenic acid.

9. Arsenic combines with a greater proportion of oxygen; and in this compound it still exhibits acid properties, and is known by the name of *arsenic acid*. The method of preparing this acid, and its properties, have already been described, in the chapter on acids; and the compounds it forms with the alkalies and earths have been particularly detailed in the chapters which treat of these substances.

10. Arsenic does not decompose water. It may be kept for any length of time under water, without undergoing any change. There is no action between arsenic and carbon or azote. Arsenic, however, is soluble in hydrogen gas, to which it communicates a fetid odour and a poisonous property.

1539 Phosphuret.

11. Arsenic enters into combination with phosphorus. When equal parts of phosphorus and arsenic are distilled together with a moderate heat, there is sublimed a dark-coloured brilliant substance, which burns on

3

Arsenic, &c. on red-hot coals, with a mixed odour of arsenic and phosphorus. This is the phosphuret of arsenic, which must be preserved under water. This compound may be formed under water at a boiling temperature in a matrass. As the phosphorus melts, it combines with the arsenic. The properties of this phosphuret of arsenic have not been examined.

1540 Sulphuret. 12. Arsenic combines readily with sulphur, either by fusion or by sublimation. The result of this combination is a yellow or red mass. This compound of sulphur and arsenic, which is a sulphuret of arsenic, is found native. The red is known by the name of *realgar*, and the yellow by that of *orpiment*.

1541 Salts and alloys. 13. Arsenic enters into combination with the acids, and forms with them peculiar salts. It also combines with the metals, forming *alloys*. The following is the order of the affinities of arsenic and of its oxide, as they have been arranged by Bergman.

1542 Affinities.

Arsenic.	Oxide of Arsenic.
Nickel,	Lime,
Cobalt,	Muriatic acid,
Copper,	Oxalic,
Iron,	Sulphuric,
Silver,	Nitric,
Tin,	Tartaric,
Gold,	Phosphoric,
Platinum,	Fluoric,
Zinc,	Saclactic,
Antimony,	Succinic,
Sulphur,	Citric,
Phosphorus.	Lactic,
	Arsenic,
	Acetic,
	Prussic.

1543 Uses. 14. Arsenic, in the metallic state, is scarcely applied to any use, except for chemical purposes. It is sometimes alloyed with the metals, by which means they acquire new properties. In the state of white oxide, it is much employed in the arts. It has even been exhibited as an internal remedy in the diseases of cancer and intermittent fevers; but in all cases this terrible poison ought to be administered with the greatest caution. To counteract the effects of arsenic, when it has been accidentally taken into the stomach, one of the best antidotes is water impregnated with sulphurated hydrogen gas, or some of the alkaline sulphurets dissolved in water *.

* Fourcroy, v. p. 80.

I. Salts of Arsenic.

1. Sulphate of Arsenic.

1544 Effect of sulphuric acid. Concentrated sulphuric acid has no action on arsenic in the cold; but when they are boiled together, an effervescence takes place, sulphurous acid gas is disengaged, the arsenic is oxidated, and falls to the bottom in the state of white powder. According to Fourcroy, this powder retains but a small portion of sulphuric acid, the whole of which is nearly carried off by washing with water; nor are crystals obtained from the solution. By evaporation the white oxide of arsenic is precipitated, and sulphuric acid remains pure in the solution. There is no action between sulphurous acid and arsenic.

2. Nitrate of Arsenic.

Concentrated nitric acid produces a violent action 1545 Of nitric.
with arsenic. Nitrous gas is disengaged, and towards the end of the process, azotic gas. The arsenic is converted at first into the white oxide, which, with a new addition of acid, passes to the state of arsenic acid; and when a great quantity of nitric acid is employed, with the aid of heat, the metal is instantly converted into arsenic acid. There remains no oxide in the solution, and there is no nitrate of arsenic formed. But, according to Bergman, when the nitric acid is diluted, it dissolves the oxide, and affords a crystallized salt like the white oxide.

3. Muriate of Arsenic.

1. Muriatic acid has no action on arsenic in the cold; but when they are boiled together, the solution takes place, and there is disengaged a fetid gas, which seems to be arseniated hydrogen gas. From this it appears, that muriatic acid enables the arsenic to decompose water. A little nitric acid added, promotes the solution; and this solution, heated and concentrated at first in close vessels, is entirely sublimed in the form of a thick liquid, which was formerly called *butter of arsenic*. This salt is decomposed by water alone, which precipitates the metal. The muriate of arsenic, therefore, can scarcely be considered as a permanent salt *. 1546 Preparation.

* Fourcroy, v. p. 73.

2. When arsenic in the state of powder is thrown into oxymuriatic acid gas, it instantly catches fire, burns with a very brilliant white flame, and is converted into white oxide. If arsenic be added to liquid oxymuriatic acid, it is converted into arsenic acid, while the acid returns to the state of muriatic acid. 1547 Oxymuriatic acid.

4. Fluate of Arsenic.

Fluoric acid combines with the white oxide of arsenic, and affords small grains, which have a crystalline form; but their properties are unknown.

5. Borate of Arsenic.

Boracic acid also combines with the white oxide of arsenic, and affords a salt which is in the state of white powder, or in the form of small needles. Their properties are also unknown.

6. Acetate of Arsenic.

Acetic acid enters into combination with the white oxide of arsenic, and forms crystals, which are only known to be difficultly soluble in water.

7. Oxalate of Arsenic.

Oxalic acid, combined with arsenic, affords crystals in the form of prisms. Similar crystals are obtained by the combination of arsenic with the tartaric acid.

8. Benzoate of Arsenic.

Benzoic acid combines with the white oxide of arsenic, and by evaporating the solution, plumose crystals are obtained. This salt has an acid and acrid taste, is soluble in water, sublimes with a moderate heat, but with a stronger heat is decomposed, and is not precipitated from its solutions by alkalies.

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Tungsten, &c.

Sect. II. *Of Tungsten and its Combinations.*

1548 History. 1. The name of tungsten is derived from a white, transparent mineral, which contains this metal in the state of acid united to lime. This mineral was analyzed by Scheele in 1781, and he found that one of its component parts is lime, and the other an earthy-like substance, to which he gave the name of *tungstic acid*. His discovery was confirmed about the same time by Bergman, who conjectured that the basis of the acid might be a metallic substance. This conjecture was verified by the experiments of Messieurs D'Elhuyart, two Spanish chemists, who discovered the same metal in the mineral called *wolfram*, and ascertained some of its metallic properties. It has since been farther examined by Vauquelin and Hecht, and by Allen and Aiken in London.

1549 Found native. 2. This metallic substance has been only found in the state of acid, in combination with lime, iron, manganese, and lead. When it is combined with lime, it is the tungsten of the Swedes, and in combination with iron it is called wolfram.

1550 Method of obtaining it. 3. To obtain this metal from the acid, it is mixed with charcoal in a crucible, and exposed to a very strong heat. By this process the metal was obtained in the form of a small button at the bottom of the crucible, in the first experiments which were made upon it by the German chemists. This crumbled to pieces between the fingers; and when it was examined with a magnifying glass, it was found to consist of a number of metallic globules, none of which were larger than a pin head.

1551 Properties. 4. The colour of the metal is a steel gray. The specific gravity is 17.6, or, according to others, 17.22. It is one of the hardest of the metals. It is also one of the most infusible, requiring a temperature of 170° Wedgwood. It crystallizes on cooling.

1552 Action of heat. 5. When it is heated in the open air, it is readily converted into a yellow oxide, which afterwards, by a stronger heat, becomes of a black colour, and then by combining with a greater proportion of oxygen, it assumes the character of an acid, namely the tungstic acid, whose properties and combinations with alkalies and earths have been already described.

1553 Of phosphorus, &c. 6. There is no action between tungsten and azote, hydrogen or carbon. Tungsten combines with phosphorus, forming a phosphuret, the properties of which are unknown. It also combines with sulphur, forming a sulphuret of a bluish black colour, and which may be crystallized. There is no action between this metal and sulphuric, nitric, or muriatic acids. It is only acted on by nitro-muriatic acid at a boiling temperature, and nitrous gas is disengaged. Nothing therefore is known of the combinations of tungsten with the other acids.

1554 Alloys. 7. This metal combines with the other metals, and forms alloys with them.

8. It is too little known, and has been produced in too small quantity, to be able to ascertain any thing of its uses or application.

Sect. III. *Of Molybdena and its Combinations.*

1555 History. 1. The mineral called *molybdena*, from which this metal is extracted, was analyzed by Scheele in 1778. He found that it contained sulphur, and a substance which he discovered to be possessed of acid properties. Previous to this time, this mineral had been confounded with plumbago or black lead, which it resembles in appearance. The acid which Scheele obtained from this substance, Bergman conjectured was a metallic oxide. These experiments were repeated by Pelletier; and he proved that molybdena was a peculiar metal combined with sulphur, and that in all the different processes the sulphur was separated, and the metal oxidated. The metal has since been called *molybdena*, and the mineral from which it is obtained *sulphuret of molybdena*.

Molybdena, &c.

2. Molybdena has never been found existing in any other but in the state of sulphuret, or in that of oxide. 1556 Characters of the ore. The sulphuret of molybdena, it has been observed, was long confounded with plumbago, or the carburet of iron. It has, however, a less greasy feel, more brilliancy, and inclining more to a blue colour. It stains the fingers less than carburet of iron, and leaves a bluish trace on paper. It is difficult to reduce it to powder, on account of the elasticity of the plates or scales of which it is composed. The sulphuret of molybdena too, becomes electric by friction. When the sulphuret of molybdena is treated with the blow-pipe, it exhales sulphur, which is detected by its odour, and a white vapour which is condensed on cold bodies in the form of plates or crystallized needles, of a yellowish colour, but which become blue by the contact of the interior flame. 1557 Properties of the metal. Molybdena has only been obtained in black, friable, agglutinated masses, which have some metallic brilliancy; and when broken, exhibit small round grains, of a grayish brilliant appearance. The specific gravity is about 7, and it is extremely infusible; but since the experiments of Dr Hielm, which were made in 1782, this metal has been procured in such small quantity, that its characteristic metallic properties have not been ascertained.

3. When molybdena is exposed to a high temperature in contact with air, it is converted into a white oxide, which sublimes and crystallizes in the form of brilliant needles. 1558 Action of heat. This oxide has acid properties. When it is heated with combustible bodies, it assumes a bluish colour, with little brilliancy, as it approaches to the metallic state. According to Mr Hatchet, who made a set of experiments on the compound of this acid with lead, the molybdate of lead, molybdena, when it is not in the metallic state, appears to suffer four degrees of oxigenation. The first is the black oxide, which contains the smallest proportion of oxygen. This oxide is obtained by exposing to heat in a crucible a mixture of molybdic acid and charcoal in powder. 1559 Oxides. A black mass remains, which is the oxide. The second is the blue oxide, which may be obtained by the same process, but it must not be continued so long. The third is the green oxide, which seems to be intermediate between an oxide and acid. 1560 Acids. Mr Hatchet proposes to call it *molybdous acid*. The fourth degree of oxidation is the molybdic acid itself, which has at first a white colour; but when it is fused and sublimed, is converted into a yellow colour. The properties of this acid and some of its combinations have been already described *.

4. Molybdena combines with phosphorus; but the properties of this phosphuret are not known. It also combines

* Phil. Trans. 1796. p. 336.

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combines readily with sulphur, and returns to the state of sulphuret of molybdena, in which it has only been found native.

1561 Action of phosphorus.

5. Molybdena enters into combination with the acids, forming with them peculiar salts.

1562 Of acids.

1563 Of alkalies.

6. The alkalies have the property of dissolving molybdena, and of promoting its oxidation. With the assistance of heat, the alkalies form with the sulphuret of molybdena an alkaline sulphuret, which holds the metal in solution.

7. Molybdena enters into combination with the metals, and forms alloys with them.

1564 Alloys.

I. Salts of Molybdena.

1. Sulphite of Molybdena.

Sulphuric acid, with the assistance of heat, dissolves molybdic acid, and affords a colourless solution; but when it is cold it becomes of a deep blue. But neither this nor any other of the salts of molybdena seem disposed to crystallize.

2. Nitrate of Molybdena.

Nitric acid converts the oxides of molybdena into molybdic acid, by giving up its oxygen.

3. Muriate of Molybdena.

Muriatic acid, when boiled with the oxide of molybdena, affords a solution of a deep blue colour, and there is formed a blue precipitate.

4. Fluate of Molybdena.

Fluoric acid forms a compound with the oxides of molybdena. The solution is of a greenish yellow colour when it is hot; but when it is evaporated to dryness, it becomes of a greenish blue.

5. Phosphate of Molybdena.

The oxide of molybdena is dissolved by phosphoric acid with the assistance of heat, and a solution of a blue colour is obtained.

6. Acetate of Molybdena.
7. Oxalate of Molybdena.
8. Tartrate of Molybdena.
9. Benzoate of Molybdena.

All these salts in solution are of a blue colour, and when evaporated to dryness, afford a blue powder. They are formed by digesting the several acids with the oxides of molybdena.

Sect. IV. *Of Chromium and its Combinations.*

1565 History.

1. This metal was discovered by Vauquelin in 1797, in a mineral called the *red lead ore of Siberia*. This ore had been formerly analyzed by several chemists, and even by Vauquelin himself; but their results of the nature of its composition only agreed, that lead was one of its constituent parts. Vauquelin by his last analysis found that it contained lead, combined with the new acid, of which the basis is a metal.

1566 Analysis of the ore.

2. The process which he followed was the following: He boiled one part of the red lead-ore of Siberia with two of carbonate of potash, in 200 parts of water. The

potash combined with the new acid, while the carbonic acid united to the lead. The carbonate of lead precipitated to the bottom in the form of a white powder, and the new salt remained in solution. By adding nitric acid, the new salt was decomposed, the acid combining with the potash. This mineral is completely dissolved in muriatic acid. The solution assumes a deep green colour, and by evaporation affords muriate of lead. The fine green colour is owing to the oxide of the new metal having been deprived of part of its oxygen by the muriatic acid, and being thus converted from an orange red to a green.

1567 Reason of the name of the metal.

3. The acid which is obtained by the first process, and the oxide by the second, being strongly heated with charcoal in a crucible, afforded a metal different from any other formerly known. To this metal the name of *chromium* was given, from the Greek word χρωμα, on account of the remarkable property which it possesses of communicating colour to all its saline combinations.

1568 Properties.

4. The metal which was obtained, is of a grayish white colour, very hard and brittle, and extremely difficult of fusion; but the small quantity which has been hitherto obtained, precludes chemists from ascertaining its properties.

1569 Found in different minerals.

5. This substance has been found in four different minerals, existing in two states; in the state of green oxide, combined with the oxide of lead, and in the same state in the emerald; and in the state of acid, combined with the oxide of lead in the red lead-ore of Siberia, and also in the spinel ruby. It has also been discovered in the state of chromic acid, combined with iron, forming a chromate of iron. It has also been discovered in France.

1570 Oxides.

6. Chromium, therefore, combines with oxygen in two different proportions; the green oxide, and the yellow, or the chromic acid. It is this acid which exists in the red lead-ore. When it is separated from the lead, it is in the form of powder, of an orange yellow colour, and is soluble in water. Its other properties have been already examined. The green oxide is prepared by exposing the latter to heat in close vessels. The chromic acid is partially decomposed; part of the oxygen is driven off, and the green oxide remains behind. Another oxide also, it is said, which is intermediate between chromic acid and the green oxide, has been obtained.

1571 Action of acids.

7. Little is known of the action of acids on this metal; but in the few experiments which have been made, it appears, that it undergoes no change by means of sulphuric and muriatic acids. Nitric acid distilled upon it several times successively, changes it into green oxide, and at last into chromic acid. The same effect is produced more rapidly by means of the nitro-muriatic acid.

Sect. V. *Of Columbium and its Combinations.*

1572 History.

1. This metal was discovered by Mr Hatchet, in the year 1802, in a mineral which he found in the British Museum. This mineral had been sent along with specimens of iron ores from Massachusets in America, to Sir Hans Sloane, in whose catalogue it is described as a "very heavy black stone, with golden streaks." These streaks, Mr Hatchet observes, proved to be yellow

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1573 Characters of the ore. low mica. This mineral is externally of a dark-brownish gray colour; internally the same, inclining to iron gray. The longitudinal fracture is imperfectly lamellated; the cross fracture shews a fine grain. The lustre is vitreous, in some parts inclining to the metallic. It is moderately hard, but very brittle. The colour of the powder is dark chocolate brown. The particles are not attracted by the magnet. The specific gravity is 5.918.

1574 Analysis. 2. In the analysis of this mineral, Mr Hatchet discovered, that it consists of one part of oxide of iron, and three parts of a white-coloured substance, which exhibited the properties of an acid. The acid, under the name of *columbic acid*, with its combinations with the alkalies and earths, has been already described. Having found that it possessed properties different from all other acids, and also, that its base is metallic, he gave to the metal the name of *columbium*. In the attempts which Mr Hatchet made to reduce it to the metallic state, even when it was exposed to a very strong heat with charcoal, the oxide was only found in the state of powder, of a black colour. From these experiments it appeared, that this metal combines with oxygen in different proportions, and these oxides are distinguished by different colours.

3. When the white oxide of this metal was added to phosphoric acid in solution, and evaporated to dryness, the whole was put into a crucible, lined with charcoal, and exposed to a strong heat for half an hour. The inclosed matter had assumed a dark brown, spongy appearance, which had some resemblance to the phosphuret of titanium.

4. No sulphuret was obtained when it was mixed and distilled with sulphur.

5. Columbium combines with some of the acids, and forms salts, although few of these have been examined.

I. Salts of Columbium.

1. Sulphate of Columbium.

Boiling sulphuric acid forms a transparent colourless solution, with columbic acid. When water is added to this solution, it becomes turbid, assuming a milky appearance; and a white precipitate is gradually deposited, which cracks as it becomes dry upon the filter, and, from white, it changes to a lavender blue colour; and, when completely dry, to a brownish gray. It is then insoluble in water, is semitransparent, and breaks with a vitreous fracture. This precipitate obtained from the sulphuric solution, by the addition of water, is a sulphate of columbium.

2. Nitrate of Columbium.

The oxide of columbium seems to be perfectly insoluble, and remains unchanged in colour, when digested in boiling concentrated nitric acid.

3. Muriate of Columbium.

Columbic acid, when recently separated from potash, is soluble in boiling muriatic acid. This solution may be considerably diluted with water, without any change being produced. When evaporated to dryness, it left a pale-yellow substance, insoluble in water, and which is dissolved with great difficulty, when it is again digested with muriatic acid.

4. Phosphate of Columbium.

A few drops of phosphoric acid being added to a part of the solution of columbium in concentrated sulphuric acid, at the end of about 12 hours converted the whole into a white, opaque, stiff jelly, which was insoluble in water. When a small quantity of phosphoric acid was added to the muriatic solution of columbium, in a few hours a white flocculent precipitate was formed * (A).

* Phil. Trans. 1802, p. 49.

Sect. VI. *Of Titanium and its Combinations.*

1. This metal was discovered in 1793 by Klaproth. He obtained it from a mineral called *red schorl*. In this mineral he found the oxide of a metal different from any other then known. Previous to this time, indeed, the same oxide had been discovered by Mr Gregor in a black sand, which is found in Menachan in Cornwall. To this, from the place, he gave the name 1575 History of its discovery.

(A) Another metal has been more lately announced by Ekeberg, which, in some of its properties, seems to resemble columbium. He obtained this metal from two minerals; to one of which he gave the name of *tantalite*, which is of a blackish gray colour, with some metallic lustre, and some appearance of crystallization. This mineral is very hard; the specific gravity is 7.953. When reduced to powder, it is of a brownish gray colour, and is not attracted by the magnet. To the other mineral he gave the name of *yttrotantalite*. It was found in small insulated masses, in veins of feldspar, and black mica. The fracture of this mineral is granular, of a gray metallic appearance, and may be scratched, although with difficulty, with a knife. It is not attracted by the magnet. The specific gravity is 5.13. From these minerals this chemist extracted a substance, which he concluded to be a peculiar metal in the state of oxide, having the appearance of a white powder. The following are the properties which he ascertained.

1. It is not soluble in any of the acids. 2. The alkalies attract and dissolve a considerable quantity of this substance, which may afterwards be precipitated by means of the acids. 3. The whole oxide of this metal undergoes no change of colour by the action of heat. 4. Its specific gravity when it has been exposed to a red heat is 6.5. 5. It fuses with phosphate of soda and borax, without communicating to them any colour. 6. The oxide of this metal, heated with charcoal powder, is reduced to the metallic state, exhibits a brilliant fracture, of a dark gray colour. 7. It is again converted into a white powder by the action of the acids. The other properties of this substance have not been detailed *. To this metal Ekeberg has given the name of *tantalium*.

* Ann. de Chim. xliii. p. 276.

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Titanium, &c. name of *menachine*, but he had not succeeded in reducing it to the metallic state. Klaproth afterwards analyzed the *menachanite* of Mr Gregor, and found that it was precisely the same as the oxide of the metal which he discovered in red schorl. To this metal he gave the name of *titanium*. The experiments of Klaproth were afterwards repeated by Vauquelin and Hecht in 1796. His results were confirmed, and they also succeeded in reducing a small quantity of the oxide to the metallic state.

1576 Natural history. 2. This metal has been found only in the state of oxide. Red schorl consists entirely of this oxide. It has been found in different countries, as in Spain, France, and Hungary. This oxide is disseminated in the fine specimens of rock crystal, which are brought from Madagascar, crystallized in long brilliant needles, the form of the primitive crystal being a six-sided prism, with two-sided summits; that of the molecule is a triangular prism, with right-angled isosceles bases. It is of a red colour of different shades. It is brittle, but the fragments are so hard as to scratch glass. The specific gravity is from 4.180 to 4.246. The other mineral, to which Klaproth has given the name of *titanite*, is composed of oxide of titanium, silica, and lime, nearly in equal proportions. Its specific gravity is 3.510.

1577 Analysis of its ore. 3. Titanium was obtained by Vauquelin, by reducing the native red oxide. He mixed together 100 parts of this oxide with 50 of calcined borax, and 50 of charcoal, formed into a paste with oil; and exposed the whole to the heat of a forge raised to 166° Wedgwood. By this process he obtained a dark-coloured, agglutinated mass, having a brilliant appearance on the surface.

1578 Properties. 4. Titanium obtained in this way is of a reddish yellow colour, shining and brilliant on the surface, and equally brilliant in some of its internal cavities. Its other properties, as it has been only procured in very small quantity, have not been determined.

1579 Action of heat. 5. Titanium seems to be one of the most infusible metals known. When the red oxide is exposed to heat in a crucible, it loses its lustre. By the action of the blow-pipe it is deprived of its transparence, and becomes of a grayish white colour. On charcoal it becomes still more opaque, and of a slate gray. The artificial carbonate of titanium, exposed to heat in a crucible, loses $\frac{25}{100}$ of its weight, becomes yellow, and, as it cools, resumes its white colour.

1580 Phosphuret. 6. Titanium enters into combination with phosphorus, and forms with it a phosphuret. This was prepared by Mr Chenevix, by exposing a mixture of phosphate of titanium, charcoal, and a little borax, in a crucible, to a very strong heat. The phosphuret which he obtained was in the form of a metallic button, of a pale white colour, brittle and granular, and infusible by the action of the blow-pipe. Titanium has not been combined with sulphur.

1581 Affinities. 7. This metal enters into combination with the acids, and forms salts with them. The affinities of the oxides of titanium, as they have been ascertained by Lampadius, are in the following order.

Gallic acid,
Phosphoric,
Arsenic,
Oxalic,
Sulphuric,
Muriatic,
Nitric,
Acetic †.

† *Ann. de Chim.* xxvi. p. 91.

1582 Alloys. 8. In the experiments which were made by Vauquelin and Hecht, to combine titanium with other metals, they did not succeed with silver, copper, lead, or arsenic; but they formed an infusible alloy with iron, of a gray colour, interspersed with yellow-coloured shining particles.

I. Salts of Titanium.

1. Sulphate of Titanium.

1583 Salts. According to the experiments of Klaproth, sulphuric acid has no action on the native red oxide of titanium from Hungary; but this acid is found to dissolve the carbonate of titanium with effervescence; and when this solution is evaporated, the red oxide is converted into a white, opaque, gelatinous mass. This was the result of Klaproth's experiment. In those of Vauquelin and Hecht, sulphuric acid being boiled with carbonate of titanium, assumed a milky appearance, and there were formed white, light flakes, which were dissolved by a stronger heat; the fluid became transparent, but did not afford crystals.

2. Nitrate of Titanium.

Nitric acid has scarcely any perceptible action on titanium, but it combines with the carbonate, and forms a transparent solution, which assumes an oily appearance in the air, and affords transparent crystals in the form of elongated rhombs, having the opposite angles truncated, so as to represent hexagonal tables. But according to Vauquelin and Hecht, when they heated a mixture of nitric acid with carbonate of titanium, nitrous gas was disengaged, and the liquid remained milky. Sugar added to the mixture causes a precipitate of the oxide, of a whiter colour than the carbonate; and if the nitric acid be employed diluted, the oxide of titanium is dissolved, but the solution becomes turbid by means of heat, and thus the addition of caloric opposes the combination of this oxide with nitric acid, by oxidating it in a higher degree than what is soluble in this acid.

3. Muriate of Titanium.

The carbonate of titanium is soluble in muriatic acid; and according to Klaproth, the solution affords a yellowish, transparent jelly, which contains numerous transparent, cubic crystals. Vauquelin and Hecht found, that the carbonate of titanium is dissolved with effervescence in concentrated muriatic acid; and the solution assumes a deep yellow colour, when it is made without the assistance of heat. When it was heated, it was reduced to a flaky mass, which was neither redissolved by water, nor by new additions of the acid. A similar solution which was not heated remained transparent; but when this solution was exposed to a temperature of about 170°, it was converted into a yellow, transparent jelly, of an acid and very astringent taste, which, by cooling, deposited a great number of small crystals which effloresced in the air.

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When this solution was boiled, oxymuriatic acid gas was disengaged, the oxide was precipitated, and is no longer soluble in muriatic acid, till it is boiled for a long time with nitric acid; from which it appears, that the oxide of titanium must have a great proportion of oxygen, to combine with muriatic acid, and in this state it can only combine with it in the cold, because when it is exposed to heat, the acid carries off a portion of its oxygen, which renders it insoluble. The oxide of titanium, separated from muriatic acid by the action of the blow-pipe, assumes a beautiful orange-yellow colour.

1584 Preparation.

4. Carbonate of Titanium.

One part of the red oxide of titanium, and five parts of carbonate of potash, exposed to a red heat in a crucible, were soon fused, and formed a solid mass of a whitish gray colour, with small needle-form crystals on the surface. When this was reduced to powder, and washed with warm water, there was deposited a light white powder, which was found to be carbonate of titanium. The arsenic and phosphoric acids cause a white precipitate of the oxide of titanium from its solution in acids. A similar precipitate is produced by oxalic and tartaric acids; but it is instantly re-dissolved, and the solution recovers its transparency.

1585 Salts of titanium decomposed. The oxide of titanium is precipitated from its solution in acids; 1. By carbonate of potash, in the form of a white flaky matter, and by ammonia in the same way. 2. Prussiate of potash causes a copious precipitate of a mixed colour of green and brown. 3. Infusion of nut-galls produces a very voluminous precipitate, of a reddish brown colour; and if the solution be not too much diluted with water, it coagulates like blood. A rod of tin introduced into a small bottle, with a solution of this oxide in muriatic acid, caused in a few minutes a pale rose colour, in that part of the solution near the rod. This colour soon changed to a beautiful ruby. A rod of zinc first produced a violet colour, and afterwards that of indigo. 4. Sulphuret of ammonia combined with this solution, produced a pale green colour, and a precipitate of a bluish green.

Sect. VII. *Of Uranium and its Combinations.*

1586 Discovery. 1. This metal was discovered by Klaproth in the year 1789. It was then announced as a metal more difficult to be reduced than manganese, externally of a gray colour, and internally of a clear brown, of considerable lustre, and middling hardness; that it might be scratched and filed, and that its oxide gives a deep orange colour to porcelain.

1587 Natural history. 2. It has been obtained from three different minerals. The first is in the state of sulphuret, of a blackish colour, and of a shining fracture, and sometimes lamellated. This has been called *pitch blende*. The specific gravity is from 6.37 to 7.50. In this state it is sometimes combined with iron and sulphurated lead. The uranium is in the metallic state. The second ore from which this metal is obtained, is the native oxide of uranium. It is always in the state of yellow powder, on the surface of the sulphuret. The specific gravity is 3.24. When it is of a pure yellow colour, it is then a pure oxide. The third ore of the metal is the native carbonate of uranium. Of this there are two distinct varieties, the one of a pale green, and sometimes of a silvery white colour. This contains but a small quantity of the oxide of copper, and is very rare. The other is of a shining deep green, which is the green mica or *glimmer* of mineralogists. Klaproth supposed that it contained an oxide of uranium, mixed with the oxide of copper; but it has been since discovered to have carbonic acid in its composition. It is crystallized in small square plates, and sometimes, though rarely, in complete octahedrons. 1588

3. The process by which Klaproth reduced this metal, is the following. He mixed the yellow oxide of uranium, precipitated from its solutions by an alkali, with linseed oil, in the form of a paste, and this being exposed to a strong heat, there remained a black powder, which had lost rather more than one-fourth of its weight. It was then exposed to the heat of a porcelain furnace, in a close crucible, and the oxide was afterwards found in a coherent mass, but friable under the fingers, and reduced to a black shining powder. It decomposed nitric acid with effervescence. This black powder, covered with calcined borax, was for the second time exposed to a still stronger heat, by which a metallic mass was obtained, consisting of very small globules adhering together. Analysis of the ore.

4. The colour of uranium is of a dark gray, and internally of a pale brown. It has little brilliancy, on account of the spongy mass, in which state it was obtained. It may be scratched with a knife, and is extremely infusible. The specific gravity is 6.440. 1589 Properties.

5. When uranium is exposed to a red heat in the open air, or when it is acted on by the blow-pipe, it undergoes no change. The yellow oxide of uranium does not melt. It acquires a brownish gray colour when it is long heated in the air, but it has not been ascertained whether it gains or loses oxygen.

6. The oxide of uranium is reduced by means of charcoal, when it is exposed to heat. Little is known of the combination of uranium with phosphorus; but when the oxide was treated with blood, and a strong heat applied, an acrid bitter mass was obtained, which was supposed to owe its fusibility to the phosphorus which it contained.

7. Uranium has not been artificially combined with sulphur, but it is not improbable that such a combination might take place, since it is found native in this state. Of the alloys of uranium with other metals nothing is yet known.

I. Salts of Uranium. 1590 Salts.

1. Sulphate of Uranium.

The yellow oxide of uranium is readily dissolved in diluted sulphuric acid; and the solution affords, by evaporation, a salt of a yellow colour, in the form of small prisms. The sulphate of uranium is different from all other metallic salts yet known, in colour, form, and other properties.

2. Nitrate of Uranium.

Nitric acid dissolves with equal facility the oxide of uranium. The solution being slowly evaporated, yields large crystals in regular hexagonal tables, of a yellowish

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Cobalt, &c. yellowish green colour. The crystals of nitrate of uranium are the most beautiful of all the metallic salts.

3. Muriate of Uranium.

Muriatic acid also dissolves the oxide of uranium, and furnishes small yellow crystals, which are deliquescent in the air.

4. Fluate of Uranium.

Fluoric acid combines with the oxide of uranium, and forms with it a crystallized salt, which is not altered by exposure to the air.

5. Phosphate of Uranium.

Phosphoric acid enters into combination with the oxide of uranium, and forms with it yellowish white flakes, which are very little soluble in water.

6. Arseniate of Uranium.

Arsenic acid may be combined with uranium, by decomposing the nitrate by means of an alkali. A precipitate is obtained of a yellowish powder, which is the arseniate of uranium.

7. Molybdate of Uranium.

In the same way molybdate of uranium may be obtained by adding a solution of molybdate of potash to the nitrate of uranium. It is obtained in the form of powder.

8. Acetate of Uranium.

The oxide of uranium is soluble in concentrated acetic acid, with the assistance of heat; and beautiful yellow crystals are obtained, in the form of long, slender, transparent, four-sided prisms, terminated by four-sided pyramids.

1591 Decomposition of the salts of uranium. The solutions of the oxide of uranium in acids are precipitated by the alkaline sulphurets, of a brownish yellow, and their surface is covered at the same time with a gray metallic pellicle. The fixed alkalies precipitate from their solutions an oxide of uranium, of an orange yellow colour; ammonia occasions a precipitate of a bright yellow; and the alkaline carbonates throw down a carbonate of uranium of a whitish yellow, which is redissolved in an excess of alkali. The infusion of nut-galls thrown into one of these solutions, the excess of whose acid has been taken up by an alkali, produces a chocolate brown precipitate. Zinc, iron, and tin, introduced into these solutions, produce no change of colour, either in the cold or by heat.

Sect. VIII. *Of Cerium.*

1592 History and combinations. Cerium was discovered by Berzelius and Hisinger in a Swedish mineral, formerly supposed to be an ore of tungsten. It is denominated cerium, from the planet Ceres, discovered about the same time; and the mineral containing it is named *cerite*. When this mineral is dissolved in nitro-muriatic acid, the solution, after being rendered neutral by potash, is precipitated with tartrite of potash or oxalic acid. This precipitate, when calcined, is the white oxide of cerium. The metal itself has very seldom been obtained pure, and only in very minute quantity. It is white, very hard, brittle, and volatile. It is capable of combining with another portion of oxygen by heat, and the peroxide thus obtained is red. The solutions of the oxides in the acids are either yellow or red, and give precipitates of different shades of these colours.

Sect. IX. *Of Cobalt and its Combinations.*

1592 History. 1. The mineral called *cobalt*, or *cobolt*, (B) seems to have been first employed to give a blue colour to glass after the middle of the 16th century; but it was not till about the year 1732, that cobalt was distinguished as a peculiar metal by Brandt, a Swedish chemist, who extracted it from its ore, and examined some of its properties. In 1761 Lehman gave a particular account of the nature and properties of this substance; but his researches were chiefly limited to the mineral in the state of ore. Bergman afterwards examined this metal, and pointed out the difference between it and nickel, manganese, and iron. The nature of it has been more lately investigated by Tassaert and Thenard, and some other French chemists.

2. Cobalt

(B) The following curious information is given by Beckman with regard to the discovery of this mineral. "About the end of the 15th century, cobalt appears to have been dug up in great quantity in the mines on the borders of Saxony and Bohemia, discovered not long before that period. As it was not known at first to what use it could be applied, it was thrown aside as a useless mineral. The miners had an aversion to it, not only because it gave them much fruitless labour, but because it often proved prejudicial to their health by the arsenical particles with which it was combined; and it appears even that the mineralogical name *cobalt* then first took its rise. At any rate, I have never met with it before the beginning of the sixteenth century; and Mathesius and Agricola seem to have first used it in their writings. Frisch derives it from the Bohemian word *kow*, which signifies metal; but the conjecture that it was formed from *cobalus*, which was the name of a spirit that, according to the superstitious notion of the times, haunted mines, destroyed the labours of the miners, and often gave them a great deal of unnecessary trouble, is probable; and there is reason to think that the latter is borrowed from the Greek. The miners, perhaps, gave this name to the mineral out of joke, because it thwarted them as much as the supposed spirit, by exciting false hopes, and rendering their labour often fruitless. It was once customary, therefore, to introduce into the church service a prayer that God would preserve miners and their works from *kobolts* and spirits."

"Mathesius, in his tenth sermon, p. 501, where he speaks of the *cadmia fossilis*, says: 'Ye miners call it *kobolt*; the Germans call the black devil and the old devil's whores and hags old and black *kobel*, which by their witchcraft do injury to people and to their cattle.'—Whether the devil, therefore, and his hags, gave this name to cobalt, or cobalt gave its name to witches, it is a poisonous and noxious metal."

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1594 Ores. 2. Cobalt has never been found in nature in a state of purity. It is either alloyed with arsenic, both metals being in the metallic state, or it is combined with sulphur and arsenic, or in the state of oxide, or forming a salt with arsenic acid. 1. In the first state, when it is alloyed with arsenic, it is of a gray or whitish appearance, with some degree of brilliancy. The specific gravity is 7.72. It is sometimes crystallized in cubes, or octahedrons. When small fragments of this mineral are exposed to the action of the blow-pipe, or even to the flame of a candle, they give out a garlic smell. 2. The combination of sulphur and arsenic with cobalt is denominated *gray cobalt ore*. The specific gravity is from 6.33 to 6.45. The structure is lamellated, and when it is heated, it emits no garlic smell. It crystallizes in octahedrons, dodecahedrons, and some other forms resembling the sulphuret of iron, with which it is frequently combined. 3. The third species of cobalt ore is the oxide. It is found in black, friable masses, or in the state of a black efflorescence, which soils the fingers. This is a pure oxide of cobalt. 4. The fourth species is the arseniate of cobalt, which has been distinguished by the names of *flowers of cobalt*, *cobalt bloom*. It is of a peach-blossom colour, sometimes in the state of efflorescence, sometimes in the form of small needles of a deep colour, which remains even after they are reduced to powder, and sometimes in four-sided prisms terminated by two sided summits. When it is placed on hot coals, it gives out a strong garlic smell, loses its colour, and becomes black.

1595 Analysis of the ores. 3. To procure the pure metal from the ores of cobalt, the oxide in the state of black powder, after being roasted, is mixed with three times its own weight of black flux and a little common salt, put into a crucible lined with charcoal, and exposed to a forge heat. When the fusion is completed, the crucible is to be slightly agitated, to collect together the metallic globules into one mass. Sometimes two metallic buttons are found under the vitreous scoriæ. The cobalt occupies the upper part, and the bismuth being heaviest, is lowest. In this state the cobalt is almost always combined with a small portion of arsenic, nickel, or iron. But if the crystallized gray oxide of cobalt has been employed, the metal is obtained very pure, by the above process; and when the ore is rich, it yields from 60 to 80 per cent.

By a different process, cobalt may be obtained in the metallic state, which consists in treating the ore with nitric acid, which oxidates and dissolves both the cobalt and the iron. These oxides are precipitated by carbonate of soda, and well washed with water. They may be separated by means of nitric acid, which dissolves the oxide of cobalt, without touching that of the iron.

1596 Properties of cobalt. 4. Cobalt is of a gray colour, inclining to red, and of a very fine granulated texture. It is very brittle, so that it is easily reduced to a fine powder, which is of a gray colour, and with little brilliancy. The specific gravity, according to Bergman, is 7.700; according to others, it is from 7.811 to 8.5384.

1597 Action of heat. 5. Cobalt is one of the most infusible metals, requiring a temperature equal to 130° Wedgwood. It becomes red before it melts. When it is slowly cooled, and by pouring out a part of the fluid when it becomes solid at the edges, the cavity is found lined with prismatic crystals. The same crystallization may be effected by inclining the crucible at the moment the surface becomes solid.

6. When cobalt is exposed to a red-heat in an open vessel, it first loses its colour and its brilliancy, becomes of a deep gray colour, and then passes to a black, or an intense blue. With a still more violent heat, this last oxide melts into a bluish black glass. It appears, from the experiments of Thenard, that cobalt combines with different proportions of oxygen, forming different oxides. When a solution of cobalt in acids is precipitated by an alkali, the precipitate which is formed is first of a lilach colour; and with an excess of base it becomes successively blue and olive, and at last by drying it becomes entirely black. These different changes depend on the different proportions of oxygen with which it combines. 1598 Oxidation.

He precipitated a solution of cobalt by pure potash. The oxide collected on a filter was blue, and when exposed to the air it became of an olive colour; and when washed with oxymuriatic acid, it changed from green to brown, and from this shade to the deepest black. The black oxide dissolved with effervescence in muriatic acid; oxymuriatic acid gas was emitted in great abundance, and when the muriatic acid was concentrated, the solution was of a green colour, which in the space of 24 hours became purple. When the acid was diluted it became instantly red. The oxide is soluble in sulphuric and nitric acids, and the solution is of a red colour, accompanied with the evolution of bubbles, which seem to be oxygen gas.

The brown and coloured oxides produce with sulphuric, nitric, and muriatic acids, similar effects with the black oxide. With muriatic acid they both give out oxymuriatic acid, and form a solution of a green colour, which in time passes to a purple; or, if the acid be diluted with water, it becomes instantly red. The olive-coloured oxide is prepared by pouring potash into a solution of cobalt. There is formed a blue precipitate, which exposed to the air becomes green. If this oxide be treated with diluted muriatic acid, oxymuriatic acid is obtained with a slight degree of heat, and the solution becomes more and more red, as this acid is disengaged; so that the blue oxide combines with the oxygen of the air.

The blue oxide of cobalt, Thenard thinks, is most conveniently obtained by calcining the black oxide for half an hour in a cherry-red heat. It assumes a blue colour, by being deprived of part of its oxygen. This oxide dissolves in acids, without the disengagement of any gas. Its solution in concentrated muriatic acid is green, but if the acid be diluted with water, it is red. 1599
Thenard concludes from his experiments, that there are four different oxides of cobalt; the blue, the olive, the brown, and the black; although he supposes that the brown may be a mixture of the olive and black oxides*. Oxides, four.

7. There is no action between azote, hydrogen, or carbon, and cobalt. 1600

8. Phosphorus enters into combination with cobalt, by projecting bits of phosphorus on small pieces of cobalt, red hot, in a crucible. The metal is instantly fused, and it absorbs about $\frac{1}{15}$ of its weight of phosphorus. A crust is formed at the same time on the surface, of a violet-red colour. This phosphuret of cobalt Phosphuret.

* Annal. de Chim. lii. 280—315.

balt has a metallic lustre, is of a whiter colour than the metal itself, and is more brittle. It loses its brilliancy in the air; and by the action of the blow-pipe, phosphorus is disengaged from the metallic globule, and inflames on the surface. There remains behind a vitreous globule of a deep blue colour.

1601 Sulphuret. 9. Sulphur combines with difficulty with cobalt, but the compound may be formed by the aid of the alkalies. This metal is soluble in the alkaline sulphurets, and the result is a sulphuret of cobalt, of a yellowish white colour, which is only decomposed by means of the acids.

1602 Salts. 10. Cobalt enters into combination with the acids, and forms salts. It forms alloys also with most of the metals. The order of the affinities of cobalt and its oxides, according to Bergman, is the following:

Cobalt.	Oxide of Cobalt.
Iron,	Oxalic acid,
Nickel,	Muriatic,
Arsenic,	Sulphuric,
Copper,	Tartaric,
Gold,	Nitric,
Platinum,	Phosphoric,
Tin,	Fluoric,
Antimony,	Saclactic,
Zinc,	Succinic,
Phosphorus,	Lactic,
Sulphur,	Acetic,
	Arsenic,
	Boracic,
	Prussic,
	Carbonic.

I. Salts of Cobalt.

1. Sulphate of Cobalt.

1603 Preparation. 1. Concentrated and boiling sulphuric acid is decomposed by cobalt, with the evolution of sulphurous acid gas. A thick, grayish mass, inclining to red, is formed. Water dissolves the sulphate of cobalt, and affords a grayish coloured liquid.

1604 Properties. 2. The sulphate of cobalt crystallizes in small needles, or four-sided rhomboidal prisms, terminated by two-sided summits. It is of a reddish colour, and is soluble in 24 parts of water. It is decomposed by heat, and there remains behind the black oxide of cobalt. By the action of the blow-pipe it swells up with effervescence. The alkalies also decompose it, by precipitating a reddish yellow oxide. One hundred parts of cobalt furnish 140 parts of this precipitate by pure alkalies; but when the precipitation is effected by means of the alkaline carbonates, 160 parts are obtained.

2. Nitrate of Cobalt.

1605 Preparation. 1. Nitric acid combines with cobalt, with the assistance of a moderate heat. Nitrous gas is disengaged, the metal is oxidated, and is dissolved in the acid. The solution is of a flesh-red colour, but when it is concentrated, of a brown colour. By evaporation it affords small reddish-coloured prismatic crystals, which are deliquescent in the air, and which being placed on red-hot burning coals, swell up, and are decomposed, leaving behind a deep red oxide.

2. It is by the precipitation of this salt, that the oxide of cobalt is obtained for the purpose of enamels, and for giving a colour to porcelain. When the oxide is precipitated by means of an alkali, it is redissolved 1606 Enamels.
when the alkali is added in excess.

3. Nitrate of Ammonia and Cobalt.

This triple salt was formed by Thenard, by adding to a solution of cobalt in nitric acid, ammonia in excess. No precipitate is obtained. This solution being filtered and evaporated to dryness, and the residue being dissolved in water, and again evaporated, yielded, on cooling, regular cubic crystals of a red colour, and of a pungent taste. They were not changed by exposure to atmospheric air. Being calcined in a crucible, they burned like nitrate of ammonia, with a vivid, yellowish white flame. The residue was a black substance, which had all the properties of cobalt. The solution of this salt in water is not precipitated by any of the alkalies or earths. It is still more readily decomposed by sulphurated hydrogen, or the hydrosulphurets. When it is boiled with potash, ammonia is disengaged; the oxide of cobalt is precipitated, and a nitrate of potash is formed *.

4. Muriate of Cobalt.

1. Muriatic acid has no effect on cobalt in the cold; 1607 Preparation.
but a small quantity is dissolved with the assistance of heat. But the black oxide of cobalt is readily dissolved in muriatic acid. The solution is accompanied with effervescence, and the disengagement of oxymuriatic acid gas. When this solution is concentrated by evaporation, it becomes of a fine green colour, which changes to red when it is diluted with water. By farther evaporation it is crystallized, and affords small deliquescent crystals of muriate of cobalt in the form of needles.

2. When these crystals are dissolved in water, and 1608 Sympathetic ink.
so diluted that the solution is nearly colourless, characters marked with it on paper disappear entirely; but when heated, assume a fine green colour. This solution was one of the first known sympathetic inks. In making experiments with this solution, the characters are written on paper, or, that the experiment may be more amusing, a landscape is drawn with a pencil, representing the verdure of summer on a winter scene. Those parts of the picture in which the sympathetic ink has been used, are invisible in the cold; but when it is moderately heated, they become of a fine green colour, changing from the winter to the summer scene. When it is removed to the cold, the colour again disappears, and if too much heat be not applied, the same change may be frequently repeated. When too much heated, the blue colour is converted to a brown, which becomes permanent.

3. Various theories have been proposed to account 1609 Theories.
for this remarkable change. According to some, it is owing to the moisture of the atmosphere being absorbed that the colour disappears; and when this is driven off by heat, it is restored. But to this opinion it has been objected, that the same effect is produced, when paper, on which characters have been written with this solution, is entirely excluded from the atmosphere, by being introduced into close vessels. According to others, the sympathetic effect of this solution depends on the iron which is combined with the cobalt.

* Ann. de Chim. xlii. 215.

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Cobalt, &c.

cobalt. Some suppose that the concentration of the solution, which takes place by the action of heat, is the cause of the appearance of the colour; and its dilution, by absorbing moisture from the atmosphere, the cause of its disappearance; while others are of opinion that it is partially deprived of its oxygen by being heated, and absorbs it again in the cold, when the colour vanishes.

1610 Another process. The sympathetic ink may be easily prepared, by dissolving the zaffre of commerce in nitro-muriatic acid.

5. Fluate of Cobalt.

Fluoric acid dissolves the oxide of cobalt, and forms with it a yellow-coloured gelatinous solution; or, by careful evaporation, it affords crystals, which are fluate of cobalt.

6. Borate of Cobalt.

Boracic acid has no action on cobalt; but it combines with the oxide, by mixing a solution of nitrate of cobalt with a solution of borax.

7. Phosphate of Cobalt.

Phosphoric acid dissolves the oxide of cobalt, and forms with it a reddish-coloured turbid solution, which affords a precipitate when the acid is saturated.

8. Carbonate of Cobalt.

This salt is formed by precipitating cobalt from its solutions in acids, by means of alkaline carbonates. One hundred parts of cobalt, which afford only 140 of precipitate by means of the pure alkalies, yield 160 parts, when the precipitate is effected by carbonate of soda.

9. Arseniate of Cobalt.

This salt is formed by combining the nitrate of cobalt with the arseniate of potash or of soda. It is sometimes found native, and it exhibits the deepest and most beautiful red of all the salts of cobalt.

10. Tungstate, molybdate, chromate, and columbate of Cobalt. Unknown.

14. Acetate of Cobalt.

This salt is readily formed, by dissolving the oxide of cobalt in acetic acid. It does not yield crystals by evaporating, but is deliquescent in the air. It assumes a blue colour when it is heated, but is red in the cold, so that it forms a sympathetic ink.

15. Oxalate of Cobalt.

This salt may be formed by precipitating the oxide of cobalt from its solution in acids, by means of oxalic acid. This precipitate, when it is dried, is in the form of a red powder, which is insoluble in water, but may be dissolved in excess of oxalic acid, and crystallized.

16. Tartrate of Cobalt.

The oxide of cobalt is soluble in tartaric acid, and forms a red-coloured solution, which affords crystals by evaporation.

II. Action of Alkalies, Earths, and Salts.

1611 Alkalies. 1. The alkalies have no action whatever on cobalt; but when the oxides are suspended in water, they separate them from other matters.

Nickel, &c.

1612 Earths. 2. Some of the earths, but particularly silica, enter into combination with the oxide of cobalt and the fixed alkalies, and form a beautiful blue-coloured glass. The quantity of oxide must be small, otherwise the glass will appear nearly black and opaque, on account of the intensity of the colour.

1613 Salts. 3. Some of the neutral salts exposed to a high temperature along with cobalt burn with a perceptible flame. It is by this means that the oxide is prepared for the purpose of enamels and colouring porcelain.

The hyperoxymuriate of potash, with one-third of its weight of cobalt in powder, detonates by percussion.

1614 Uses. Cobalt is scarcely at all employed in the metallic state. *Zaffre* is used for coarse enamels and pottery ware. The purer oxides of cobalt are chosen for the purpose of colouring porcelain. *Azure* is a vitreous blue in the state of fine powder, which is prepared for similar purposes. Zaffre is fused along with silica and an alkali, and thus forms a deep blue glass, which is known by the name of *smalt*. This is reduced to a powder, and mixed with a great quantity of water. The first portion which precipitates is called *coarse azure*. Four different quantities are separated in this way. The last, which is the finest, is called azure of four fires.

Sect. X. *Of Nickel and its Combinations.*

1615 History. 1. The first mention which is made of this metal is by Hierne, a Swedish chemist, in a work entitled *The art of discovering metals*, published in 1694. He particularly describes the mineral from which nickel is extracted, and which was first called *kupfernickel*, or *false copper*, because it was taken for an ore of copper, and none could be obtained from it. This was the opinion of Henckel and Cramer, who supposed it to be copper combined with arsenic or cobalt. This mineral was generally arranged among copper ores, till it was examined and analyzed by the celebrated Swedish mineralogist Cronstedt, in 1751, and 1754. In these experiments, the account of which was published in the memoirs of the Swedish Academy, he proved that this mineral contains a new metal, different from all those which had been hitherto known, to which he gave the name of *nickel*. This opinion was generally adopted, and objected to only by Monet and Sage of France, who affirmed that this new metal was merely an alloy of cobalt, arsenic, iron, and copper. To remove these differences of opinion with regard to this substance, Bergman undertook an elaborate analysis of the ores of nickel, and an accurate examination of its peculiar properties in the metallic state. His experiments were detailed in a dissertation which was published in 1755. The object of his researches was, to ascertain if nickel was a peculiar metal; and from the result of his experiments it appeared, that it did not contain the smallest trace of copper, but that it is generally alloyed with cobalt, arsenic, and iron, from which indeed it can scarcely be completely separated; but that it possessed peculiar and distinct properties from the other metals; and these properties became more striking and characteristic in proportion to its purity.

2. Nickel

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Nickel, &c. 1616 Ores. 2. Nickel is found in the state of sulphuret, when it is called *kupfernickel*. It is of a reddish yellow colour, with little brilliancy, somewhat similar to tarnished copper, with which, from its appearance, it is frequently confounded. This mineral soon loses its brilliancy in the air, becomes of a brownish colour, and is covered at last with greenish spots. It is found forming veins in the earth, and is usually combined with arsenic, cobalt, and iron. Nickel has been found alloyed with iron, when it is of a laminated texture, and composed of rhomboidal plates. The fresh fracture is of a pale yellow, which becomes black by exposure to the air. Nickel is also found native in the state of oxide, when it is of a bright green colour. In this state it is generally on the surface of sulphuret of nickel. Native nickel has also been found, according to Bergman, or at least with a very small proportion of sulphur, but combined with iron, cobalt, and arsenic. He says, too, that it exists in combination with sulphuric acid.

1617 Separation of the metal. 3. To obtain nickel from its ores in the state of sulphuret, they are first roasted, by which means the sulphur and arsenic are driven off. In this process the mineral loses one-third or one-half of its weight; and in proportion to the quantity of pure metal, which exists in the ore, it assumes a richer green. The roasted ore is then mixed with two parts of black flux, put into a crucible covered with muriate of soda, and exposed to a forge heat, to bring it to fusion. When the apparatus has cooled, there is found under the brown, black, or blue scoriæ, a metallic button, which amounts to one-tenth, and sometimes to one-half, of the mineral employed.

1618 Properties. 4. Nickel, in the purest state in which it can be obtained, is of a yellowish white, or of a reddish white colour, with more or less lustre, and of a granulated texture. The specific gravity is 9 according to Bergman, but according to Guyton it is only 7.807. Bergman speaks of it as possessing some degree of ductility; but this, it is supposed, is owing to its alloy with iron, which latter constitutes $\frac{1}{7}$ of its weight. It is also magnetic, and this property has also been supposed to depend on the same alloy. Nickel is a very infusible metal, requiring a temperature equal to 150° Wedgwood. Its power of conducting caloric has not been ascertained, nor has its taste or its smell been recognized. It has never been obtained in crystals.

1619 Action of heat. 5. When nickel is exposed to heat in an open vessel, it combines with oxygen, and assumes a brown colour; but this requires a very high temperature. After long exposure to the air, when it is moist, and in the cold,
1620 Oxide. it becomes covered with an efflorescence of a bright green colour, of a peculiar and distinct shade. It is this efflorescence which is found on the surface of the native sulphurets of nickel, the shade of which is so remarkable, and so different from that of copper, that they can be easily distinguished. This oxide is composed of

Nickel	77
Oxygen	23
	100

6. There is no action between nickel and azote, hydrogen, or carbon; nor is it at all acted upon by water.

1621 Phosphuret. 7. Nickel combines with phosphorus, and forms with it a phosphuret. This is prepared by decomposing phosphoric acid in the state of glass, which is done by mixing phosphoric glass, charcoal, and nickel, and fusing them together. Or it may be prepared, by projecting bits of phosphorus on the metal, while it is red hot, in a crucible. It acquires an addition of one-fifth part to its weight; but it parts with a small portion of phosphorus as it cools. The phosphuret of nickel is of a more brilliant and purer white than the metal itself. The texture resembles a collection of small needles heaped together. When it is heated under the blowpipe, the phosphorus burns on its surface, and the metal is oxidated. The component parts of this phosphuret, according to Pelletier, are, 1622 Composition.

Nickel	83.3
Phosphorus	16.6
	100.0 *

* *Ann. de Chim.* xiii. 135.

1623 Sulphuret. 8. Nickel combines readily with sulphur, and forms with it a sulphuret, which is somewhat different in its properties from the native sulphuret. It is hard, of a yellowish colour, and in small brilliant facets. When it is strongly heated in the open air, it gives out luminous sparks.

1624 Alloys. 9. Nickel enters into combination with several of the metals, and forms with them alloys; the properties of which are but little known. With cobalt and arsenic it forms native alloys. The alloy with the latter is of a reddish colour, has no magnetic property, is considerably hard, and its specific gravity is less than the mean specific gravity of the two metals.

1625 Salts. 10. Nickel enters into combination with the acids, and forms with them salts, which are distinguished by peculiar properties.

1626 Affinities. 11. The order of the affinities of nickel and its oxide, as they have been ascertained by Bergman, is the following:

Nickel.	Oxide of Nickel.
Iron,	Oxalic acid,
Cobalt,	Muriatic,
Arsenic,	Sulphuric,
Copper,	Tartaric,
Gold,	Nitric,
Tin,	Phosphoric,
Antimony,	Fluoric,
Platinum,	Saclactic,
Bismuth,	Succinic,
Lead,	Citric,
Silver,	Lactic,
Zinc,	Acetic,
Sulphur,	Arsenic,
Phosphorus.	Boracic,
	Prussic,
	Carbonic.

I. Salts of Nickel.

1. Sulphate of Nickel.

1627 Preparation. Concentrated sulphuric acid, with the assistance of heat, is decomposed by nickel. Sulphurous acid gas is disengaged, and there remains behind a gray mass soluble in water, to which it communicates a beautiful green colour. By evaporating this solution, crystals of

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a pale-emerald green are obtained, which are sulphate of nickel. The oxide of nickel is also readily dissolved by sulphuric acid, from which also crystals are obtained.
1628 Properties. It crystallizes in the form of square prisms, or in decahedrons, which are composed of two four-sided pyramids, truncated at the summits.

2. Nitrate of Nickel.

Nitric acid oxidates and dissolves nickel with the assistance of heat. The oxide is dissolved by this acid, without effervescence. The solution has a blackish green colour, which affords rhomboidal, deliquescent crystals, that are decomposed by heat, and leave, after being strongly calcined, and giving out oxygen gas, a black oxide. When the nitrate of nickel is exposed to a warm dry air, it is deprived of its water of crystallization, and even of its acid, so that there remains behind only an oxide of the metal.

3. Nitrate of Ammonia and Nickel.

This triple salt is formed, by adding ammonia in excess to the solution of nitrate of nickel. This salt is of a green colour. It is obtained in crystals by evaporation. The solution does not become turbid by the addition of alkalies, but the metal is precipitated by hydrosulphurets *.

* *Annal. de Chim.* xlii. 217.

4. Muriate of Nickel.

Muriatic acid dissolves nickel and its oxide slowly, except with the assistance of heat. The solution is of a green colour, and affords irregular crystals. The muriate of nickel is decomposed by heat, and by exposure to the air.

5. Fluate of Nickel.

Fluoric acid dissolves the oxide of nickel with difficulty, and affords crystals of a bright green colour.

6. Borate of Nickel.

The compound of boracic acid and nickel can only be formed by double affinity, by adding the borate of soda, for instance, to a solution of nickel in acids.

7. Phosphate of Nickel.

Phosphoric acid has not a very strong affinity for the oxide of nickel. The solution which is formed is scarcely of a green colour, and does not afford crystals.

8. Carbonate of Nickel.

Liquid carbonic acid, exposed to the contact of nickel, did not appear, to Bergman, to combine with the metal. But when nickel is precipitated from its solutions by means of alkaline carbonates, the precipitate acquires a greater weight than when the pure alkali is employed; from which it is concluded, that part of the carbonic acid has combined with the oxide.

9. Arseniate of Nickel.

Arsenic acid forms with the oxide of nickel a green saline mass, which is obtained by precipitating the oxide of nickel from its solution in acids, by means of an alkaline arseniate. The arseniate of nickel is in the form of powder, which is scarcely soluble in water.

10. Tungstate, molybdate, chromate, and columbate of nickel. Unknown.

14. Acetate of Nickel.

Acetic acid dissolves the oxide of nickel, and forms a salt in rhomboidal crystals, which are of a deep green colour.

15. Oxalate of Nickel.

With the assistance of heat, oxalic acid acts upon nickel, and a pale green powder precipitates. This salt is scarcely soluble in water. It may be formed also, by precipitating nickel from its solutions in sulphuric, nitric, and muriatic acids, by means of oxalic acid.

16. Tartrate of Nickel.

This salt, and the combinations of the oxide of nickel with the other acids, are unknown.

II. Action of Alkalies.

The fixed alkalies dissolve the oxide of nickel, but in small quantity. They assume a yellow colour; but this oxide is very soluble in ammonia; the solution of which is of a deep-blue colour, and of a peculiar shade. When it is evaporated, it precipitates in the form of a blackish brown powder, which passes from blue to green. Most of the metals separate the nickel from this solution. 1629 Fixed alkalies. 1630 Ammonia.

III. Action of the Earths.

1. Many of the earths, as silica and alumina, have no action on nickel; but others, as barytes and strontites, convert the oxide in solution into an orange red. If it contain arsenic or cobalt, the glass, which is coloured with nickel, becomes of a blue or violet colour.

2. The nitrates and the hyperoxymuriates very readily decompose the salts of nickel, and reduce it to the state of oxide. With the boracic and phosphoric salts it assumes a pale red colour. The nitrate of potash detonates feebly with nickel, but has the property of detecting the smallest trace of cobalt, which could not have been discovered by any other reagent.

So far as is known, this metal has not been applied to much use. There is, however, little doubt, that it might be employed for enamels, and for colouring glass, porcelain, and pottery. Fourcroy observes, that it is probably employed in some of the secret processes of these manufactures, as it is brought in considerable quantities from Saxony to Paris. 1631 Uses.

SECT. XI. *Of MANGANESE and its Combinations.*

1. A substance was long employed in the manufacture of glass, which, on account of its property of depriving glass of its colour, was known under the name of *glassmaker's soap*; from its appearance it was called *black magnesia*, or *manganese*, But although it was long employed in manufactures, nothing was known of its intimate nature or constituent parts. It was generally considered as an ore of iron, because it was found sometimes combined with the oxide of this metal. By others it was arranged among the ores of zinc, supposing that it was some combination of this metal. To Bergman and Scheele we are indebted for the first accurate knowledge of its nature. Bergman, in a dissertation which he published in 1774, announces it as a peculiar 1632 History.

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Manganese, &c. peculiar metal, on account of its weight, its property of colouring glass, and of affording a white precipitate with the alkaline prussiates. Scheele, in the same year, presented to the academy of Stockholm a memoir, containing his researches concerning the nature and peculiar properties of this mineral. From these experiments he concludes that this mineral is the oxide of a peculiar metal, totally distinct from all others. Gahn, the pupil of Bergman, was the first who obtained the metal in its pure state, from the native oxide of manganese. His experiments have been repeated by others, and the results of Scheele and of Bergman fully confirmed.

1633 Ores. 2. Manganese is most generally found in the state of oxide. Of this there are three principal varieties, the white, the red, and the black. 1. The first, or the white ore of manganese, contains the smallest proportion of iron and of oxygen. Sometimes it is crystallized. This ore soon tarnishes in the air by absorbing oxygen. 2. The red ore of manganese contains more iron than the former. It is either friable, or hard as it is found in carbonate of lime, on shistus, or accompanying ores of iron; or in lamellated masses, radiated or crystallized in pyramids, rhomboids, or in short brittle needles. 3. The black or the brown ore is frequently crystallized like the red. It is also found in solid masses having a metallic or dull earthy appearance, mixed with quartz and other stony bodies. The specific gravity is 4.0. Manganese has been found native by Lapeyrouse in some iron mines in France. It was in the form of small flattened metallic buttons, of a lamellated texture. But it has been supposed that the manganese in this state is alloyed with iron.

1634 Separation of the metal. 3. Manganese is procured in the metallic state by the following process. The native oxide of manganese is reduced to a fine powder, and formed into a paste with water. Part of it is then made into a ball, and introduced into a crucible lined with charcoal. A thick stratum of charcoal is placed at the bottom of the crucible, and the ball of manganese is to be surrounded and covered with the same substance, and the crucible, which is inverted and luted to the other, is to be filled with it. The whole is then to be exposed to a very strong heat, not less than 160° Wedgwood, for more than an hour. When the apparatus cools, the metal is found in the bottom of the crucible, or in the midst of the scoriæ, in the form of globules, which amount to nearly one-third of the manganese employed. But if the heat has been too low, it will be found in grains.

1635 Properties. 4. Manganese is of a grayish white colour, with considerable brilliancy, and of a granular texture. The specific gravity is 6.850. It has neither taste nor smell. In hardness it is equal to iron. It is one of the most brittle of the metals, and at the same time one of the most infusible, requiring a temperature of 160° Wedgwood to melt it. When in the state of powder it is often attracted by the magnet, on account of the iron, from which it can only be separated with great difficulty.

1636 Action of heat. 5. When this metal is exposed to the air, it is soon tarnished. It becomes gray, brown, and black, and at last falls down into powder, which is found to have acquired considerable addition to its weight. But when it is heated in the open air, it passes more rapidly through the different changes of colour, in proportion as it combines with oxygen, to the absorption of which these changes are owing. It appears, therefore, that manganese, like some of the other metals, combines with different portions of oxygen, forming different oxides. The black oxide, which is manganese, combined with oxygen in the greatest proportion, is found native in great abundance. The red oxide is supposed to contain the oxygen in the next proportion. This also exists native, and it may be found by distilling the black oxide made into a paste with concentrated sulphuric acid in a retort to dryness. It is deprived of a great quantity of oxygen, which is given out in the state of gas. The residuum is then to be mixed with water, which is to be filtered. This solution, which is sulphate of manganese, is of a red colour. By adding an alkali, a precipitate is formed, which is the red oxide of manganese. The white oxide is also prepared by depriving the black oxide of part of its oxygen. This is effected by pouring nitric acid on the black oxide of manganese, with the addition of sugar, which absorbs the oxygen, and converts it into the white oxide. The latter is then dissolved in the acid, from which it may be precipitated by potash. The precipitate is in the form of a white powder. The proportion of manganese and oxygen in the white and brown oxides of manganese, according to Bergman, and in the black, according to Fourcroy, are,

1637 Oxides. 1638 Black. 1639 Red. 1640 White.

	White Oxide.	Brown Oxide.	Black Oxide.
Manganese	80	74	60
Oxygen	20	26	40
	100	100	100

When these oxides are exposed to the air, they absorb oxygen, and are again converted into the black oxide with the greater proportion of oxygen.

6. It is from the black oxide of manganese that chemists generally procure oxygen gas. The most economical process is that which has been already described in the chapter on oxygen. This is by exposing it to a red heat in an iron bottle. The manganese is reduced to the state of red oxide by being deprived of the difference of the quantity of oxygen between the black and the brown oxides. The same manganese may be employed after it has been for some time exposed to the air, and occasionally moistened with water. This process, however, goes on much more slowly than is generally supposed. We have kept several quantities of manganese, which had furnished abundance of oxygen, and had ceased to give out more in a red heat, exposed to the air for many months, and frequently moistened with water, but when it was again heated to redness, it did not yield above $\frac{1}{10}$ part of the original quantity from the native manganese. 1641 Furnishes oxygen.

7. Manganese is capable of combining with a still larger proportion of oxygen than that contained in the black oxide. This combination takes place when that oxide is exposed for some time to a moderate red heat, in intimate mixture with an equal weight or a much larger proportion of pure potash, or nitrate of potash. Oxygen is then acquired from the air, or from the decomposition of the nitric acid; and a compound is formed which is in fact a *manganesiate of potash*, *i. e.* the manganese 1642 Manganesic acid.

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Manganese, &c.

manganese now acquires acid properties; a *manganesic acid* is produced, which combines to form this neutral salt with the potash. This is of a beautiful green colour when the quantity of potash is small, and of a red colour when it is large. When exposed for a time to the air, or largely diluted with water, it becomes colourless. These changes acquired for it the name of the *chameleon mineral* when its nature was unknown.

8. Manganese does not enter into combination with azote, hydrogen, or carbon. It is by means of charcoal, that the oxide of manganese is reduced, by being deprived of its oxygen; and what has been supposed to be a compound of manganese and carbon, is a carburet of iron, or carbon combined with the iron, with which manganese is almost always alloyed.

1643 Phosphuret and sulphuret.

9. Phosphorus combines very readily with manganese. Pelletier formed the phosphuret of manganese by fusing a mixture of equal parts of manganese in the metallic state, and phosphoric glass, with about $\frac{1}{8}$ part of charcoal in powder; or by fusing equal parts of the two former without the charcoal; or by projecting small bits of phosphorus on manganese heated to redness in a crucible. The phosphuret obtained by any of these processes is of a white colour, of a granulated texture, and brittle, and much disposed to crystallize. It undergoes no change by exposure to the air. It was covered with an opaque, vitreous matter of a yellowish colour. It is more fusible than the manganese itself. When it is exposed to the action of the blow-pipe, the phosphorus burns, and the metal is oxidated *.

* *Ann. de Chim.* iii. 137.

10. Bergman failed in forming a compound with sulphur and manganese by direct combination. But he succeeded in combining sulphur with oxide of manganese. Three parts of sulphur, and eight parts of the oxide, exposed to heat in a glass retort, formed a greenish yellow mass, which effervesced with acids, and emitted sulphurated hydrogen gas. Scheele has observed, that a part of the sulphur is converted into sulphurous acid during the process.

1644 Affinities.

11. Manganese enters into combination with the acids, and forms salts with them. The order of the affinities of the oxides of manganese for the acids, according to Bergman, is the following:

Oxide of Manganese.

Oxalic acid,
Citric,
Phosphoric,
Fluoric,
Muriatic,
Sulphuric,
Succinic,
Nitric,
Saclactic,
Succinic,
Tartaric,
Lactic,
Acetic,
Prussic.
Carbonic.

I. Salts of Manganese.

1. Sulphate of Manganese.

1. Concentrated sulphuric acid acts on manganese, even in the cold; but the action is more powerful if the acid be diluted with two or three parts of water. Hydrogen gas is given out, and there remains behind in the liquid, a black, spongy mass, which is the carburet of iron. The solution is colourless, and it affords by evaporation, transparent, colourless crystals. Sulphuric acid does not combine with the black oxide of manganese, till it is deprived of part of its oxygen, and reduced to the state of red or white oxide; but the acid combines with either of the two latter oxides, forming salts possessed of distinct properties. There are, therefore, two sulphates of manganese, which may be distinguished, from the colour of the base or oxide, by the names of white and red sulphates. 1645 Two sulphates.

2. *White sulphate of manganese.*—This is the compound of sulphuric acid and the white oxide of manganese. This oxide combines with the acid without effervescence, and forms a colourless solution, which yields, by evaporation, transparent rhomboidal crystals, which have a very bitter taste. This salt is decomposed by heat; the acid is driven off, and oxygen gas is given out. It is decomposed also by the pure alkalies, and a precipitate is formed, of the white oxide of manganese, which soon becomes brown by exposure to the air, in consequence of the absorption of its oxygen. The alkaline carbonates precipitate a carbonate of manganese, which does not absorb the oxygen from the air, and does not become black like the former. It is the white sulphate of manganese, which is obtained by dissolving the metal in diluted sulphuric acid. In this process the manganese combines with the oxygen of the water, which is decomposed, and is converted into the white oxide, which unites with the sulphuric acid, to form the sulphate. The hydrogen of the water is driven off in the state of gas, so that the salt formed in this way occasions an effervescence. This salt may also be formed by dissolving the black oxide in sulphuric acid, but in this case it is necessary, as Scheele discovered, to add some vegetable matter, as sugar, honey, or gum, to absorb the superabundant quantity of oxygen, which prevents the solution of the manganese in the acid. When, therefore, the black oxide is reduced to the state of white oxide, by depriving it of part of its oxygen, it combines with the acid, and forms white sulphate of manganese, as in the former processes. 1646 With the white oxide.

3. *Red Sulphate of Manganese.*—If the black oxide of manganese be distilled to dryness with sulphuric acid, diluted with half its weight of water, and if the residuum be washed with water, a reddish or violet-coloured solution, which is the red sulphate of manganese, is obtained. By evaporation it affords thin crystalline masses, which have no regular form. These are also of a reddish colour. The alkalies occasion a red precipitate, which becomes black by exposure to the air. This sulphate may be also formed by the direct combination of the red oxide with the acid. 1647 With the red oxide.

Bergman has observed, that the red oxide of manganese is intermediate between the black and the white; that it is more soluble in sulphuric acid than the former, and less soluble than the latter; that the red forms a red-coloured sulphate, while the white affords a colourless sulphate.

4. Sulphurous acid acts feebly or scarcely at all on manganese; but it dissolves the black oxide readily, and

Manganese, &c. and without effervescence. There is not formed, however, a sulphite of manganese; for the sulphurous acid deprives the black oxide of a portion of its oxygen, and thus converts it into a white oxide, while the acid itself is converted into sulphuric acid. The white oxide is then dissolved in the sulphuric acid, and forms the white sulphate of manganese.

2. Nitrate of Manganese.

1648 White oxide. 1. Nitric acid dissolves manganese with effervescence, and with the evolution of nitrous gas. There remains behind a black, spongy mass, which is carburet of iron, and insoluble. The solution thus formed is of a dark colour, on account of the iron which it contains; for it does not appear that the red oxide of manganese combines with nitric acid. The white oxide of manganese dissolves very readily in nitric acid, and without effervescence, or the emission of nitrous gas. This solution, if the oxide be pure, is colourless. It does not afford crystals, even by slow evaporation. The black oxide of manganese cannot be dissolved in nitric acid, but by long digestion; but by adding some vegetable matters, as honey, sugar, oils, or even some of the metals, to deprive the oxide of part of its oxygen, the combination is effected. Carbonic acid gas, which is formed by the union of the carbon of the vegetable matters with the oxygen of the manganese, is given out during the process.

2. Nitrous acid dissolves the oxide of manganese much more readily than the nitric acid. No effervescence takes place, because the oxygen of the manganese combines with the nitrous acid, and forms nitric acid, which latter combines with the oxide of manganese, reduced to the state of white oxide; and thus there is formed, not a nitrite, but a nitrate of manganese.

3. Muriate of Manganese.

1649 White oxide. 1. Manganese is dissolved with effervescence, and with the evolution of hydrogen gas, in liquid muriatic acid. The white oxide combines with the acid, without effervescence, and without the separation of any gas, because it is sufficiently oxidated, to be dissolved in this acid. The black oxide is dissolved with equal facility in muriatic acid as in the other acids. In this case an effervescence takes place, with the disengagement of oxymuriatic acid gas. The nature of this action is obvious. Part of the muriatic acid combines with part of the oxygen of the manganese, and forms oxymuriatic acid, which is disengaged in the state of gas. The black oxide is deprived of part of its oxygen, and converted into the white oxide, which latter dissolves in the remaining part of the muriatic acid, and forms a muriate of manganese. This salt, being a compound of the white oxide of manganese and muriatic acid, may be called the *white muriate of manganese*. If any combustible matter be added, the solution of the black oxide of manganese in this acid goes on, without the production of oxymuriatic acid.

2. Oxymuriatic acid readily parts with its oxygen to manganese, which is thus converted into the white oxide. It combines also with the oxides of manganese, and forms solutions of a brown, red, or violet colour, which afford crystals of the same colour. There is, therefore, a red muriate of manganese.

It is from the black oxide of manganese that oxymuriatic acid is obtained, either by adding to the oxide muriatic acid, part of which combines with the oxygen of the manganese, and is converted into oxymuriatic acid; or, by adding sulphuric acid to a mixture of the black oxide of manganese and muriate of soda. The sulphuric acid decomposes the latter, and the muriatic acid being disengaged, combines with part of the oxygen of the manganese, and forms oxymuriatic acid.

4. Fluate of Manganese.

Fluoric acid has little action on manganese or its oxides; but a fluate of manganese may be formed by double affinity, by adding an alkaline fluate to the nitrate or muriate of manganese. The fluate of manganese thus formed, is not very soluble in water. Its other properties are unknown.

5. Borate of Manganese.

This salt may be formed in the same way as the former. It is equally soluble in water, and its other properties are also unknown.

6. Phosphate of Manganese.

A phosphate of manganese may be formed in the same way as the two former salts. It is not very soluble in water, and its other properties have not been examined.

7. Carbonate of Manganese.

Liquid carbonic acid dissolves a small portion of manganese, as well as of its black oxide. When this solution is exposed to the air, the oxide is gradually precipitated, and appears on the surface in the form of a white pellicle. Bergman has remarked, that during the combination of manganese with carbonic acid, there is evolved an odour somewhat analogous to that of burnt fat.

8. Arseniate of Manganese.

Arsenic acid combines with the white oxide of manganese, and forms an arseniate. The arsenious acid, or white oxide of arsenic, deprives the black oxide of manganese of part of its oxygen, and passes to the state of arsenic acid, and then combines with the manganese, now reduced to the state of white oxide. When the arsenic acid is nearly saturated with the oxide, the solution becomes thick, and small crystals make their appearance. This salt, when heated, does not melt, nor is the arsenic sublimed, without the addition of charcoal.

9. Tungstate of Manganese,
10. Molybdate of Manganese,
11. Chromate of Manganese,
12. Columbate of Manganese.
} Unknown.

13. Acetate of Manganese.

Acetic acid dissolves part of the black oxide of manganese, but acts very feebly on the metal itself. This acid may be employed to separate manganese from iron; for when it is added to a solution containing both these metals, the acid combines with the manganese, 1650 Process for separating iron.

Manganese, &c. nese, for which it has a stronger affinity, and leaves the oxide of iron. Several successive solutions and evaporations are necessary to separate the whole of the iron, which is known when the solution becomes colourless, and when it affords a white precipitate with prussiate of potash. The solution of acetate of manganese does not crystallize, and when evaporated to dryness, it soon deliquesces*.

* *Ann. de Chim.* xli. p. 249.

14. Oxalate of Manganese.

Oxalic acid forms a salt with the oxide of manganese, which, when the solution is saturated, precipitates in the form of white powder. It may be formed also by adding oxalic acid to the sulphate, nitrate, and muriate of manganese in solution.

15. Tartrate of Manganese.

This salt may be formed by double affinity, by adding tartrate of potash to the solution of manganese in sulphuric or nitric acids. The black oxide of manganese is dissolved in tartaric acid, and gives a black coloured solution. When it is heated, an effervescence takes place; the acid is partially decomposed, carbonic acid gas is evolved, and the solution at last becomes colourless.

16. Citrate of Manganese.

Citric acid, in its combination with the black oxide of manganese, exhibits the same phenomena as the former.

17. Benzoate of Manganese.

Benzoic acid readily combines with the white oxide of manganese. By evaporation, crystals in the form of small scales are obtained, which are little altered by exposure to the air, and are soluble in water.

II. Action of Alkalies on Manganese.

1651 Pure alkalies. It has been already stated, that potash acts on the black oxide of manganese, so as to give origin to the absorption of an additional quantity of oxgyen, and the formation of a metallic acid. Soda, in its pure state, has a similar agency. This agency is also exerted with the white oxide of this metal, and with the metal itself. According to some recent experiments of Forhhammer,
1652 Mineral chameleon. it appears that two different acids may be formed in this manner; that, in fact, *chameleon mineral*, in its green state, consists of a *manganeseous* acid in union with potash; and, in its red state, contains the acid formerly mentioned, the *manganesic*.

1653 Ammonia. 2. Scheele had observed the change which ammonia undergoes by the action of oxide of manganese, in the distillation of this oxide with the muriate of ammonia. He suspected that the ammonia was partially decomposed, and to this decomposition he ascribes the formation of a gas, which he obtained by this process, and which he found to be different from carbonic acid. Berthollet has shewn, that in this process, the hydrogen, leaving the ammonia which is decomposed, combines with the oxygen of the oxide of manganese, and forms water; and the azote, the other component part of ammonia, is set at liberty.

A very interesting experiment was contrived by Dr Milner, which illustrates the reciprocal action, and decompositions of the oxide of manganese and ammonia. He filled a tube with oxide of manganese, exposed it to a red heat, and made a stream of ammoniacal gas pass through it. The gas was decomposed, 1654 Curious experiment. and its azote combining with the oxygen of the oxide, formed nitrous gas.

Some of the alkaline salts have peculiar effects on the oxides of manganese and their compounds. The sulphates have the property of destroying the colour of glass, which has been communicated by manganese; but for this effect a high temperature is necessary. The nitrates readily burn this metal, and oxidate it strongly. Melted nitre gives a violet or red colour to glass, which has been rendered colourless, by restoring to it the oxygen of which it has been deprived by the fusion of the glass. With the nitrate of potash and the black oxide of manganese, heated in a crucible to redness, a compound is formed, similar to that which is the result of the direct combination of the oxide with the alkali.

The alkaline phosphates and borates fused by means of the blow-pipe, with the oxide of manganese, produce various colours according to the degree of oxidation, and the intensity of the heat.

A white precipitate is formed, by adding hydrosulphuret of potash to the salts of manganese, and a yellowish-white precipitate is obtained, by means of the triple prussiate of potash.

III. Action of the Earths on Manganese.

There is no action between manganese and any of the earths; but its oxide combines with them, and forms vitreous matters, which are of different colours, according to the degree of oxidation of the manganese, and its mixture with iron. In general, these colours are green, brown, black, or yellowish green. 1655 Colours of glass.

Manganese and its oxides are of great importance, both in chemistry and in the arts. This must be obvious, from the minute detail of its properties and combinations, which has now been given. 1656 Uses.

Sect. XII. *Of Bismuth and its Combinations.*

1. Bismuth, it would appear, was known to the ancients, to the alchemists, and some of the earliest mineralogists; but it was considered merely as a variety of some other metal, and generally of tin and lead. Hence it was distinguished by the name of *green tin*, *gray lead*, and *white antimony*. It was not till the year 1753, when its properties were particularly examined by Pott and Geoffroy the younger, that it was ascertained to be a peculiar metal. Darcet and Rouelle afterwards instituted a set of experiments on this metal, and discovered more of its properties. Monnet and Beaumé investigated its principal combinations at still greater length; and Bergman examined, with more accuracy, some of its compounds and precipitates. 1657 History.

2. Bismuth is found native in the state of sulphuret and in that of oxide. Native bismuth is easily distinguished by its colour, brittleness, and fusibility. The sulphuret of bismuth is of a bluish gray, sometimes with a yellowish shade, and is in irregular masses, or crystallized 1658 Ores.

Bismuth, &c. lized in the form of small prisms. It has a brilliant, lamellated fracture. The native oxide of bismuth accompanies the metal, or is found on the surface of the sulphuret. It is of a greenish yellow colour.

1659 Analysis in the dry way. 3. Bismuth is easily extracted from its ores. The mineral, after being reduced to powder, and well washed, is mixed with about $\frac{1}{2}$ of its weight of black flux, is put into a crucible lined with charcoal, and well covered. It is then exposed to a moderate heat, which must be quickly applied, to prevent the metal from being sublimed. By this process a metallic button is obtained.

1660 Humid way. In the humid way, the ore of bismuth being reduced to powder, is dissolved in nitric acid, and precipitated from this solution by water. If the native bismuth be combined with any other metals, they remain in the solution. The sulphuret of bismuth is also dissolved in the same acid by boiling. The sulphur is separated, as the metal, being oxidated, combines with the acid. The native oxide is treated in the same way, and is precipitated by water.

1661 Properties. 4. Bismuth is of a white colour, inclining to yellow, exhibiting a texture composed of large brilliant plates. Its specific gravity is 9.822. It has scarcely either tase or smell. By a violent stroke of the hammer it is broken, and divides into small fragments of a lamellated structure; the figure of its particles is the regular octahedron. It has considerable hardness; and by hammering, its density may be increased. It has very little elasticity, and no ductility. Bismuth is very fusible. When it is exposed to the temperature of 490°, according to Guyton, it melts; and, if after fusion it be allowed to cool slowly, it crystallizes in parallelopipeds which cross each other at right angles. This metal crystallizes more easily and more regularly than any other yet known. If the heat be long continued after the fusion, and sufficiently strong; and if the process be conducted in close vessels, it sublimes, and attaches itself to the upper part of the apparatus, where it crystallizes in brilliant plates.

5. Bismuth is but slightly affected by exposure to the air in the cold. It loses its brilliancy, and is covered with a fine powder of a yellowish gray colour; but, when it is heated in contact with air, the surface is soon covered with an iridescent pellicle, which, by agitation and continuing the heat, is converted into a greenish gray or brown-coloured oxide. It acquires about $\frac{1}{12}$ of addition to its weight. By continuing the heat, and occasionally stirring the fused metal, it becomes of an orange-yellow colour, and acquires a farther addition to its weight. If the metal in fusion be exposed to a red heat, it takes fire with a slight explosion, burns with a bluish flame, and is sublimed in the form of a

1662 Two oxides, brown and yellow. yellowish vapour, which, being condensed and collected, is known under the name of *flowers of bismuth*. It appears then, that bismuth combines with oxygen in two proportions. The first, or the smaller proportion, is that of the brown oxide; and the second is the yellow oxide or flowers of bismuth.

1663 Phosphuret. 6. There is no action between bismuth and azote, hydrogen, or carbon. It combines but in very small proportion with phosphorus, forming a phosphuret. When phosphorus is dropped into bismuth in fusion, it seems to unite with it, according to Pelletier, in the proportion of four parts in the hundred. But the properties of the bismuth are very little changed.

7. Sulphur unites readily with bismuth. When equal parts of bismuth and sulphur are heated together in a crucible, the fusion of the metal is greatly retarded. It requires a higher temperature than when the metal is alone. The sulphuret of bismuth is of a shining dark gray colour, and crystallizes by proper cooling into needle-form prisms, shaded with splendid blue and deep-red colours. The crystals are obtained by piercing the surface when it becomes solid after fusion, and pouring out the liquid parts; a cavity is thus left in which they are formed. 1664 Sulphuret.

Sulphurated hydrogen gas occasions a dark colour on the surface of bismuth, and converts the oxides into a deep black colour, which is the commencement of reduction.

8. Bismuth combines with many of the metals, and forms alloys; but its combinations with the metals, already described, are little or scarcely at all known. Bismuth also combines with the acids, and forms salts. 1665 Alloys and salts.

9. The affinities of bismuth and its oxides are arranged by Bergman in the following order: 1666 Affinities.

Bismuth.	Oxide of Bismuth.
Lead,	Oxalic acid,
Silver,	Arsenic,
Gold,	Tartaric,
Mercury,	Phosphoric,
Antimony,	Sulphuric,
Tin,	Muriatic,
Copper,	Nitric,
Platinum,	Fluoric,
Nickel,	Saclactic,
Iron,	Succinic,
Sulphur.	Citric,
	Lactic,
	Acetic,
	Prussic,
	Carbonic.

I. Salts of Bismuth.

1667 Different from other metallic solutions. The solutions of bismuth in the acids, and also the crystallized salts which are obtained from them, resemble each other, but differ from almost all other metallic solutions, as well as from all other salts; and particularly in one circumstance, which is, that water in sufficient quantity decomposes them, and precipitates an oxide of bismuth of a white colour. This shows that bismuth is strongly oxidated by the action of the acids, to which it adheres with no great affinity, and that it forms with them compounds which are not very permanent. It seems at the same time remarkable, that this metal should be more oxidated in this way, than by the usual process of oxidation, by means of heat, and by the action of water; and that it should have a white colour, while in the usual way it is of a yellowish gray.

1. Sulphate of Bismuth.

Concentrated sulphuric acid has no action on bismuth in the cold; but this metal decomposes the acid at a boiling temperature. Sulphurous acid gas is disengaged, and the bismuth is oxidated, and converted into

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Bismuth, &c.

into a white powder. If the heat be strong, sulphur is sublimed. When the remaining mass is washed with water, it carries off the remaining acid and a small quantity of the oxide of bismuth. The solution, by proper evaporation, affords small soft needle-formed crystals, which are sulphate of bismuth. This sulphate is decomposed by water, which separates a white oxide.

2. Sulphite of Bismuth.

Sulphurous acid has no action on bismuth; but it unites with its oxide, and forms a white sulphite, which is insoluble in water, and even in its own acid; of a sulphurous taste; fusible by the blow-pipe into a reddish yellow mass, which is reduced on charcoal into metallic globules; decomposed with effervescence by means of sulphuric acid; giving out by distillation sulphurous acid, and leaving behind a pure white oxide.

3. Nitrate of Bismuth.

1668 Violent action.

1. Nitric acid exhibits a very violent action with bismuth. When the acid is a little concentrated, and the bismuth in the state of powder, there is a violent effervescence, with the evolution of nitrous gas. There is at the same time great heat produced. The bismuth is converted into white oxide at the expence of the acid, and when the action ceases, if no more acid be added than what is necessary to its oxidation, remains dry.

1669 Properties.

2. The nitric solution, thus prepared, is colourless, and affords crystals by evaporation. It crystallizes in tetrahedral prisms, compressed into obtuse three-sided summits. It has sometimes been obtained in flattened rhomboïdal parallelopipeds, similar to those of Iceland crystal. When this salt is thrown on red hot coals, it melts, boils, and frothes up; exhales nitrous vapour, and leaves behind a greenish yellow oxide. It dries in the air, and becomes moist when the air is humid. When it is brought into contact with water, it becomes turbid, is decomposed, and a white oxide is precipitated. The decomposition is effected with the nitric acid, which is poured gradually into a large quantity of water. The oxide which is thus obtained was formerly called *magistery of bismuth*. It is known in the shops by the name of *pearl white*. It becomes of a deep gray, brown, or even black colour, when it is exposed to the action of sulphurated hydrogen gas.

4. Muriate of Bismuth.

1670 Preparation.

Muriatic acid has but a feeble action on bismuth. It is necessary to assist its action, that the acid be concentrated, and long digested with the metal, or distilled off it in the state of powder. During the process, a fetid odour is emitted, which is owing to the decomposition of water, its oxygen combining with the metals, and the hydrogen being set at liberty. By evaporating this solution, small needles of muriate of bismuth are obtained; but only in very small quantity; for the greatest part of the oxide of bismuth is separated by water. The muriate is sublimed by heat into a thick, solid, fusible matter, which was formerly called *butter of bismuth*. It is deliquescent, and may be decomposed by water, which separates a very fine white oxide.

Oxymuriatic acid readily dissolves bismuth, and forms with the oxide, which is previously produced, a salt similar to the preceding.

5. Fluate of Bismuth.
6. Borate of Bismuth.

These two salts may be formed by adding a fluate or borate of an alkali to a solution of nitrate of bismuth. A white precipitate is formed of the fluate or borate of bismuth; but little is known of their properties.

7. Phosphate of Bismuth.

This salt is formed by combining the acid with the oxide of the metal, when precipitated by an alkali. The phosphate of bismuth is in the state of an insoluble white powder.

8. Carbonate of Bismuth.

This salt may be formed by precipitating the oxide of bismuth from its solution in acids, by means of an alkaline carbonate.

9. Arseniate of Bismuth.

Arsenic acid acts upon bismuth with the assistance of heat. A white powder appears on the surface of the metal, and the oxide is precipitated from the solution, by adding water. The arseniate of bismuth may be formed by adding arsenic acid to a solution of the nitrate of bismuth. The arseniate of bismuth falls to the bottom in the form of precipitate.

10. Tungstate of Bismuth.

Unknown.

11. Molybdate of Bismuth.

Muriate of bismuth is precipitated, if there be no excess of acid, by molybdic acid. The molybdate of bismuth, thus formed, is of a white colour.

12. Chromate of Bismuth, }
13. Columbate of Bismuth. } Unknown.

14. Acetate of Bismuth.

This salt may be formed, by adding a solution of acetate of potash to a solution of nitrate of bismuth. A precipitate of acetate of bismuth is formed. The addition of acetic acid to the nitrate of bismuth, Guyton observes, prevented the latter from being precipitated by means of water.

15. Oxalate of Bismuth.

Oxalic acid combines with the oxide of bismuth, and forms with it a salt in the state of white powder, which is scarcely soluble in water. Oxalic acid added to nitrate of bismuth, occasions a precipitate in the form of small transparent crystals, which are oxalate of bismuth.

16. Tartrate of Bismuth.

Tartaric acid added to the solution of bismuth in any of the mineral acids, precipitates the oxide in the form of a white powder, which is the tartrate of bismuth, and is insoluble in water.

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17. Benzoate of Bismuth.

Benzoic acid combines readily with the oxide of bismuth. The solution, by evaporation, affords crystals in the form of needles. They undergo no change by exposure to the air, are soluble in water, and decomposed by sulphuric and muriatic acids. This salt is also decomposed by heat, which drives off its acid.

18. Succinate of Bismuth.

Succinic acid combines with the oxide of bismuth, at a boiling heat. By evaporating the solution, crystals of succinate of bismuth are obtained, in the form of plates, and of a yellow colour.

II. Action of Alkalies, Earths, and Salts, on Bismuth.

1671 Alkalies. 1. Scarcely any thing is known of the action of the alkalies on bismuth. Ammonia, it is said, communicates to it a yellow colour, and the oxide of bismuth is soluble in ammonia in the liquid state.

1672 Silica. 2. The oxide of bismuth combines by fusion with silica, to which it communicates a greenish yellow colour.

1673 Salts. 3. Bismuth is not changed by the action of the sulphates or sulphites. It is oxidated by the nitrates. When it is strongly heated, and thrown into a red-hot crucible with nitrate of potash, it detonates feebly, and without much inflammation. It is reduced to the state of oxide, of which one part combines with the potash. Bismuth has no action on muriate of ammonia, but its oxide very readily decomposes this salt. In the cold, it disengages a little ammonia, by simple trituration; but when exposed to heat, it is totally decomposed, and there remains a muriate of bismuth.

1674 Uses. 4. Bismuth is applied to a great many uses. It forms some important alloys with the softer metals, to give them hardness and consistency. The oxides of bismuth are of still more extensive utility. It is employed in this form by the manufacturers of porcelain, for the preparation of yellow enamels, and it is mixed with other oxides, to give variety of shade to their colours. It is sometimes employed in the fabrication of coloured glasses, to communicate a greenish yellow. The white oxide, which is most commonly employed for these different purposes, is also employed as a paint for the skin, under the name of *pearl white*; but it is extremely improper for this purpose, for besides the injury which it does to the skin, it becomes black, when it is exposed to the action of sulphurated hydrogen gas. It is sometimes used also to give a black colour to the hair.

Sect. XIII. *Of Antimony and its Combinations.*

1675 History. 1. It does not appear that the ancients were acquainted with antimony as a distinct metal, although it is supposed that it was employed by them in alloys of other metals. It is said, that they were acquainted with the oxide of antimony, and that it was employed as an external remedy in inflammation of the eyes. As a peculiar metal it was not certainly known till the time of Basil Valentine, who lived about the end of the 15th century. In his work, entitled *Currus Triumphalis Antimonii*, he has detailed all that was then known of this metallic substance, and he has particularly described the process by which it is extracted from its ore.

No substance has been more the subject of investigation than antimony, and on no subject, perhaps, has there been so much written. The alchemists regarded antimony as peculiarly appropriate to the object of these researches. Their labours on this subject were almost incredible; and indeed this is scarcely to be wondered at, since it appears that they were inspired with the hope of making, by its means, the fortunate discovery of the universal medicine. It was therefore tortured and tried in every possible way, to obtain the object of their researches; and on this account it is almost impossible to reckon up the number of medicinal preparations which were proposed and employed with this metal and its ores. It is owing to these views and researches concerning antimony, that its nature and properties are now so fully known.

2. About the end of the 17th century, Lemery published a treatise, which was the first correct and rational account of antimony. In this he arranged and detailed the discoveries of his predecessors, and added some of his own, with a number of curious experiments and accurate processes for many of the preparations of antimony and its sulphuret. Mender afterwards published a very complete history of all the facts that were then known concerning antimony; and it has been since examined by more modern chemists; among whom Bergman, Scheele, Berthollet, Proust, and Thenard, are the principal writers on this subject.

1676 Ores. 3. Antimony exists in nature in four different states: In the state of native antimony, that of sulphuret, hydrosulphuret of the oxide of antimony, and muriate. Native antimony is easily distinguished by its colour and brilliancy. It has been found in Sweden and in France. The most common ore of antimony is the sulphuret, which is of a grayish colour, and stains the fingers. It is sometimes crystallized in square prisms, which are slightly rhomboidal, and terminated by four-sided pyramids. The hydrosulphurated oxide of antimony is in shining filaments, of a deep red colour, disposed in rays going from a common centre, adhering to the surface or cavities of the sulphuret. The muriate of antimony, which is a rare production, is of a brilliant, pearly-white colour, in the form of small divergent needles, somewhat resembling radiated zeolite.

1677 Analysis. 4. To obtain the pure metal from the sulphuret of antimony, the ore is first roasted, to separate the greatest part of the sulphur. It is then mixed with its own weight of black flux, formed into a paste with oil, and exposed to a strong heat in a crucible, at the bottom of which the metal is found reduced. By a shorter process, eight parts of sulphuret of antimony, six of tartar, and three of nitre, reduced to powder, and well mixed, are projected in small quantities into a red-hot crucible. At each projection there is a strong detonation; the tartar forms, by means of the nitre, a black flux, and the sulphuret being burnt, the metal is fused, but not oxidated, on account of the charcoal of the tar-

tar.

tar with which it is surrounded, and the liquid alkali which covers it. The whole is then fused in a conical iron pot; and, when it is cool, the metallic antimony is found at the bottom, marked on its surface with needle-shaped crystals, arranged in the form of a star.

1678 Properties.

5. Antimony, in a state of purity, is of a brilliant white colour, having a good deal of resemblance to that of silver or tin. It has a lamellated texture, composed of plates which cross each other in all directions. It exhibits sometimes perceptible traces of crystallization. The form of the crystals, which was discovered with difficulty by Hauy, on account of its complicated structure, is the octahedron, composed of a great number of regular tetrahedrons. Antimony has a very perceptible taste and smell, and particularly if it is rubbed for some time on the hands. The specific gravity is 6.702. It is very brittle, so that it can be reduced to powder, which is of a grayish white colour.

1679 Action of water.

6. Antimony undergoes no change by being exposed to the air, nor is there any perceptible action between antimony and water in the cold; but when water comes in contact with antimony red-hot, it is instantaneously decomposed, and accompanied with a violent detonation, and a very brilliant white flame. Accidents of this kind have happened, attended with considerable danger.

1680 Of heat.

7. When antimony is heated to the temperature of 808°, it melts. If the heat be continued after its fusion, it is sublimed, and if the process be performed in close vessels, it is condensed in shining crystallized plates. If it be allowed to cool slowly, and part of it be poured off when the surface becomes solid, the cavity is lined with pyramidal crystals, composed of small octahedrons.

1681 Oxides.

8. When antimony is kept in fusion in the open air, it rises in the form of white vapour, which is precipitated on the surface of the metal, or upper part of the crucible, and crystallizes in long prisms, or in small, white, brilliant needles. This is an oxide of antimony, which was formerly called *argentine flowers*, or *snow of regulus of antimony*. By this process it is found, that the antimony has acquired an addition of weight of about 50 per cent. This oxide may be obtained, by exposing the antimony in a crucible to a white heat, and then by suddenly agitating it in contact with air, it takes fire with a kind of explosion, and burns with a white light.

Thenard, in his researches concerning antimony, distinguishes six different degrees of oxidation of this metal. But in a memoir on the same metal by Proust, he considers that the oxides of antimony may be reduced to two. According to the experiments of this chemist, 100 parts of antimony treated with nitric acid in a retort, uniformly afford 130 of a yellow oxide in the state of powder. It is reduced to 126 by washing with water before drying it, because the nitric acid dissolves a small proportion. This oxide is not reduced by being exposed to a red heat, but it is sublimed, and condensed in close vessels, in groups of crystals. It is insoluble in water. It is the same oxide which was formerly distinguished by the name of *argentine flowers*. The component parts of this oxide, according to Proust, are,

Antimony	77
Oxygen	23
	100 *

The oxide, with a smaller proportion of oxygen, is formed by dissolving antimony in muriatic acid; and by adding water to the solution, a white powder is precipitated, which being washed, is separated from any acid that may adhere to it. To purify it still more, it is to be boiled with carbonate of potash, and afterwards washed, and dried on a filter. This oxide is of a yellowish white colour, and has little brilliancy; it melts at a moderate red heat, and when it is allowed to cool, it crystallizes on the surface. The crystals are of a yellowish white colour, which are thrown together in heaps, in a radiated form. This oxide was formerly known by the name of *powder of algaroth*. Its component parts are,

Antimony	81.5
Oxygen	18.5
	100.0 †

* *Jour. de Phys.* lv. p. 332.

† *Ibid.*

9. There is no action between antimony and azote, hydrogen, or carbon.

1682 Phosphuret.

10. Antimony enters into combination with phosphorus, and forms with it a phosphuret. Equal parts of phosphoric glass and antimony are fused together in a crucible, or with the addition of ⅛ of charcoal, or by projecting pieces of phosphorus on the metal in fusion in a crucible; and thus a phosphuret of antimony is obtained. The phosphuret has a metallic lustre, is brittle, and has a lamellated fracture. When it is placed on burning charcoal, it melts, gives out a small green flame, and is converted into the white oxide of antimony, which is sublimed.

1683 Sulphuret.

11. Antimony combines very readily with sulphur, and forms with it an artificial sulphuret, which is exactly similar to the native sulphuret. It is formed by mixing the antimony and the sulphur together, and fusing them in a crucible. This sulphuret is of a brilliant gray colour, is more fusible than the metal itself, and by slow cooling, may be obtained in crystals. The component parts of the sulphuret, according to Proust, are,

Antimony	75.1
Oxygen	24.9
	100.0

1684 Oxides with sulphur.

12. The yellow oxide of antimony combines with different proportions of sulphur, and forms compounds of different colours, and which were formerly distinguished by different names. With eight parts of the oxide and one part of the sulphuret, a red-coloured, semitransparent mass is obtained, which was formerly called *glass of antimony*. When two parts of sulphuret are added to eight parts of the oxide, a yellowish mass is formed, which was known by the name of *crocus metallorum*. Six parts of oxide and one of sulphur, form a dark red opaque mass, with a vitreous fracture, which is the true *liver of sulphur*. In these combinations,

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Antimony, &c. tions, the sulphur deprives the oxide of part of the antimony, and combines with it, forming a sulphuret. This sulphuret then combines with the oxide †.

† Journ de Physique, lv. p 330.

1685 Affinities. 13. Antimony enters into combination with the acids, and forms salts. It also forms alloys with many of the metals. The affinities of antimony and of its oxides are, according to Bergman, in the following order :

Antimony.	Oxide of Antimony.
Iron,	Muriatic acid,
Copper,	Oxalic,
Tin,	Sulphuric,
Lead,	Nitric,
Nickel,	Tartaric,
Silver,	Saclactic,
Bismuth,	Phosphoric,
Zinc,	Citric,
Gold,	Succinic,
Platinum,	Fluoric,
Mercury,	Arsenic,
Arsenic,	Lactic,
Cobalt,	Acetic,
Sulphur.	Boracic,
	Prussic,
	Carbonic.

I. Salts of Antimony.

1. Sulphite of Antimony.

Sulphuric acid has no action on antimony in the cold. At a boiling temperature the acid is decomposed; sulphurous acid gas is emitted with effervescence, and if distilled in a retort to dryness, sulphur is sublimed. There remains a white oxide of antimony. If this mass be washed with water, the acid which adheres to it is carried off, with a small portion of the oxide; and what remains is the white oxide, which is insoluble. By adding a large quantity of water to the solution, the oxide which it had carried off is precipitated; but this solution being evaporated yields no crystals. It is decomposed by the earths and the alkalies, which precipitate a white oxide. Sulphuric acid, therefore, oxidates antimony, but does not seem to have the property of forming a salt.

2. Sulphate of Antimony.

Sulphurous acid, with the assistance of heat, is decomposed by antimony. The metal is oxidated, and there is formed a sulphite of antimony. This salt may be also obtained by adding sulphurous acid to the solution of antimony in muriatic acid. A white precipitate appears, which is insoluble, of an acrid, bitter taste, and is decomposed by heat. When it is distilled in close vessels, it yields a little sulphurous acid, then sulphuric acid, and the residuum is a reddish brown mass, which is soluble in fixed alkali, and may be precipitated by means of muriatic acid, into a hydrosulphuret of antimony.

3. Nitrate of Antimony.

Nitric acid is rapidly decomposed by antimony, even in the cold. There is evolved a great quantity of nitrous gas, and sometimes the rapidity of the oxidation is such, that it is accompanied with actual combustion. The water also is partially decomposed. The antimony is converted into a white oxide. The hydrogen of the water combines with the azote of the acid, and forms ammonia, which combines with part of the nitric acid, and the compound is nitrate of ammonia. The small quantity of oxide of antimony which is dissolved in nitric acid, is precipitated by water, so that it adheres very slightly to the acid.

4. Muriate of Antimony.

Muriatic acid acts on antimony very feebly. By digesting the metal with the acid for a long time, it dissolves a small quantity, and the solution becomes of a yellowish colour. The white oxide is more soluble in this acid, and forms with it a colourless solution. The first solution yields crystals by evaporation, in the form of small needles, which are deliquescent, and sublimed by heat, and are precipitated and decomposed by water. The solution formed with the oxide is fixed in the fire, and crystallizes in brilliant plates. It is also decomposed by water. Muriatic acid dissolves more readily the sulphuret of antimony, for it does not require the aid of heat. There is disengaged a strong odour of sulphurated hydrogen gas. When the mixture is heated, the whole of the metal is dissolved.

Nitromuriatic acid dissolves antimony more readily than any of the acids which have been mentioned. This solution is colourless. The muriate of antimony which remains after the evaporation, by being distilled, comes over of a thicker consistence, in proportion as it is concentrated. The muriate of antimony was formerly called *butter of antimony*. It is of a grayish white colour, and sometimes crystallizes in four-sided prisms. It is deliquescent in the air, and extremely caustic and corrosive. When it is diluted with water, a white powder is precipitated, which is the *powder of algaroth*.

5. Fluate of Antimony.

6. Borate of Antimony.

Fluoric and boracic acids have no action on antimony, but combine with its oxide, or precipitate it from its solution in acids, in the form of white powder, forming a fluate or borate of antimony.

7. Phosphate of Antimony.

Phosphoric acid combines with the oxide of antimony. The solution, by evaporation, yields a blackish green mass.

8. Phosphate of Lime and Antimony.

This triple salt is formed by calcining together equal parts of sulphuret of antimony and the ashes of bones; or, according to the process recommended by Mr Chenevix, by dissolving white oxide of antimony and phosphite of lime in equal parts in muriatic acid; and then by adding this solution to a sufficient quantity of distilled water, which contains pure ammonia. A precipitate is formed in the state of white powder. This 1686 James's powder.

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Antimony, &c. This powder is nearly insoluble in water. It has been long known as a diaphoretic and emetic, under the name of *James's Powder*. According to the analysis of Dr Pearson, it is composed of

Phosphate of lime	43
Oxide of antimony	57
	100

9. Carbonate of Antimony.

Unknown.

10. Arseniate of Antimony.

By digesting together arsenic acid and antimony, a white powder is obtained, which is arseniate of antimony. Muriatic acid dissolves this powder, but it may be separated by adding water. This salt may be formed, also, by adding an alkaline arseniate to the solution of antimony in muriatic, tartaric, or acetic acids.

11. Molybdate of Antimony.

Muriate of antimony is precipitated by molybdic acid; and if the acid be not in excess, the precipitate is white.

12. Acetate of Antimony.

Acetic acid dissolves a small portion of the oxide of antimony, and according to some, yields small crystals. The acetate of antimony has been employed as an emetic.

13. Oxalate of Antimony.

Oxalic acid combines with the oxide of antimony, and the solution affords crystals in the form of small grains, which are scarcely soluble in water.

14. Tartrate of Antimony.

Tartaric acid also combines with a small portion of the oxide of antimony, and affords a salt which assumes the form of a jelly.

15. Tartrate of Potash and Antimony.

This triple salt was formerly prepared by boiling together the preparation of what was called crocus metallorum, and tartar, in water. But if the white oxide be mixed with its own weight of tartar, and the mixture boiled in 10 or 12 parts of water, till the tartar be saturated, and the solution filtered and evaporated, crystals are obtained, which are crystals of the tartrate of potash and antimony, which have been long and better known by the name of *tartar emetic*. This salt is of a white colour, and it crystallizes in regular tetrahedrons. It effloresces by exposure to the air, and is soluble in 80 parts of cold, and in half that quantity of water at the boiling temperature. When it is exposed to heat, it is decomposed. It is also decomposed by the alkalies and their carbonates.

1687 Tartar emetic.

According to the analysis of Thenard, this salt is composed of

Antimony	38
Acid	34
Potash	16
Water	8
	96, loss 4.*

This salt has been greatly employed as a diaphoretic and emetic, from which property it has derived its name. An account of the mode of preparing a similar powder, which, it is said, was invented by an earl of Warwick, and became famous in Italy as a powerful and effectual medicine, was published in Italy, in the year 1620. The preparation of tartar emetic itself was first published in 1631.

* Ann. de Chim. xxxvi. p. 39.

16. Benzoate of Antimony.

Benzoic acid combines with the oxide of antimony, and, by evaporating the solution, crystals are obtained. This salt is not altered by exposure to the air, but it is readily decomposed by heat.

II. Action of Alkalies, &c. on Antimony.

1688 Alkalies.

1. All the alkalies have a peculiar action on the sulphuret of antimony. Sulphuret of antimony and potash form a preparation which is known by the name of *kermes mineral*, a name which it derives from the red animal called *kermes*. This is prepared in the dry way by mixing together one part of sulphuret of antimony and two of potash, and in proportion to the quantity of sulphuret, add a sixteenth part of sulphur. Fuse the mixture in a crucible, and pour it into an iron mortar. When it is cool, reduce it to powder, and boil it in water; filter the liquid, and as it cools, a reddish brown powder is deposited. Wash the precipitate, first with cold and then with boiling water, till it comes off insipid. It may be prepared in the humid way, by boiling 10 or 12 parts of pure liquid alkali with two of sulphuret of antimony, for half an hour, and then filtering the liquid; the kermes is deposited as it cools.

The compound which is first formed, is a hydrosulphuret of potash and antimony. When boiling water is added in sufficient quantity, the whole is dissolved, but the solution becomes turbid in cooling, and divides into two parts; the one, which is deposited in the form of a reddish brown powder, is the kermes mineral, and the other which remains in solution, containing a smaller proportion of sulphur and oxide of antimony than the former, has been distinguished by the name of *golden sulphur*. The cause of the separation is, that the alkali, if it is not in great quantity, cannot hold the sulphurated oxide of antimony in solution while it is cold. What remains in solution after the spontaneous precipitation, contains a greater proportion of sulphur, and less of the oxide of antimony. When an acid is added to this solution, another precipitate is formed, which is of an orange yellow colour, from the greater proportion of sulphur, and on this account has been called *golden sulphur*. Kermes mineral, or the hydrosulphuret of antimony, according to Thenard, contains the following proportions.

Brown

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Antimony, &c.

Brown oxide of antimony	72.760
Sulphurated hydrogen	20.298
Sulphur	4.156
Water and loss	2.786
	100.000

From the analysis of the same chemist, the golden sulphur, or *sulphur auratum*, is also a hydrosulphuret, having a greater proportion of sulphur, and a smaller proportion of the oxide. The component parts are the following:

Brown oxide of antimony	68.300
Sulphurated hydrogen	17.877
Sulphur	12.000
	98.177*

* *Ann. de Chim.* xxxii. p. 277.

1689 Earths. 2. The oxide of antimony has the property of combining with some of the earths during their vitrification, and communicating to them different shades of colour, more or less yellow and orange.

1690 Salts. 3. Most of the salts have a peculiar action on antimony or its sulphuret. By fusing in a crucible two parts of sulphuret of potash and one of antimony, the metal disappears, and a vitreous mass of a yellow colour is formed, which has a caustic property. Dissolved in hot water, it affords, on cooling, a hydrosulphuret of antimony. The antimony has carried off the oxygen of the acid, and combined in the state of oxide, with the sulphuret of potash, which is formed by the sulphur of the acid uniting with the potash during the process.

The nitrates have a powerful action on antimony and its sulphuret. A mixture of two or three parts of nitrate of potash and one of antimony in fine powder, well rubbed together in a mortar, produces a lively detonation, by throwing it on burning coals, or projecting it into a red-hot crucible, or heating it to redness in a close vessel. This detonation is accompanied with a bright white flame: and the antimony is strongly oxidated by the oxygen of the nitre, which is decomposed, and reduced to its alkaline base. The residuum of this detonation is a white scorified mass, which being washed with water, leaves a portion of the oxide of antimony united to a small quantity of potash, and affords, besides, another compound, with more of the alkali. The white matter which is first deposited, has been called *washed diaphoretic antimony*. The water which remains holds in solution a portion of metallic oxide, united to the potash of the nitre. The oxide in this case performs the part of an acid. This compound has been found susceptible of crystallization. It is decomposed by acids, and the precipitate from it, which is an oxide of antimony, has been distinguished by the names of *ceruse of antimony*, *magistery of diaphoretic antimony*, and *pearly matter of Kerkringius*.

When equal parts of nitre and sulphuret of antimony are treated in the same way, a vitrified mass is obtained, similar to what has been already described by the name of *liver of antimony*.

III. Alloys.

Tellurium, &c.

Antimony enters into combination with the metals, and forms alloys with them, some of which are of considerable importance. But the alloys of antimony, with the metals already described, are either little known, or have been applied to no use. The alloys of cobalt and nickel, with antimony, have not been examined. With manganese antimony forms but an imperfect alloy, and the compound of antimony and bismuth is very brittle.

Besides the various preparations of antimony used in medicine, which are now comparatively but few in number, it is much employed in many arts. In the metallic state it is of the greatest importance as an alloy with other metals which will be afterwards mentioned. In the state of oxide, it is much used in the fabrication of coloured glass, and of enamels for pottery and porcelain: particularly in forming different shades of brown, orange, and yellow colours. The oxide is mixed with different other metallic oxides, to produce various shades of colour. 1691 Uses of antimony.

Sect. XIV. *Of Tellurium and its Combinations.*

1. In the year 1782, Muller of Richenstein, in examining a gold ore, distinguished by the names of *aurum paradoxum* and *aurum problematicum*, conjectured that it contained a peculiar metal. Bergman, to whom this mineralogist had sent a specimen of the mineral, could not, from the small quantity which he had received, ascertain whether it was really a new metal, or merely antimony, with which it possesses some common properties. He inclined, however, to the former opinion. This mineral was analyzed by Klaproth in the end of the year 1797, the account of which was published in 1798. By this analysis the conjecture of Muller was verified, and to the new metal Klaproth gave the name of *tellurium*. 1692 History.

2. This metal has been found in four different minerals. First, In that in which Klaproth first detected it, which is called *white gold ore*, a mineral found in the mountains of Fatzbay in Transylvania. In this mineral the tellurium is combined with iron and gold. The second is what is called *graphic gold ore*, which is composed of tellurium, gold, and silver. The third is known by the name of *yellow gold ore of Nagyag*. This mineral contains, besides tellurium, gold, silver, and a little sulphur. The fourth is a variety of the last, and is denominated *gray gold ore*. Besides the metals in the former, it contains a little copper. To obtain the metal from the ore, a quantity of it is slightly heated with six parts of muriatic acid, and having added three parts of nitric acid, it is then boiled. A considerable effervescence takes place, and the whole is dissolved. The solution being diluted with distilled water, is mixed with a solution of caustic potash, to dissolve the precipitate; and there remains only a brown, flaky matter, formed of the oxides of gold and iron. The alkaline solution of the oxide of tellurium is mixed with muriatic acid, to saturate the potash, and there is deposited a copious, very heavy, white powder. By forming this powder into a paste with oil, and heating it to

to redness in a small glass retort, the metal is obtained, partly fused and crystallized at the bottom of the retort, and partly sublimed at the upper part.

1693 Properties.

3. Tellurium is of a white colour, somewhat resembling lead, and has a considerable lustre. It is very brittle, and may be easily reduced to powder. It has a lamellated texture, similar to antimony. By slow cooling it assumes a crystalline form, especially on the surface. Its specific gravity is 6.115. It is one of the most fusible of the metals, and when heated in close vessels it boils readily, and is sublimed in the form of brilliant globules, which adhere to the upper part of the vessels.

1694 Action of heat.

4. When tellurium is heated by the action of the blow-pipe on charcoal, it burns, after being melted, with a lively flame, of a blue colour, and green at the edges. It is entirely volatilized in the form of a grayish white smoke, diffusing a fetid odour, which Klaproth compares to that of radishes.

The oxide of tellurium is very fusible. By heating it in a retort, a yellow, straw-coloured mass is obtained, which assumes a radiated texture on cooling. When the oxide is heated on charcoal, and surrounded with it, it is so rapidly reduced, that it is accompanied with a kind of explosion.

1695 Sulphuret.

5. Tellurium enters into combination with sulphur, and forms with it a sulphuret. This sulphuret is of a grayish colour, of a radiated structure, and is easily crystallized.

I. Salts of Tellurium.

1. Sulphate of Tellurium.

One part of tellurium mixed in the cold, in a close vessel, with 100 parts of concentrated sulphuric acid, communicates to it a beautiful crimson colour. By adding water drop by drop to this solution, the colour vanishes, and the metal is deposited in the form of black flakes. When the solution is heated, the colour also disappears, and the oxide of tellurium is gradually precipitated in the state of white powder; but when diluted sulphuric acid is employed, with the addition of a small quantity of nitric acid, a larger portion of tellurium is dissolved. The solution is transparent and colourless, and is not decomposed by adding water.

2. Nitrate of Tellurium.

Nitric acid readily dissolves tellurium, and forms a transparent, colourless solution, which being concentrated, spontaneously affords small, light, white, needle-shaped crystals, disposed in a dendritical form.

3. Muriate of Tellurium.

Nitromuriatic acid very readily dissolves tellurium, which is precipitated by adding a considerable quantity of water in the form of oxide. This is a white powder, which is soluble in muriatic acid.

The infusion of nut-galls added to solutions of tellurium in acids, occasions a flaky precipitate, which is of a yellow colour.

II. Action of Alkalies and Earths.

1696 Alkalies and earths.

1. All the pure alkalies precipitate the solutions of tellurium in acids, in the form of white oxide. With an excess of alkali the precipitate is redissolved. With the alkaline carbonates a precipitate is obtained, which is much less soluble in excess of alkali.

2. The alkaline sulphurets added to solutions of tellurium in acids, produce a brown or black precipitate, as the metal is more or less oxidated. This precipitate sometimes resembles the hydrosulphurets of antimony. The hydrosulphuret of tellurium thus formed, exposed to heat on burning coals, burns with a small blue flame, and is volatilized in white smoke. No precipitate is formed by the prussiate of potash.

3. The action of the oxide of tellurium with the earths is not known; but from its great fusibility, it has been supposed that it is susceptible of forming a vitreous matter with the earths, and communicating to them a straw colour.

III. Action of metals.

The alloys of tellurium are unknown. 1697

Tellurium is separated from its solutions in acids, by zinc and iron, in the form of small, black flakes, which may be reduced to the metallic state on burning charcoal, or even by simple friction. Antimony causes a similar precipitation in a solution of nitrate and sulphate of tellurium. Tin produces a similar effect. 1698

Precipitated by zinc and iron.

Tellurium has hitherto been found in such small quantity, that it has not yet been applied to any use. Were it found in abundance, it has been supposed, from its easy fusibility, that it might be of considerable importance in some of the arts.

Uses.

Sect. XV. *Of Selenium.*

1699 History and properties.

This metal is contained in minute quantity in the pyrites of Fahlun in Sweden, and was discovered in consequence of the attention of Berzelius being directed to a red precipitate, which appeared in the manufacture of sulphuric acid from the sulphur of that mineral. From the odour of this substance, he conjectured it at first to contain tellurium, but found it to be a new metal, which, from its analogies to tellurium, he named from the moon *selenium*. It has a gray colour, and a brilliant metallic lustre. It becomes soft at 212, and fuses a few degrees higher. When cooling, it shews great ductility, admitting of being kneaded between the fingers, and drawn out into fine threads. When cold, it shows a granulated fracture, or rather crystalline or radiant, like that of a piece of sulphur. It gives a fine blue tinge to the flame of the blow-pipe, and exhales a smell of horse radish, so strong, that $\frac{1}{50}$ of a grain is sufficient to give a complete impregnation to the air of a large apartment. It combines with most of the metals, often with ignition. With the fixed alkalies it forms compounds of a cinnabar red colour. In fixed oils it forms red-coloured solutions. The nitric acid, in acting on this metal, oxidizes it to such a degree, that the compound is found to possess the qualities of an acid, and has been so considered, under the name of the *selenic*.

Sect. XVI. *Of Mercury and its Combinations.*

1700 History.

1. Mercury appears to have been known from the earliest ages. By comparing its properties with silver, and being in the fluid state, it has been called *quicksilver*. Mercury was long the subject of the researches of

of the alchemists, with the view of discovering the method of transmuting it into gold or silver. It was supposed to approach so near to these metals, particularly to the latter, in its nature, that all that was wanted for this transmutation, was to fix it, or bring it to the solid state. In consequence of the numerous experiments to which it was subjected, and the great variety of forms it assumed, they regarded it as the principle of all other bodies, and one of the elements of nature. It was supposed to exist in all metals, and also to form one of the component parts of many bodies. Hence, according to this theory, there were two kinds of mercury; the one the principle of a great number of bodies, and the other common mercury, or the metal known by that name. Hence, according to Beccher, it was called *the mercurial principle*, or *the mercurial earth*. But however extravagant the researches of the alchemists may now be considered to have been, it is to their labours that chemistry is indebted for the knowledge of many important properties and combinations of this metal.

1701 Ores. 2. Mercury is found in four different states. In the metallic state, alloyed with other metals, combined with sulphur, and with muriatic acid. 1. Native or virgin mercury is found in the cavities or clefts of rocks, in strata of clay, or of chalk, in the form of liquid globules, which are easily distinguished by their brilliancy. 2. It is found more frequently alloyed with other metals, or, as it is called when mercury is combined with a metal, *amalgamated*, and most frequently with silver. 3. A frequent ore of mercury is the red sulphuret, which is known by the name of *cinnabar*. The sulphuret of mercury is of various colours, from vermilion red to brown. Sometimes it effloresces on the surface of the ore, when it is called *flowers of cinnabar*, or *native vermilion*. 4. The fourth ore of this metal is the muriate. This salt is white and brilliant, and of a lamellated structure.

1702 Analysis. 3. Native mercury is frequently alloyed with other metals; it is therefore of importance to be able to ascertain the proportions. For this purpose it is to be dissolved in nitric acid. If it contain gold, this metal remains in a state of powder at the bottom of the vessel. If alloyed with bismuth, it may be precipitated with water, which does not separate the oxide of mercury. Silver is detected by precipitating the solution by means of muriate of soda. The muriate of silver and the muriate of mercury fall down together; but the latter being more soluble in water than the former, may be easily separated.

The sulphuret of mercury may be decomposed by boiling it with eight times its weight, of a mixture of three parts of nitric, and one of muriatic acid; the metallic part is dissolved, and the sulphur remains in the state of powder.

1703 To discover its purity. It may be known whether mercury has been adulterated with other metals, by its dull and less brilliant lustre, and by its soiling the hands, or white bodies on which it is rubbed, and by its dividing with more difficulty into round globules, which appear flat and uneven, adhere to the vessels in which they are agitated, and when poured along a smooth surface, by their *dragging* a tail. Mercury is also impure, when the globules do not readily run together, and when it is agitated with water, separating from it a black powder.

To procure mercury in a state of purity, or to revive it, as it is called, two parts of cinnabar and one of filings of iron are well triturated together, and distilled in an iron retort, introducing the beak of the retort into a receiver, with water. The iron has a greater affinity for the oxygen and the sulphur of the mercury than the latter. The mercury, therefore, rises in vapour, and is condensed by the water. There remains in the retort a sulphuret of iron, in which the metal is a little oxidated. The mercury thus obtained, being dried, and passed through a skin, is very pure and brilliant. 1704 Purification.

4. Mercury is of a white colour, is one of the most brilliant of the metals, and when its surface is clean and not tarnished, makes a good mirror. Next to gold, platinum, and tungsten, it is the heaviest of the metals; its specific gravity is 13.568. It has no perceptible taste or smell. 1705 Properties.

5. At the ordinary temperature of the atmosphere mercury is always in the liquid state; but when it is exposed to a degree of cold equal to —39° it becomes solid. This was first discovered in the year 1759 by the academicians of Petersburgh. Similar experiments have since been frequently repeated. In 1772, Pallas succeeded in the congelation of mercury at Krasnojark, by a natural cold equal to —55½° Fahrenheit. Mercury was also congealed by a natural cold in 1775 at Hudson's bay. The freezing of mercury is now a common experiment by means of artificial cold, and the method of producing this has been already described, in treating of freezing mixtures. In some experiments which have been made on the congelation of mercury, it was remarked, that a slight shock was communicated to the person who held the tube containing the metal, by its sudden contraction at the moment it became solid. Mercury crystallizes in very small octahedrons. It appears to be malleable, for by striking it with a hammer in the solid state, it was flattened and extended.

6. At the temperature of 660° mercury boils, and is then converted into vapour. This vapour, like common air, is invisible and elastic. When mercury is exposed to the air, the surface becomes tarnished, and is covered with a black powder. This change is owing to the absorption of the oxygen of the air, and the conversion of the mercury into an oxide. This process is greatly promoted by applying heat to the mercury, or by shaking it, so that it may be brought in contact with the air. To this black powder, which is the first degree of the oxidation of the metal, the name of *ethiops per se* was formerly given, because it is obtained without the assistance of any other substance. According to Fourcroy, this oxide contains 1706 Action of heat. 1707 Oxides. 1708 Black.

Mercury	96
Oxygen	4
	100

By a strong heat the oxygen is driven off, and the mercury is reduced to the metallic state: but when the oxide is exposed to a more moderate degree of heat, it combines with more oxygen, and is converted into the red oxide, so called from its colour. This oxide may also be obtained, by exposing a quantity of mercury for some length of time in a vessel provided with 1709 Red.

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with a long narrow neck, by which means the vapours of the mercury are prevented from escaping, while the air is admitted. By this process the mercury is also converted into the red oxide; and, obtained in this way, it was formerly called *precipitate per se*, or *red precipitate*. This oxide may also be obtained by dissolving mercury in nitric acid, evaporating to dryness, and exposing the mass to a very strong heat, to drive off the acid. What remains being reduced to powder, is the red oxide of mercury, or red precipitate. This oxide, according to Fourcroy, contains one-tenth of its weight of oxygen. It is of an acrid disagreeable taste, and has so powerful an effect upon animal matters, that it may be considered as a poison. It corrodes the skin with which it comes in contact. When this oxide is exposed to heat, it is decomposed; part of its oxygen is given out, and it is converted into the black oxide. Even by exposure to the light of the sun, this change is effected, as it passes through different shades of colour.

1710 Action of hydrogen. 7. Mercury does not enter into combination with azote, hydrogen, or carbon; but if hydrogen gas be kept in contact with the red oxide, it is gradually converted into the black oxide. If hydrogen gas be made to pass through a tube heated to redness, containing red oxide of mercury, a detonation takes place. The oxygen and hydrogen combine together to form water, while the mercury is reduced to the metallic state. This oxide may be also reduced by means of charcoal, with the assistance of heat. The oxygen of the oxide combines with carbon, and forms carbonic acid, and the mercury is revived.

1711 Phosphuret. 8. Phosphorus combines with mercury with difficulty. Pelletier took equal parts of phosphorus and red oxide of mercury, and introduced them into a matrass, to which he added a little water, to cover the mixture. It was exposed to the heat of a sand bath, and agitated from time to time. The oxide soon became black, and united to the phosphorus. The water retained phosphoric acid; so that it appears to be a compound of phosphorus and the black oxide of mercury. The phosphuret of mercury, thus formed, becomes soft in boiling water, and acquires some consistence in the cold. When it is heated, it is decomposed. The phosphorus and the mercury are separately emitted. Exposed to a dry air, it diffuses white vapours, which have the odour of phosphorus.

1712 Sulphuret. 9. Mercury combines readily with sulphur, either by simple trituration in the cold, or by the action of heat. One part of mercury and two of sulphur, triturated together in a mortar, the mercury soon disappearing, form a black powder, which was formerly distinguished by the name of *ethiops mineral*. Fourcroy is of opinion, that in this process the mercury is oxidated, and the sulphur is combined with the black oxide; in support of which, he states that the sulphur cannot be separated from the mercury, but by some chemical action. Berthollet supposes that this substance contains sulphurated hydrogen; and hence it is concluded that *ethiops mineral* is a hydrogenous sulphuret of mercury, composed of mercury, sulphur, and sulphurated hydrogen.

When this compound is heated in an open vessel, the sulphur, which is in a state of minute division, takes fire, and is soon reduced to sulphurous acid gas. The mercury is at the same time more strongly oxidated; is converted to a deep violet-coloured powder; and if in this state it be heated in a matrass, it is sublimed in the form of a deep red cake, of a brilliant, crystalline appearance. This substance was formerly called *artificial cinnabar*, or, in the present language of chemistry, *red sulphurated oxide of mercury*. Various processes have been given for the preparation of this substance. Seven parts of mercury squeezed through leather to purify it, are to be fused with one part of sulphur in an earthen vessel, agitating the mixture till it is completely reduced to the black sulphurated oxide. Introduce this into a matrass, placed in a crucible furnished with sand, and expose it gradually to the heat of a furnace, which is to be increased till the matter is sublimed, and collected, at the top of the vessel. It is then removed, and when the vessel is broken, a red mass is obtained, with a degree of beauty and brilliancy in proportion to the temperature which has been employed, and the small quantity of sulphur which it retains. Fourcroy considers this as a compound of sulphur and the red oxide of mercury: but according to Proust, it is a sulphuret of mercury; that is, a compound of sulphur and metallic mercury. Its component parts are, 1713 Cinnabar.

Mercury	85
Sulphur	15
	100

This sulphuret is of a fine scarlet colour. It is not altered by exposure to the air, and is insoluble in water. The specific gravity is 10. When a sufficient degree of heat is applied to it, it takes fire, and burns with a blue flame. When reduced to powder, it is then called vermilion, which is well known as a paint. 1714 Properties. 1715 Vermilion.

10. The order of the affinities of mercury is the following: 1716 Affinities.

MERCURY.	OXIDE of MERCURY.
Gold,	Muriatic acid,
Silver,	Oxalic,
Tin,	Succinic,
Lead,	Arsenic,
Bismuth,	Phosphoric,
Platinum,	Sulphuric,
Zinc,	Saclactic,
Copper,	Tartaric,
Antimony,	Citric,
Arsenic,	Sulphurous,
Iron.	Nitric,
	Fluoric,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

I. Salts of Mercury.

1. Sulphate of Mercury.

1717 Different sulphates. 1. Sulphuric acid forms salts with the different oxides of mercury, and with different proportions of these oxides, so that there is a considerable variety of the

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the sulphates of mercury. This seems to depend on the nature of the action between sulphuric acid and mercury, according to the temperature in which the combination is made, and the quantity of acid employed.

1718 Preparation.

2. Sulphuric acid has no effect on mercury in the cold; but if two parts of mercury and three of sulphuric acid be introduced into a retort, and exposed to heat, an effervescence takes place, with the evolution of sulphurous acid gas. If the process be stopped, when the mercury is converted into a white mass, and there yet remains part of the liquid, it is found to be acrid and corrosive, and it reddens vegetable blues. This is the sulphate of mercury with excess of acid. This acidulous sulphate of mercury contains very different proportions of sulphuric acid, according to the original quantity employed. If this sulphate be washed with a smaller quantity of water than is necessary for its complete solution, and if this be repeated till the water no longer changes vegetable blues, there remains a white salt without acidity, and which is much less acrid and corrosive than the saline mass from which it is obtained. This may be considered as a neutral sulphate of mercury.

1719 Properties.

3. It is of a white colour, crystallizes in plates, and in fine, needle-shaped prisms. The taste is not acrid. It is soluble in 500 parts of cold water, and in one half that quantity of boiling water. When crystallized, it is composed of

Mercury	75
Oxygen	8
Sulphuric acid	12
Water	5
	100

It is soluble both in cold and hot water, without being decomposed. The pure alkalies and lime water occasion a precipitate of a grayish-black powder. When sulphuric acid is added, it is then reduced to the state of acidulous sulphate, and its solubility increases in proportion to the additional quantity of acid. A twelfth part of acid renders it soluble in 157 parts of cold water, and in 33 of boiling water. But if $\frac{1}{4}$ of this quantity of cold water be added, it combines with the whole excess of acid, and forming a liquid of greater density than when it is diluted with 157 parts of water necessary for its complete solution, it dissolves much more of the sulphate of mercury, and brings the salt to a state of greater acidity. It then requires 500 parts of water for its solution.

1720 A different salt by continuing the heat.

4. But if the same proportions of sulphuric acid and mercury, namely, three parts of acid, and two of mercury, be exposed for a longer time to the action of heat, a greater proportion of sulphuric acid is decomposed, and the mercury combines with a greater proportion of oxygen. The salt thus obtained, possesses different properties from the former. It crystallizes in small prisms, and when it is neutralized, it is of a dirty-white colour; but if it be obtained in the dry state, it is pure white, and in this state it is combined with an excess of acid. It is then deliquescent in the air; but, in the neutral state, it undergoes no change. When hot water is added to this salt, it is converted into a yellow powder, which has been long distinguished by the name of *turpeth mineral*.

5. It was formerly supposed that turpeth mineral, which is obtained by the addition of warm water to this salt, was a simple oxide of mercury, without any portion of sulphuric acid. Fourcroy mentions, that Rouelle first conjectured, that it was combined with a certain portion of the acid, and that his experiments have verified and confirmed this conjecture; for in treating turpeth mineral, after being well washed with muriatic acid, this solution precipitates by means of muriate of barytes, a sulphate of barytes from this base. Fourcroy denominates this salt *sulphate of mercury with excess of acid*, or *yellow sulphate of mercury*. It is soluble in 600 parts of boiling water; but another sulphate of mercury remains in the solution. This contains an excess of acid, and is therefore more soluble in water.

1721 Three sulphates.

6. From a series of experiments which Fourcroy made on this subject, he concludes, that there are three distinct sulphates of mercury. 1. The first is the neutral sulphate of mercury, which crystallizes, is soluble in 500 parts of cold water, and forms a copious precipitate with the alkalies, which is not decomposed by nitric acid, but forms a mild muriate of mercury with the addition of muriatic acid. 2. The acidulous sulphate of mercury, which is more soluble than the former, is precipitated of an orange colour by means of the alkalies. The excess of acid is removed, and also a portion of the salt, with $\frac{1}{4}$ of the water necessary for its complete solution. The neutral sulphate of mercury remains behind, and is not decomposed by means of nitric acid. 3. The third sulphate of mercury contains an excess of base, or of the oxide of mercury. It is of a yellow colour, soluble in 200 parts of water, and is precipitated of a gray colour by the alkalies. It is decomposed by nitric acid; and muriatic acid converts it into a hyperoxymuriate of mercury.

1722 Acidulous sulphate.

1723 Subsulphate.

2. Sulphate of Ammonia and Mercury.

1724 Preparation.

This triple salt is formed by adding ammonia to a solution of neutral sulphate of mercury. A copious gray precipitate is thrown down, which, being exposed to the light of the sun, is partly reduced to the metallic state, and partly to that of a gray powder. This last is the sulphate of ammonia and mercury. It is soluble in ammonia; and by evaporation, brilliant polygonal crystals are formed. Or, if a large quantity of water be added to the solution, it becomes white and milky, and there is precipitated the same salt, but without any regular form. This salt has a pungent, austere taste. 1725 Properties.
When it is heated, it gives out ammonia, azotic gas, a small quantity of metallic mercury, and a little sulphite of ammonia. There remains in the retort yellow sulphate of mercury. According to the analysis of Fourcroy, this triple salt is composed of 1726 Composition.

Sulphuric acid	18
Mercury	39
Ammonia	33
Water	10
	100

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3. Nitrate of Mercury.

1727 Preparation. 1. Nitric acid is rapidly decomposed by mercury. It is accompanied with effervescence, and the evolution of nitrous gas. The mercury combines with part of the oxygen of the acid; it is thus oxidated, and is then dissolved in the remaining portion of the acid. This solution of mercury in nitric acid, when it is made in the cold, is colourless, very heavy, and so extremely caustic, that it has been employed as an escharotic, under the name of *mercurial water*. It produces an indelible brownish black spot on all animal and vegetable substances. By spontaneous evaporation it affords regular transparent crystals, composed of two four-sided pyramids, truncated near their bases, and on the four angles which result from the union of the pyramids. But different crystals are formed, according to the nature of the solution, and the evaporation, whether it has been more slowly or more rapidly conducted. When this solution of mercury in nitric acid is made in the cold, the compound formed is a nitrate of mercury without excess of the oxide or base; but if mercury be added to this solution, and the action be aided by heat, a new portion of the oxide is dissolved. It is then a nitrate of mercury with excess of base. Fourcroy distinguishes three nitrates of mercury.

1728 Three nitrates. 1. Nitrate of mercury neutralized. From this regular crystals are obtained, and it is not precipitated by water. 2. The acidulous nitrate of mercury, or with excess of acid. This is obtained by dissolving the first in water containing nitric acid, or by adding this acid to the other nitrates. 3. The nitrate of mercury with excess of oxide. This exists in the solution precipitated by water, or by exposing the other nitrates to the action of heat. In this way is produced what was formerly called *nitrous turpeth*.

2. These different nitrates of mercury possess many common properties, but are sufficiently distinguished by others, and particularly by their decomposition. When the nitrate of mercury is placed upon burning coals, it detonates feebly, although with a vivid white flame, when it has been sufficiently dried; but when it is moist it melts, blackens, extinguishes that part of the coal which it touches, and throws out small red sparks, with a slight decrepitation about the dried edges of the mass. The nitrate of mercury with excess of oxide possesses a still more feeble detonating property. The nitrate of mercury with excess of acid boils up, melts very rapidly, swells greatly, and exhales red vapours, with very little detonation. If the nitrate of mercury, neutralized, be heated in a crucible without any combustible matter, it melts, exhales nitrous gas, becomes of a deep yellow colour, then passes to an orange, and at last is converted into a deep red. In this state it was formerly called *red precipitate*. It is the red oxide of mercury, which is obtained by the decomposition of the nitrate.

3. The pure nitrate of mercury exposed to the air in the state of crystals, is soon changed. It gradually absorbs oxygen from the atmosphere, and passes from a white to a yellow colour. This is the *nitrous turpeth*. It is a yellow oxide of mercury combined with a small portion of nitric acid, or a nitrate of mercury with excess of base. The yellow colour becomes deeper with the addition of boiling water. The nitrous turpeth, it has been observed, contains a greater quantity of oxygen than that which is prepared by sulphuric acid, and from this circumstance it is more readily converted into red oxide by the action of heat.

4. The nitrate of mercury is decomposed by all the alkalies, but with different phenomena, according to the state of the combination, and particularly the degree of oxidation of the base. Bergman has distinguished the two solutions of mercury, that which is not precipitated by water, from that which is precipitated by the different products which are obtained by means of alkalies. The nitrate of mercury affords, with potash, a yellowish white oxide; with carbonate of potash, a white oxide; and with ammonia, an oxide of a dark gray colour. Sulphuric acid and the sulphates occasion a precipitate in form of a white powder. Muriatic acid and the muriates give a thick mass resembling curd. But the solution which is precipitated by water, and which is more acrid, and less disposed to crystallize, affords precipitates by means of the fixed alkalies, of a deeper yellow or brown colour. By means of ammonia, a white precipitate is formed; by means of the sulphuric acid and the sulphates, a yellow precipitate, and by the muriatic acid, a more copious, curdled matter. Fourcroy has observed in the decomposition of nitrate of mercury with excess of acid, that a precipitate in the state of black powder is formed, with a great addition of the alkali; but if it be added in small quantity, the precipitate is white or gray. A copious precipitate is obtained, from the clear supernatant solution, by diluting it with water. The same white precipitate is obtained, by mixing together nitrate of mercury and nitrate of ammonia. By evaporating the liquid, which is rendered turbid by the addition of water, six-sided prismatic crystals are deposited, as the ammonia is volatilized. The white precipitate is a brittle salt, which has very little solubility, having an excess of oxide, of mercury, and ammonia. The component parts of this salt, according to Fourcroy are, 1729 Decomposition. 1730 Composition.

Acid and water	15.80
Oxide of mercury	68.20
Ammonia	16.00
	100.00

5. From a solution of mercury in nitric acid, Mr Howard prepared a fulminating powder possessed of peculiar properties; the process which he found to answer best is the following: 1731 Mr Howard's fulminating powder.

1732 Preparation. "One hundred grains, or a greater proportional quantity, of quicksilver (not exceeding 500 grains) are to be dissolved with heat, in a measured ounce and a half of nitric acid. This solution being poured cold upon two measured ounces of alcohol, previously introduced into any convenient glass vessel, a moderate heat is to be applied until an effervescence is excited. A white fume then begins to undulate on the surface of the liquor; and the powder will be gradually precipitated upon the cessation of action and re-action. The precipitate is to be immediately collected on a filter, well washed with distilled water, and carefully dried in a heat not much exceeding that of a water bath. The immediate

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Mercury, &c. immediate edulcoration of the powder is material, because it is liable to the re-action of the nitric acid; and, whilst any of that acid adheres to it, it is very subject to the influence of light. Let it also be cautiously remembered, that the mercurial solution is to be poured upon the alcohol.

"I have recommended quicksilver to be used in preference to an oxide, because it seems to answer equally, and is less expensive; otherwise, not only the pure red oxide, but the red nitrous oxide and turpeth may be substituted; neither does it seem essential to attend to the precise specific gravity of the acid or the alcohol. The rectified spirit of wine and the nitrous acid of commerce never failed, with me, to produce a fulminating mercury. It is indeed true, that the powder prepared without attention, is produced in different quantities, varies in colour, and probably in strength. From analogy, I am disposed to think the whitest is the strongest; for it is well known, that black precipitates of mercury approach the nearest to the metallic state. The variation in quantity is remarkable; the smallest quantity I ever obtained from 100 grains of quicksilver being 120 grains, and the largest 132 grains. Much depends on very minute circumstances. The greatest product seems to be obtained, when a vessel is used which condenses and causes most ether to return into the mother liquor; besides which, care is to be had in applying the requisite heat, that a speedy and not a violent action be effected. One hundred grains of an oxide are not so productive as 100 grains of quicksilver.

1733 Properties. This powder, struck on an anvil with a hammer, explodes with a stunning disagreeable noise, and with such force, as to indent both the hammer and the anvil. Half a grain or a grain, if quite dry, is as much as ought to be used on such an occasion. The shock of an electric battery, sent through five or six

1734 Decomposition. grains, produces a very similar effect. The powder explodes at the 368th degree of Fahrenheit's thermometer. A quantity of it, sufficient to discharge a bullet from a gun, with a greater force than an ordinary charge of gunpowder, always bursts the piece. Ten grains of the powder, exploded in a glass globe, produce only four cubic inches of air, consisting of carbonic acid gas and nitrogene, or azotic gas.

This powder is decomposed by sulphuric, nitric, and muriatic acids. When concentrated sulphuric acid is poured upon it, an immediate explosion takes place. According to the experiments of Mr Howard,

1735 Composition. this powder consists of oxalate of mercury, and nitrous etherised gas. But it appears that the nature of the component parts varies with the different modes which are followed in its preparation. When it is prepared with little heat, it consists of nitric acid, oxide of mercury, and a peculiar vegetable substance; but by continuing the heat during the fermentation, a greenish colour is communicated to the powder. It is then found to be composed of ammonia, oxide of mercury, and a greater proportion of the vegetable matter. Its detonating power is more feeble, and it gives out a blue flame when placed on hot coals. By boiling the mixture for half an hour, it is composed of oxalate of mercury, and a small proportion of vegetable matter; does not detonate, but decrepitates when it is heated*.

* Phil. Trans. 1800.

4. Muriate of Mercury.

1. Muriatic acid has no action whatever on mercury; but it combines readily with its oxides, and forms salts which have been the subject of research among chemists, almost in every age. The muriates of mercury were known to the Arabians in the 10th and 11th centuries. They were the first objects of study and examination with the alchemists, in their search after the philosophers stone; and since chemistry assumed the form of a science, they have greatly occupied the attention of philosophers, in discovering their nature and properties. 1736 This compound long known.

2. There are two compounds of muriatic acid and the oxides of mercury, which possess very different properties, according to the degree of oxidation of the mercury. According to the views already mentioned, relative to the simple nature of chlorine, this substance is, when dry, considered as a compound of chlorine and mercury, with a double proportion of the former, and is therefore called a bi-chloride. The other is considered as a chloride. 1737 Two muriates.

3. Muriatic acid precipitates the oxides of mercury from their solutions in sulphuric and nitric acids. If muriatic acid be added to the yellow sulphate of mercury, or to the nitrate of mercury which is precipitable by water, a muriate of mercury is obtained, which is soluble in water, and which, on account of its properties, was formerly called *corrosive sublimate*, or *corrosive muriate of mercury*. But if muriatic acid be added to the acidulous sulphate of mercury, or to the nitrate of mercury which affords no precipitate with water, a white, insoluble, insipid precipitate is obtained, which was formerly called *sweet mercury* or *calomel*, and is now known by the name of *submuriate*, and sometimes *sweet muriate of mercury*. 1738 Preparation.

4. The muriate of mercury, or corrosive sublimate, may be prepared by the following process. Boil two parts of mercury with two and a half of sulphuric acid in a matrass, with the heat of a sand bath, to dryness. Let this dry mass be mixed with four parts of dried muriate of soda, and let the whole be sublimed in a glass vessel, by gradually increasing the heat. In the first part of this process, part of the sulphuric acid is decomposed; the mercury combines with the oxygen, and forms an oxide, which is dissolved in the undecomposed part of the sulphuric acid, and a sulphate of mercury is thus obtained. The muriate of soda being mixed with this salt, produces another decomposition. The muriatic acid combines with the mercury, forming the muriate of mercury, which is sublimed; and the sulphuric acid of the sulphate of mercury combines with the soda, forming a sulphate of soda, which remains behind. 1739 Of the muriate.

5. The muriate of mercury, thus obtained, forms a beautiful white, semitransparent mass, which is found to be composed of small prismatic crystals in the form of needles. It may be obtained by evaporation, in the form of cubes or rhomboidal prisms, or four-sided prisms, having the alternate sides narrower, and terminated by two-sided summits. The taste is extremely acrid and caustic, and the metallic impression remains long on the tongue. The specific gravity is 5.1398. It is soluble in 20 parts of cold water, and in less weight of 1740 Properties.

Mercury, &c. of boiling water. This salt is not altered by exposure to the air; and, when it is sublimed by heat, it remains unchanged. It is soluble in sulphuric, nitric, and muriatic acids, and, when these solutions are evaporated, the muriate of mercury is obtained unaltered. It is precipitated by all the alkalies and earths, of an orange-yellow colour, which gradually changes to a brick-red. The carbonates of the fixed alkalies afford a permanent yellow colour. Ammonia forms with it a triple salt.

1741 Composition. The component parts of this salt, according to Mr Chenevix, are,

Oxide of mercury	82
Acid	18
	100

Muriate of mercury is one of the most violent poisons known. When taken internally, it produces nausea and vomiting, with severe pain, and, in a short time, corrodes the stomach and bowels. Externally, it is employed as an escharotic for destroying fungous flesh. It sublimes readily when heated, and is extremely injurious in the state of vapour, to those who breathe it.

1742 Preparation. *Submuriate*, or *Chloride of Mercury*.—This salt is prepared by triturating together in a glass mortar, four parts of muriate of mercury or corrosive sublimate, with three of mercury, till the latter disappear. When this is formed into an uniform mass, it is put into a matrass, of which it should fill $\frac{1}{3}$, and it is to be sublimed with the heat of a sand bath. When the process is finished, the phial is broken; and the white matter at the upper part of the vessel, and the red matter at the bottom, are to be separated, and the remaining part of the mass is to be sublimed, and afterwards reduced to a fine powder, which is to be well washed with boiling water.

In this process, it is obvious, that the mercury which is added, combines with part of the oxygen of the oxide of mercury, formerly combined with the muriatic acid; and the whole of the oxide of mercury having now a smaller proportion of oxygen, is combined with a smaller proportion of muriatic acid. This will appear from the proportions of its component parts, as they have been ascertained by Mr Chenevix.

1743 Composition. Oxide of mercury in calomel contains,

Mercury	89.3
Oxygen	10.7
	100.0

Calomel composed of

Oxide of mercury	88.5
Muriatic acid	11.5
	100.0

1744 Properties. Submuriate of mercury, or calomel, is generally in the form of a white, solid mass; but it is susceptible of crystallization in four-sided prisms, terminated by pyramids. It has scarcely any taste, has no poisonous property, and is very little soluble in water. The specific gravity is 7.1758. It becomes dark coloured by exposure to light, is phosphorescent when rubbed in the dark, and requires a higher temperature for its sublimation than the muriate of mercury. It is converted into muriate or corrosive sublimate, by the nitric and oxymuriatic acids.

This salt, which is now generally known in the shops by the name of *calomel* or *sweet mercury*, was formerly described under a great variety of names, derived from its effects, or the mode of its preparation. 1745 Different names. In the beginning of the 17th century, it was regarded as an important secret. But, in the year 1608, Beguin described it very accurately, in his *tyrocinium chemicum*, under the name of *the dragon tamed*, on account of the corrosive sublimate from which it was prepared, being deprived of its poisonous and destructive qualities. At different periods it was distinguished by other names, as *aquila alba*, *aquila mitigata*, *manna metallorum*, *panchymagogus quercitanus*, &c. The use of this salt as a purgative, and indeed in all cases where mercurial preparatious are required, is well known.

5. Muriate of Ammonia and Mercury.

If ammonia be added to a solution of muriate of mercury, or corrosive sublimate, a white precipitate is obtained, which is a triple salt, formed by the combination of the ammonia with the muriate of mercury. 1746 Preparation. This white precipitate has at first an earthy taste, which becomes afterwards metallic and disagreeable. It seems to be insoluble in water. Sulphuric acid forms with this triple salt, corrosive sublimate, and sulphate of ammonia and mercury. Nitric acid converts it into corrosive sublimate and nitrate of ammonia and mercury. It is completely soluble in muriatic acid, and there is formed a muriate of mercury and ammonia. This preparation was known to the alchemists, and distinguished by the names of *sal alembroth*, and *salt of wisdom*. The component parts of this salt, according to Fourcroy, are

Acid	16
Oxide of mercury	81
Ammonia	3
	100 *

6. Hyperoxymuriate of Mercury.

1747 Preparation. The salt was formed by Mr Chenevix, by passing a current of oxymuriatic acid gas through water, in which there was red oxide of mercury. The oxide became of a dark brown colour, and a solution appeared to have taken place. The liquor was evaporated to dryness, and a salt was obtained which consisted partly of corrosive sublimate, and partly of hyperoxymuriate of mercury. 1748 Properties. By separating the latter, and crystallizing it again, it was obtained nearly pure. This salt is more soluble than corrosive sublimate, four parts of water retaining it in solution. Hyperoxymuriatic acid is given out by the addition of sulphuric, or even weaker acids, and the liquid assumes an orange colour †.

7. Fluate of Mercury.

Fluoric acid combines only with the oxide of mercury; or the soluble fluates mixed with a solution of nitrate of mercury, produce a precipitate of a white colour, which is the fluate of mercury, of which the properties are little known.

8. Borate

* Fourcr. v. 341.

† Phil. Trans. 1802. p. 162.

8. Borate of Mercury.

Boracic acid has no direct action on mercury; but by mixing together a solution of borate of soda with a solution of nitrate of mercury, a yellowish precipitate is obtained, which is the borate of mercury. This salt acquires a greenish colour by exposure to the air. Lime water forms a precipitate of a red powder.

9. Phosphate of Mercury.

Phosphoric acid has no action on mercury, but it combines with its oxide. This salt may be prepared by precipitating the nitrate of mercury in solution, by means of phosphate of soda. A white precipitate is formed, which is phosphate of mercury. This salt is insoluble in water, phosphoresces when rubbed in the dark, and is decomposed by heat, giving out phosphorus.

10. Carbonate of Mercury.

By precipitating the solutions of mercury in the other acids by means of the alkaline carbonates, a white precipitate is obtained, which is a carbonate of mercury.

11. Arseniate of Mercury.

When arsenic acid is distilled in a retort with mercury, it is partially decomposed. Arsenious acid is sublimed, with a portion of metallic mercury and a small quantity of yellow oxide. There remains behind a yellow mass, which is arseniate of mercury. It is insoluble in water, and in sulphuric and nitric acids. It is soluble in muriatic acid, and affords by evaporation and sublimation, the muriate of mercury, or corrosive sublimate. Arsenic acid precipitates the sulphate and nitrate of mercury in the form of a white powder, which is also arseniate of mercury.

12. Tungstate of Mercury.

This salt is formed, by adding to a solution of nitrate of mercury, an alkaline tungstate. This salt is decomposed, and the tungstate of mercury is precipitated in the form of a white insoluble powder.

13. Molybdate of Mercury.

Molybdic acid precipitates mercury from its solution, in nitric acid, in the form of a white flaky powder. It is also insoluble in water.

14. Chromate of Mercury.

An alkaline chromate in solution, added to a solution of nitrate of mercury, forms a precipitate of a fine reddish purple colour. This is the chromate of mercury, which is insoluble in water, and which Vauquelin, who discovered it, suggests to be employed as a pigment.

15. Columbate of Mercury.

Unknown.

16. Acetate of Mercury.

1749 Combines with two oxides. 1. Acetic acid combines with the oxides of mercury, and forms different salts, according to the oxide which enters into the combination. With the red oxide of mercury it forms a salt which does not crystallize; but when the liquid is concentrated, and evaporated to dryness, it affords a yellow deliquescent mass. When this salt is dissolved in water, it divides into two parts; the one falls down in the state of yellow powder, which is acetate of mercury with excess of base; and the other part remains in solution, because it contains an excess of acid.

2. But when nitrate of mercury is precipitated by means of alkalies, and the precipitate is dissolved in acetic acid, the solution yields, by evaporation and cooling, acetate of mercury, in thin brilliant flakes. This salt may also be formed by mixing together solutions of acetate of potash and nitrate of mercury. The acetate of mercury appears in the form of large flat crystals, which have an acrid taste, and are scarcely soluble in water. This latter salt is a compound of acetic acid and the oxide of mercury, with a smaller proportion of oxygen. It is employed in medicine, and forms the principal ingredient of *Keyser's pills*.

17. Oxalate of Mercury.

Oxalic acid combines with the oxide of mercury, and forms an oxalate in the state of white powder, which is scarcely soluble in water. It becomes black by exposure to the light. When it is heated it detonates. This salt may also be obtained, by adding oxalic acid to a solution of the nitrate or sulphate of mercury.

18. Tartrate of Mercury.

Tartaric acid forms an insoluble salt of a white colour, with the oxide of mercury, which becomes yellow by exposure to the light.

19. Tartrate of Potash and Mercury.

This triple salt may be prepared by boiling together in water, one part of oxide of mercury, and six of tartar. Crystals of the triple salt are obtained by evaporating the liquid.

20. Citrate of Mercury.

Citric acid produces an effervescence with the red oxide of mercury, changes into a white colour, and then unites it in one mass. This salt is scarcely soluble in water. It has a metallic taste, and is decomposed by nitric acid.

21. Malate of Mercury.

When malic acid is added to a solution of nitrate of mercury, a white precipitate is formed, which is malate of mercury.

22. Benzoate of Mercury.

Benzoic acid forms with the oxide of mercury a salt in the state of white powder, which is insoluble in water, and is scarcely altered by exposure to the air. It is decomposed by heat.

23. Succinate of Mercury.

Succinic acid combines with the oxide of mercury with the assistance of heat, and forms with it an irregular mass, in which some crystals are observed.

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Zinc, &c.

24. Saccolate of Mercury.

By adding saclactic acid to a solution of nitrate of mercury, a white precipitate is formed, which is saccolate of mercury.

25. Mellate of Mercury.

Mellitic acid, added to a solution of nitrate of mercury, produces a copious precipitate, which is re-dissolved by the addition of nitric acid *.

* *Klaproth Essays*, ii. 102, *Trans.*

26. Prussiate of Mercury.

This salt is obtained by boiling the red oxide of mercury with Prussian blue. It forms crystals in four-sided prisms, terminated by four-sided pyramids. The specific gravity is 2.7612. It forms triple salts with sulphuric and muriatic acids, the properties of which are not known.

II. Action of Alkalies, &c.

There is no action between mercury and the alkalies of alkaline earths; but the alkalies combine with the oxides of mercury, and form with them compounds in which the latter seem to act the part of acids. Some of these compounds have been already treated of, in speaking of the action of ammonia on some of the mercurial salts.

Salts formed with the alkalies and earths have no action on mercury or its oxides, if we except the muriates. By dissolving the muriate of mercury in a solution of muriate of ammonia, a triple salt, which is muriate of ammonia and mercury, and which has been
1750 already described, is obtained.

Uses.

Mercury is one of the metals of the most extensive utility. In the metallic state it is applied to the construction of meteorological instruments, as the barometer and thermometer. Mercury is also applied to a great variety of purposes in the arts; in gilding with silver and gold; in forming an amalgam with tin for covering the back of mirrors; and in metallurgy for the purpose of separating gold and silver from their ores. Mercury is also of considerable importance for the purposes of chemistry. Many of its preparations form some of the most effectual and most certain remedies in different diseases.

Sect. XVII. *Of Zinc and its Combinations.*

1751 History.

1. Paracelsus is the first who speaks of zinc under its present name. It is supposed that the Greeks were acquainted with this metal in the state of compound with copper, which formed the famous Corinthian brass; but it does not appear that they made any distinction between it and other metals. It is particularly mentioned by Albertus Magnus, who died in 1280, and he seems to have known that it inflamed, and communicated a colour to metals with which it was combined. The method of obtaining zinc from the ore called *calamine*, is mentioned by Henckel in his Pyrotology in 1721. Swab extracted it by distillation in 1742, and Margraaf was occupied with this process in 1746. Zinc was supposed by the earlier chemists to be a variety or compound of some of the other metals. Lemery thought it was a kind of bismuth, and Homberg took it for a mixture of iron and tin; while others supposed that it was tin rendered brittle by sulphur, or that it was a coagulated mercury.

1752 Ores.

2. Zinc is found in four different states: In the state of oxide in the state of sulphuret, in that of sulphate, and in that of carbonate. 1. In the state of oxide it is known by the name of *calamine*, or *lapis calaminaris*, deposited in a regular form, or in that of incrustations and stalactites, in the cavities of metallic veins. 2. The sulphuret of zinc, known by the name of *blende*, is sometimes disposed in scales, and sometimes crystallized in tetrahedrons, or octahedrons. It is frequently found in lead mines, accompanying the ores of lead. 3. The sulphate of zinc, which is found native, is readily known by its white colour and transparency, its strong acrid taste, and solubility in water. It is generally found in a stalactitical form, or in fine silky crystals, like those of amianthus. 4. The native carbonate of zinc, which is sometimes confounded with the oxide or calamine, forms another ore of zinc. It is transparent, white, or yellowish. It is insipid and insoluble in water, and dissolves with effervescence in nitric and muriatic acids. 1753

Analysis.

3. To reduce oxides of zinc to the metallic state, the ore is pulverized and mixed with charcoal, and the mixture is heated in a crucible covered with a plate of copper. The zinc is sublimed in the metallic state, and combines with the copper, which it converts into brass; and in this rude process the richness of the ore is ascertained by the intensity of the colour. The sulphurets of zinc are reduced by roasting, by which process the sulphur is separated, and the residuum is then treated in the same way as the oxides. In the humid way Bergman has proposed to analyze the oxides of zinc by means of sulphuric acid, and then by precipitating the oxide by carbonate of soda, he has ascertained that 193 parts of this precipitate give 100 parts of the metal. 1754

Properties.

4. Zinc is of a brilliant white colour with a bluish shade, which is very perceptible in its metallic state, and of a distinct lamellated texture; but the plates of which it is composed are smaller than those of bismuth and antimony. The specific gravity is 7.190. Zinc is not quite so brittle as the preceding metals. It requires a smart and sudden blow to separate its fragments. It is susceptible of a slight degree of malleability, for, by gradual and cautious pressure, it may be formed into thin plates which have some degree of elasticity. It has a slight odour, and a peculiar taste, which is communicated to the fingers when they are rubbed on this metal. 1755

Action of heat.

5. When zinc is exposed to a heat of about 700° it melts, and by increasing the heat it evaporates, so that in close vessels it may be distilled. When allowed to cool slowly after being in fusion, it crystallizes in fine needles. When zinc is exposed to the air, it undergoes very little alteration in the cold. Its brilliancy is slightly tarnished, and it becomes at length covered 1756
with a thin gray oxide. When zinc is fused in close vessels and exposed to heated air, at the moment it becomes solid on the surface, it exhibits a great variety of shades of colour, which is the commencement of oxidation. When it is kept in fusion, in the open air, the surface becomes covered with a gray pellicle, which being removed, is succeeded by another, till the whole of

Oxidation.

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Zinc, &c. of the zinc is converted into this gray-coloured matter, which is an oxide of zinc. This process may be promoted by agitating the vessel, so that the metal in fusion may be exposed to the air. By heating together the gray pellicles which have been collected in an open vessel, the whole is converted into a uniform gray powder, which at last assumes a yellowish colour. The yellow oxide, thus formed, has acquired an additional weight of about 17 per cent. of the metallic zinc.

When this metal is heated to redness in an open vessel, by agitating the vessel, it suddenly takes fire, and burns with a very brilliant white and somewhat greenish flame. Zinc is at the same time reduced to a state of vapour, which is condensed in the air, in light, filamentous, white flakes, of a very delicate texture. This is an oxide of zinc. It has been distinguished by different names, as *flowers of zinc*, *nihil album* or *white nothing*, *lana philosophica*, or *philosophic wool*.

1757 Oxides two. Thus, there are two oxides of zinc; the gray oxide, which consists of about 88 parts of zinc, and 12 of oxygen; and the white oxide, which, according to Proust, is composed of 80 parts of zinc, and 20 of oxygen.

1758 Action of hydrogen. 6. There is no action between azote and this metal. Hydrogen gas, it is supposed, dissolves a small quantity of zinc; for, by dissolving zinc in diluted sulphuric acid, the hydrogen gas which is obtained by the decomposition of the water, has been found to hold a little zinc

1759 Of carbon. in solution, which is deposited on the sides of the jars containing the gas. It is supposed, too, that zinc is sometimes combined with carbon, because hydrogen gas, obtained by the above process, is sometimes contaminated with carbonated hydrogen gas.

1760 Phosphuret. 7. Zinc combines with phosphorus, and forms a phosphuret. This may be prepared by adding small bits of phosphorus to zinc in fusion, but previously throwing in a little resinous matter, to prevent the oxidation of the zinc. This was the process by which Pelletier formed the phosphuret of zinc. This phosphuret is of a white colour and metallic lustre. It has some degree of malleability. When it is hammered it emits the odour of phosphorus, and when exposed to a strong

1761 Phosphorated oxide. heat, it burns like zinc. Phosphorus also enters into combination with the oxide of zinc, and forms with it a phosphorated oxide. This is formed by distilling in an earthen-ware retort, equal parts of oxide of zinc, and phosphoric glass, with one-sixth of charcoal powder. A strong heat is applied, and a metallic substance of a silvery white colour is sublimed, which has a vitreous fracture. When it is heated by the blow-pipe, the phosphorus burns, and there remains behind a vitreous matter, which is transparent while in fusion, but becomes opaque when it is cold.

1762 Sulphuret. 8. Zinc has not been combined directly with sulphur. When they are heated together in a crucible, the sulphur separates without producing any other change on the zinc than that of being a little more infusible; but it has been observed that sulphur and zinc, when fused together in a crucible, enter into combination, as the zinc is oxidated. This compound assumes a brownish gray colour. Guyton afterwards discovered that sulphur and the oxide of zinc readily unite together by fusion, and that the compound is of a gray colour, similar to the native sulphuret of zinc, as it has been called, or the sulphurated oxide of zinc, according to this experiment; but according to Proust, the ore of zinc, which is known by the name of *blende*, is a sulphuret, that is, sulphur combined with zinc in the metallic state.

9. The order of the affinities of zinc and its oxide is the following: 1763 Affinities.

Zinc.	Oxide of Zinc.
Copper,	Oxalic acid,
Antimony,	Sulphuric,
Tin,	Muriatic,
Mercury,	Saclactic,
Silver,	Nitric,
Gold,	Tartaric,
Cobalt,	Phospheric,
Arsenic,	Citric,
Platinum,	Succinic,
Bismuth,	Fluoric,
Lead,	Arsenic,
Nickel,	Lactic,
Iron.	Acetic,
	Boracic,
	Prussic.
	Carbonic.

I. Salts of Zinc.

1. Sulphate of Zinc.

1. Sulphuric acid diluted with water, acts very powerfully on zinc. A violent effervescence takes place; the mixture is strongly heated, and a great quantity of hydrogen gas is evolved. In this process, which is usually followed for obtaining the purest hydrogen gas for chemical purposes, the water is decomposed; its oxygen combines with the metal and forms an oxide, which is then dissolved in the sulphuric acid, and forms a sulphate of zinc, while the hydrogen, the other component part of the water, escapes in the form of gas. A black powder is sometimes observed floating in the solution, which is carburet of iron, with which the zinc is frequently contaminated. As the effervescence ceases, a white powder is formed, which gradually disappears towards the end of the process, and with the addition of water forms a transparent solution. By evaporation and cooling, the sulphate of zinc is obtained crystallized. 1764 Preparation.

2. The sulphate of zinc is frequently contaminated with other metals, as with lead, iron, and copper; but when it is pure, it crystallizes in four-sided prisms, terminated by pyramids with four faces. This salt has an acrid, astringent, and strongly metallic taste. When it is exposed to the air it effloresces. It is soluble in less than two and a half parts of cold water, and more soluble in boiling water. The specific gravity of the crystallized salt is 1.912; but as it is generally met with in the shops, it is only 1.3275. When heated in a retort, it melts, loses its water of crystallization, and part of its acid in the state of sulphurous acid, and a little water. It is decomposed and precipitated in the state of white oxide by all the alkalies; and if the precipitate is formed by means of the carbonates, a white pigment is obtained. The sulphate of zinc is also decomposed with the assistance of heat, by means of nitre. The alkaline sulphurets and hydrosulphurets also precipitate the sulphate of zinc, 1765 Properties.

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Zinc, &c. zinc, of a deep orange or brown colour. The component parts of this salt are, according to

1766 Composition.

	Bergman.	Kirwan.
Acid	40	20.5
Oxide	20	40.0
Water	40	39.5
	100	100.0

1767 White vitriol. 3. The salt known in commerce by the name of *white vitriol*, is a sulphate of zinc, and is supposed to contain an excess of acid. It is in the form of white granular masses, resembling sugar, and often marked with yellow spots. This salt is usually prepared by roasting the sulphuret of zinc or blende, by which means the sulphuret is converted into sulphuric acid. It is then dissolved in water, which is purified and evaporated, and the salt is crystallized by sudden cooling. Part of its water of crystallization is afterwards driven off by heat, so that it is obtained in a regular, solid, and granulated mass. It is generally contaminated with iron and other metals; but it may be purified from these, by adding filings of zinc, which precipitate the other metals, and leave a pure sulphate of zinc.

2. Sulphite of Zinc.

1768 Preparation. Concentrated sulphurous acid readily combines with the white oxide of zinc, without any effervescence, but with the evolution of heat, and the acid being deprived of its odour. When the saturation is completed, white crystals appear on the surface of the liquid. This salt has a pungent, astringent taste. It crystal-
1769 Properties. lizes readily. It is decomposed by the acids, with effervescence. It is insoluble in alcohol. It forms white precipitates with the alkalies, and when exposed to the air, it is readily converted into sulphate of
1770 Combines with sulphur. zinc.

Sulphurated sulphite of Zinc.—When sulphurous acid is added to zinc in the state of powder or filings, a great degree of heat is produced; sulphurated hydrogen gas is disengaged; the liquid becomes at first brown, sometimes muddy, and assumes a yellow colour, and towards the end of the process it becomes transparent. The solution has an acrid, astringent, and sulphureous taste. Sulphuric and muriatic acids disengage with effervescence, sulphurous acid gas, and precipitate a yellowish white powder. Nitric acid at first separates sulphurous acid gas, and afterwards a flaky precipitate, which is pure sulphur. When this solution is exposed to the air, it becomes thick like honey, and affords crystals in the form of needles or fine
1771 Properties. four-sided prisms, terminated by four-sided pyramids. These are crystals of sulphurated sulphite of zinc, which become white by exposure to the air, and form a white powder insoluble in water. When this salt is heated by the blow-pipe, it swells up, gives out a bright light like burning zinc, and forms dendritical ramifications. This salt is partly soluble in alcohol. The part not dissolved, only gives out sulphurous acid gas by means of sulphuric acid, whilst the part which is dissolved affords, besides sulphurous acid gas, a copious precipitate of sulphur. When it is distilled in a retort, it gives out water, sulphurous acid, sulphuric acid, and sulphur sublimed. There remains behind oxide of zinc, mixed with a little of the sulphate.

1772 Theory of the process. In the solution of zinc in liquid sulphurous acid, water, and part of the sulphurous acid itself, are decomposed; for sulphurated hydrogen gas is disengaged, which is composed of the hydrogen of the water and part of the sulphur of the sulphurous acid. There is no precipitation of sulphur during the solution, for it combines with the sulphite of zinc, as it is formed; but this is not completely saturated, since alcohol dissolves only the portion of sulphurated sulphite which it contains, and separates the sulphite *.

* Fourcroy, v. p. 353.

3. Nitrate of Zinc.

1773 Preparation. 1. Concentrated nitric acid produces a violent action with zinc, and sometimes even inflames it. To effect this solution, with a moderate action, the acid should be diluted with water. Great heat is produced, with violent effervescence and the evolution of nitrous gas. The acid is decomposed; its oxygen combining with the metal forms an oxide, which combines with the acid as it is formed.

1774 Properties. 2. This solution is of a greenish-yellow colour, and extremely caustic. By evaporation it affords crystals, in the form of four-sided, compressed, and striated prisms, terminated by four-sided pyramids. The specific gravity is 2.096. This salt is deliquescent in the air. When it is heated on burning coals, it melts, and detonates with a small red flame. When heated in a crucible, it gives out red vapour, and assumes a deep colour and gelatinous consistence. When cooled in this state, it retains its softness for some time. By continuing the heat, it dries, gives out nitrous and oxygen gases, and leaves behind a yellow oxide.

4. Muriate of Zinc.

1775 Preparation. Muriatic acid produces a rapid action on zinc. It is dissolved with effervescence, and with the evolution of pure hydrogen gas. The solution of zinc in muriatic acid is colourless; it does not crystallize, but assumes the form of a transparent jelly. It affords by distillation a small quantity of fuming acid, and a solid muriate of zinc, which is fusible with a moderate heat, and was formerly known by the name of *butter of zinc*. When this muriate of zinc is sublimed by heat, it becomes of a fine white colour, composing a mass of crystals in the form of small prisms. It is decomposed by
1776 Properties. sulphuric acid, and is precipitated by the alkalies. It is soluble in water, attracts moisture from the atmosphere, and is soon converted into a transparent jelly. The specific gravity is 1.577.

5. Muriate of Ammonia and Zinc.

This triple salt is formed by boiling white oxide of zinc in a solution of muriate of ammonia. The oxide of zinc is dissolved; part of which is afterwards deposited, when the solution cools, but what remains in the solution is not precipitated by the alkalies or the alkaline carbonates.

6. Fluate of Zinc.

Fluoric acid produces a violent action with zinc; there is considerable effervescence, with the evolution of

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Zinc, &c. of hydrogen gas. The metal is oxidated, and then dissolves in the acid; but the properties of this salt are little known.

7. Borate of Zinc.

Boracic acid combines with the oxide of zinc, by adding the borate of potash or soda to the solution of zinc in nitric or muriatic acid. This salt is insoluble in water.

8. Phosphate of Zinc.

1777 Preparation. Phosphoric acid diluted with water, acts upon zinc with the evolution of hydrogen gas, owing to the decomposition of water. A white powder is deposited, which is phosphate of zinc. By exposing phosphoric glass and zinc to a strong heat, a phosphuret of zinc is formed, by the decomposition of the acid.

9. Carbonate of Zinc.

1778 Preparation. Zinc reduced to a fine powder, and added to liquid carbonic acid, is oxidated and copiously dissolved in the acid, at the end of 24 hours. This solution, exposed to the air, is covered with a pellicle of carbonate of zinc of different colours. The carbonate of zinc is found native, and has been distinguished by the name of *calamine*, thus confounding it with the oxide of zinc. Carbonate of zinc, according to the analysis of Bergman, is composed of

Acid	28
Oxide	66
Water	6
	100

10. Arseniate of Zinc.

When arsenic acid is added to zinc, it produces an effervescence, with the evolution of hydrogen gas, holding arsenic in solution. A black powder is deposited, which is metallic arsenic. In this process, the zinc decomposes part of the water, and combines with its oxygen, and at the same time deprives the arsenic acid of its oxygen, by which it is reduced to the metallic state. The arseniate of zinc may be obtained by adding a solution of an alkaline arseniate to a solution of the sulphate of zinc. A white precipitate is formed, which is the arseniate of zinc. It is insoluble in water.

11. Tungstate of Zinc.

12. Molybdate of Zinc.

These salts may be formed by a similar process. A white powder is obtained, which is insoluble in water.

13. Chromate of Zinc.

This salt is obtained by combining an alkaline chromate with a solution of zinc in nitric acid. A precipitate is formed of an orange red colour, which is chromate of zinc.

14. Columbate of Zinc.

Unknown.

15. Acetate of Zinc.

Acetic acid dissolves zinc, and the solution by evaporation crystallizes in the form of rhomboidal or hexagonal plates. This salt has a bitter metallic taste, is not altered by exposure to the air, and is soluble in water. It burns with a blue flame when thrown on burning coals. When distilled, it yields water, an inflammable liquid, and some oil. At the end of the process, when the salt is completely decomposed, the oxide of zinc is sublimed, which being brought in contact with a candle, burns with a fine blue flame. The residuum is in the state of pyrophorus, but it has little combustibility. 1779 Preparation and properties.

16. Oxalate of Zinc.

Oxalic acid acts upon zinc with effervescence, and the evolution of hydrogen gas. Water is decomposed, and as the zinc is oxidated, it combines with the acid, forming an oxalate of zinc. It is in the state of white powder, of an acrid taste, and but little soluble in water.

17. Tartrate of Zinc.

Tartaric acid combines with zinc with effervescence, and the evolution of hydrogen gas. The properties of this salt have not been examined.

18. Citrate of Zinc.

Citric acid acts upon zinc with effervescence and the evolution of hydrogen gas. At the end of 24 hours the action ceases, and the liquid deposits on the sides of the vessel and on its surface, small, brilliant crystals in the form of plates, which are insoluble in water. The citrate of zinc has an astringent, metallic taste. It is composed of equal parts of acid and of oxide of zinc.

19. Malate of Zinc.

Malic acid dissolves zinc, and, by evaporating the solution, crystals may be obtained.

20. Benzoate of Zinc.

Benzoic acid readily dissolves zinc, and by evaporation the solution affords needle-shaped crystals. The benzoate of zinc is soluble in water and alcohol. When it is exposed to heat the acid is sublimed.

21. Succinate of Zinc.

Zinc is dissolved in succinic acid with effervescence. By evaporation the solution affords slender, foliated crystals.

22. Lactate of Zinc.

Zinc is soluble in lactic acid with effervescence, and by evaporating the solution, the salt may be obtained crystallized.

II. Action of Alkalies, &c. on Zinc.

1. When zinc is immersed in a solution of potash 1780 Fixed alkalies.
or soda, it is tarnished, and becomes black; and when it is boiled in the solution, hydrogen gas is evolved. The solution assumes a dirty-yellow colour, from which an oxide of zinc may be precipitated by acids.

2. Ammonia

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Tin, &c.

2. Ammonia has a still more powerful action on zinc. Hydrogen gas is more copiously evolved, and
1781 Ammonia. the oxide which is formed is more abundantly dissolved in the liquid, and at the end of some time a considerable quantity of white oxide is deposited. These alkaline solutions become turbid by exposure to the air; its oxygen and carbonic acid, acting at the same time, precipitate the oxide.

1782 Sulphates. 3. The alkaline and earthy sulphates are readily decomposed by zinc, with the assistance of heat. It attracts the oxygen of the sulphuric acid, and thus decomposing it, separates the sulphur, which combines with the bases of the sulphates. Alum boiled in solution with zinc, is decomposed, and there is formed a triple salt, which is sulphate of zinc and alumina.

1783 Nitrates. 4. The nitrates produce a vivid inflammation with zinc at a red heat. The acid is decomposed, its oxygen combines with the metal, and by this rapid combination, a violent detonation is produced. The azotic gas is disengaged, and the zinc is fully oxidated. Three parts of nitre well dried, and one of zinc in fine powder, well mixed together and projected into a red-hot crucible, produce a very brilliant inflammation. The burning matter is sometimes thrown out to a considerable distance; so that the experiment should be made with caution. This compound is sometimes employed in fire-works.

1784 Muriates. 5. Zinc has a considerable action on the muriates. Triturated with the muriate of ammonia, the salt is decomposed, and ammonia is disengaged. By distilling this salt with zinc, ammoniacal and hydrogen gases are obtained; the latter is obviously owing to the decomposition of the water contained in the salt, by means of the zinc, which combines with the oxygen, and then forms a muriate of zinc with the muriatic acid.

1785 Phosphates, &c. 6. The phosphates and borates combine by fusion with the oxide of zinc, which communicates to the glass thus formed a greenish-yellow colour.

7. Zinc decomposes the greatest number of the metallic salts from their solutions, by its strong affinity for oxygen. They are precipitated in the metallic form, or in the state of oxide, but deprived of a portion of oxygen.

1786 Uses. 8. Zinc is employed in many of the arts. It forms useful alloys with some of the other metals, some of which will be mentioned afterwards. It is also employed in medicine. The sulphate of zinc is sometimes exhibited as an emetic, and frequently used in solution as an eye-wash. The oxide of zinc, or the flowers of zinc, have been prescribed as an antispasmodic, and particularly in cases of epilepsy.

Sect. XVIII. *Of Tin and its Combinations.*

1787 History. 1. Tin has been known from the earliest ages. It was much employed by the Egyptians in the arts, and by the Greeks as an alloy with other metals. Pliny speaks of it under the name of white lead, as a metal well known in the arts, and even applied in the fabrication of many ornaments of luxury. He ascribes to the Gauls the invention of the art of tinning, or covering other metals with a thin coat of tin. The alchemists were much employed in their researches concerning tin. They gave it the name of *Jupiter*, from which the salts or preparations of tin were called *jovial*. Since their time, the nature and properties of tin have been particularly investigated by many chemists, and it has proved the subject of some important discoveries in chemical science. So early as the year 1630, John Rey threw out a conjecture, that the air was fixed in this metal during its calcination. Boyle, towards the end of the same century, attempted to account for the increase of weight which this metal acquired during this process; but this was only fully ascertained by Lavoisier, who repeated the experiment of Boyle, and calcined the metal in close vessels; but the method of conducting this experiment and the result of it, have been already detailed. 1788

2. Tin exists in nature in three different states. It Ores. is found native, in the state of oxide, and in that of sulphurated oxide. Native tin is in brilliant plates, or regularly crystallized. The native oxide of tin, which is the most common ore of this metal, exists under a variety of forms. It is generally found crystallized. The sulphuret of tin is of a pale or dark gray colour, and when pure, has some resemblance to an ore of silver. 1789

3. To obtain the metal from its ores, they are first Analysis. roasted, and then treated with a flux, to reduce the metal. It has been recommended by some, to mix a small quantity of pitch with the fused mass, to prevent the oxidation of the tin. After the ore is roasted, it fuses readily with three times its weight of black flux, and a little decrepitated muriate of soda.

In the humid way, native tin may be dissolved in nitric acid, which readily oxidates, and reduces it to the state of white powder, which is an oxide of tin; and if it contain iron and copper, these two metals remain in the solution. 1790

4. Tin is of a white colour, nearly as brilliant as Properties. silver. The specific gravity of tin is 7.291. It is one of the softest of the metals. It may be scratched with the nail, and easily cut with a knife. It is extremely flexible, and produces a peculiar noise when it is bent or folded. It is so malleable, that it can be easily beaten out to $\frac{1}{1000}$ part of an inch, which is the thickness of tinfoil. It has little elasticity or tenacity. A wire of this metal about $\frac{1}{10}$ of an inch in diameter supports a weight of about 30 lbs. without breaking. 1791

5. Tin is susceptible of very considerable expansion Action of heat. by means of caloric, and on this account it has been proposed to employ it as a pyrometer. Tin is one of the most fusible of the metals, and melts at the temperature of 442°, but it requires a very high temperature to raise it in vapour. If it be allowed to cool slowly, and when the surface becomes solid, by pouring out part of the liquid metal, crystals are formed, in large rhomboids, composed of a great number of small needles. 1792

6. Tin is a good conductor of electricity. It Odour, &c. possesses a peculiar odour, which is communicated to the hands by friction. It has also a perceptible taste. 1793

7. When this metal is exposed to the air, it is soon Oxidation. tarnished, and assumes a grayish white colour; but it undergoes no farther change. When it is melted in an open vessel, it is soon covered with a grayish pellicle, which is the commencement of the oxidation of the

the metal. When this pellicle is removed, another forms, and so on successively sill the whole is oxidated. By continuing the heat, and by agitation, the process goes on more rapidly, and the metal is converted into a whitish powder. This oxide contains about 20 parts of oxygen in 100 of the metal. With the addition of lead to promote the oxidation, this oxide is the *putty of tin*. It contains about two parts of oxide of lead, and one part of oxide of tin. But when tin is strongly heated, it is converted into a fine white oxide, which during the process gives out a vivid white flame. This oxide is condensed in the cold, and crystallizes in shining transparent needles.

1794 Two oxides. According to Proust, tin combines with two proportions of oxygen, thus forming two oxides. The yellow oxide, which has the smaller proportion of oxygen, may be prepared by dissolving tin in nitric acid diluted with water, without the aid of heat. By precipitating the oxide with pure potash, it is obtained in the form of a yellowish powder. Its component parts are those already stated, namely,

20 oxygen,
80 tin,

100

By dissolving tin in concentrated nitric acid, with the assistance of heat, the whole is converted with effervescence into a white powder, which falls to the bottom of the vessel. The component parts of this oxide are, 28 oxygen, and 72 of tin.

8. There is no action between tin and azote, hydrogen, or carbon, nor is there any perceptible action between tin or its oxides and water.

1795 Phosphuret. 9. Phosphorus combines very readily with tin, by projecting bits of phosphorus on melted tin in a crucible. A phosphuret of tin is thus obtained, which crystallizes on cooling. This compound is of a silvery white colour, may be cut with a knife, and extended under the hammer, but soon separates into plates. The filings of this phosphuret are like those of lead, and when they are thrown on red-hot coals, they take fire, and burn with the smell and flame of phosphorus. By the action of the blow-pipe, the phosphorus only burns, and the small metallic button which remains is surrounded with a transparent glass. Pelletier distilled this phosphuret often with hyperoxymuriate of mercury, and obtained a fuming muriate of tin, with the mercury reduced to the metallic state, and phosphorated hydrogen gas, which exploded as it came in contact with the air. There remained in the retort a spongy inflammable matter, which he supposed to be a compound of tin and phosphorus.

1796 Sulphuret. 10. Sulphur combines very readily with tin, by adding the sulphur to the metal while in a state of fusion. This compound forms a grayish or bluish matter, which has a metallic lustre, a lamellated structure, and crystallizes in cubes, or in octahedrons. It is decomposed by acids with effervescence. The component parts are, according to

1797 Composition.

	Bergman.	Pelletier.
Tin	80	85
Sulphur	20	15
	100	100

11. If equal parts of oxide of tin and sulphur be fused together in a retort, sulphurous acid and some sulphur are disengaged, and there remains in the vessel a compound of a brilliant golden colour. It crystallizes in six-sided plates. It is not acted on by the acids. When it is strongly heated, it gives out sulphurous acid and sulphur, and there remains behind a black mass, which is sulphuret of tin. This compound, which is a sulphurated oxide of tin, was formerly distinguished by the name of *aurum musivum*, *musicum*, or *mosaicum*. The component parts of this sulphurated oxide of tin are, 1798 Sulphurated oxide.

Oxide of tin	60
Sulphur	40
	100

12. Tin enters into combination with many of the metals, and forms alloys with them, some of which are of great importance. It also combines with acids, and forms salts. The affinities of tin and its oxides are in the following order: 1799 Affinities.

Tin.	Oxide of Tin.
Zinc,	Tartaric acid,
Mercury,	Muriatic,
Copper,	Sulphuric,
Antimony,	Oxalic,
Gold,	Arsenic,
Silver,	Phosphoric,
Lead,	Nitric,
Iron,	Succinic,
Manganese,	Fluoric,
Nickel,	Saclactic,
Arsenic,	Citric,
Platinum,	Lactic,
Bismuth,	Acetic,
Cobalt,	Boracic,
Sulphur.	Prussic.

I. Salts of Tin.

1. Sulphate of Tin.

1. Sulphuric acid acts very feebly on tin in the cold. The acid, however, is at last decomposed; its oxygen combines with the metal, sulphurous acid gas is emitted, and the oxide falls to the bottom in the state of white powder. In this case, the oxide has the smaller proportion of oxygen, and then the solution is more permanent. There is no precipitation by water. 1800 Two sulphates.

2. But when the solution of tin in sulphuric acid is promoted by the action of heat, the acid is still farther decomposed; a greater quantity of sulphurous acid is given out, and sulphur is deposited. In this case the white oxide of tin is formed. This compound, when evaporated, assumes the form of a jelly, and does not crystallize by the addition of water. It is precipitated in the form of white powder. The first might be called the yellow sulphate of tin, and the second the white sulphate of tin.

2. Sulphite of Tin.

When tin is immersed in liquid sulphurous acid, it assumes a yellow colour. At the end of some days it becomes

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becomes black like charcoal, and there is deposited in the liquid a black powder. In this process part of the sulphurous acid is decomposed; its oxygen combining with the metal, forms an oxide, which enters into combination with another part of the acid, and forms the sulphate of tin. A portion of sulphur is deposited along with a white sulphite, which is not very soluble, and another portion remains in solution with part of the sulphite, forming a sulphurated sulphite. A third portion of the sulphur combines with part of the metallic tin, and forms a black sulphuret, on which the acid has no action *.

* *Fourcroy Connaiss. Chim.* iv. p. 30.

3. Nitrate of Tin.

1801 History. 1. Nitric acid produces a very violent action with tin. It is accompanied with great heat, and the evolution of nitrous gas. The metal is converted into a white oxide, which gives to the liquid the appearance of coagulated milk. It had been long observed by chemists, that the solution of tin in nitric acid was not permanent, for by evaporating or concentrating the solution, the oxide is always precipitated. This difficulty has been solved by the discoveries of modern chemistry.

1802 Preparation. 2. If tin be dissolved in nitric acid, diluted with water, and the great increase of temperature moderated by the application of cold, as by immersing the vessel in cold water, a solution of a small quantity of the oxide of tin is effected. The solution is of a yellow colour, and contains the oxide of tin, with a smaller proportion of oxygen, which is the yellow oxide. In this process the tin is chiefly oxidated by the decomposition of the water. In this process, too, ammonia is formed from the azote of the acid combining with the hydrogen of the water. This becomes perceptible by adding potash to the liquid. When the solution is heated, the oxide of tin is separated in great abundance.

1803 In different proportions. 3. But when nitric acid is more concentrated, a more violent action takes place between this acid and tin. The metal is oxidated, and the whole of it separates from the liquid. To one part of pure nitric acid Guyton added $1\frac{1}{2}$ of tin in a retort, when a violent effervescence took place, but no gas was given out. In this experiment a quantity of ammonia equal to $\frac{1}{20}$ of the weight of the acid and tin employed, was formed. The acid and the water are decomposed, and the oxygen of both combines with the tin, and forms an oxide, while the azote of the acid and the hydrogen of the water combine together and form ammonia. In this state of oxidation, the tin does not combine with the acid.

4. Muriate of Tin.

1804 Preparation. 1. Concentrated muriatic acid dissolves tin, either in the cold or with the assistance of a gentle heat. The acid is soon deprived of its fuming property, and of its yellow colour. A slight effervescence takes place, which is owing to the decomposition of water, and the evolution of a fetid hydrogen gas. This peculiar odour is supposed to be occasioned by the hydrogen gas holding in solution a portion of the metal. Muriatic acid dissolves more than $\frac{1}{2}$ its weight of tin. No precipitate is formed, as with the other acids. When it is

1805 Properties. evaporated, it furnishes crystals in the form of brilliant needle-shaped prisms, which are deliquescent in the air.

2. This muriate of tin is precipitated by the alkalies 1806 Decomposition. in the form of a copious white oxide, which is re-dissolved with an excess of alkali. The alkaline solution is of a brownish yellow colour. The sulphuret of ammonia precipitates this salt in the form of powder, which becomes black as it dries, and by distillation yields ammonia and *aurum musivum*. The sulphuret of potash produces a yellow precipitate, which, by distillation, furnishes sulphurous acid and sulphur, and what remains is converted into *aurum musivum*, or the sulphurated oxide of tin. This oxide, precipitated by means of soda, and distilled with its weight of sulphur, yields sulphurous acid gas, sulphur, and the residuum is *aurum musivum*.

3. This solution of tin absorbs oxygen, with the evolution of heat, from oxymuriatic acid, which is deprived 1807 Absorbs oxygen. of its odour. With nitric acid, a violent effervescence takes place. Nitrous gas is disengaged, and in both these cases, the oxide of tin combines with an additional portion of oxygen. With the addition of sulphurous acid, this solution of tin deposits the yellow sulphurated oxide of a fine bright colour. This solution converts 1808 Forms an oxymuriate. arsenic acid into the metallic state, and it produces the same effect on the molybdic and tungstic acids, by combining with their oxygen. The red oxide of mercury, the hyperoxymuriate of mercury, the white oxide of antimony, the oxides of zinc and silver, are all reduced to the metallic state by being deprived of their oxygen by the muriate of tin. This muriate also precipitates from the solution of gold, *the purple powder of Cassius*, by attracting that portion of oxygen which renders the oxide of gold soluble. In all these processes, the results of which were ascertained by Pelletier, the muriate of tin is converted into an oxymuriate.

4. This oxymuriate of tin is formed by making a 1809 Formed by another process. stream of oxymuriatic acid gas pass into a solution of muriate of tin. It is also prepared by triturating equal parts of an amalgam, consisting of two parts of tin, and one of mercury, and muriate of mercury, or corrosive sublimate, and distilling this mixture in a glass retort, with a very moderate heat. A colourless liquor first passes over, which is followed with the sudden evolution of a white vapour, which lines the inside of the receiver. This vapour is condensed into a transparent liquid, which, in the air, exhales a copious, heavy, white vapour, from which this liquid has been called *the smoking liquor of Libavius*, or the *oxymuriate of tin*. When this liquor is included in a vessel, it no longer gives out any visible vapour, but it deposits at the top of the vessel needle-shaped crystals, while similar crystals are precipitated to the bottom. Water does not precipitate the fuming muriate of tin. When it is thrown into the water, it produces a noise similar to that which is occasioned by concentrated sulphuric acid. A number of transparent bubbles of air being evolved from the mixture, collect on the surface, and become white by the contact of air. By agitating the water, they are more readily dissipated, and the liquid fumes no longer.

5. Nitromuriatic acid, which is composed of one 1810 In nitromuriatic. part of nitric acid, and two or three of muriatic acid, very readily dissolves tin. A strong heat is produced, which

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which may be moderated by immersing the vessel, in which the solution is made, in cold water. The metal should be added in small portions, and one part should be dissolved before the addition of another. In this way the acid will dissolve half its weight of tin. It is by this process that the muriate of tin is obtained for the purpose of dyeing scarlet; but it is found to vary considerably in its effects, which, no doubt, depends on the strength of the acids employed, and the different proportions in the mixture. This solution is almost always coloured. Sometimes it affords a gelatinous mass on cooling, which becomes in time more solid. Sometimes it is of a white colour like milk. This solution has not the fetid odour of the simple solution of tin in muriatic acid. It often happens, that it does not assume the viscid or solid form, without the addition of $\frac{1}{4}$ its weight of water. It is then slightly opaque, which is owing to the precipitation of part of its oxide. When this solution is heated, an effervescence takes place; the tin is more strongly oxidated, and it is generally after this process that it assumes the form of a transparent jelly.

5. Fluate of Tin.

Fluoric acid has very little action on tin, but it dissolves its oxide, and forms with it a solution which assumes a gelatinous form. The fluate of tin may be also obtained by adding a solution of an alkaline fluate to a solution of tin in muriatic acid.

6. Borate of Tin.

By a similar process boracic acid combines with the oxide of tin, and forms a borate of tin, which is insoluble.

7. Phosphate of Tin.

This salt may be formed by precipitating the oxide of tin from its solution in muriatic acid, by means of an alkaline phosphate. A phosphate of tin is thus obtained, which is insoluble in water.

8. Carbonate of Tin.

This salt is prepared by precipitating the oxide of tin from its solution in muriatic acid, by means of the carbonates of the alkalies. When this carbonate of tin is dissolved in an acid, it effervesces; but, according to Bergman, the oxide of tin, precipitated by an alkaline carbonate, is not found to have received any sensible addition of weight, so that the effervescence occasioned by the action of an acid, on what is supposed to be a carbonate of tin, probably depends on the decomposition of the acid itself.

9. Arseniate of Tin.

Arsenic acid, with a moderate heat, dissolves a small quantity of tin, and the solution assumes the form of a jelly. Arseniate of tin is formed by adding to a solution of tin in muriatic acid, an alkaline arseniate. A precipitate is formed, which is arseniate of tin in the state of insoluble powder.

All the metallic acids are decomposed by means of tin. They also combine with the oxide of tin, and form salts in the state of powder, which has little solubility.

10. Acetate of Tin.

Acetic acid dissolves only a small portion of tin; but when the acid is boiled on tin, the action is more powerful, and the solution, which is of a whitish colour, affords by evaporation small crystals. The solution of tin in acetic acid sometimes does not crystallize, but affords only a gelatinous mass; so that, by the action of acetic acid on tin, the metal is either in different degrees of oxidation, or there are different proportions of the acid and base.

11. Oxalate of Tin.

Oxalic acid added to tin in thin plates or filings, first blacken the surface, which is afterwards covered with a white powder. The oxalate of tin, which is soluble in water, has an austere metallic taste. By slow evaporation it furnishes needle-shaped or prismatic crystals. When it is more rapidly evaporated, it affords a transparent mass like horn.

12. Tartrate of Tin.

Tartaric acid dissolves the oxide of tin, but the nature of this salt has not been examined.

13. Tartrate of Potash and Tin.

This triple salt may be obtained by boiling together the oxide of tin and tartar in water. It is a soluble salt, and crystallizes with difficulty. It is not precipitated by the alkalies or the alkaline carbonates.

14. Benzoate of Tin.

This salt is formed by adding to a solution of tin in muriatic acid benzoate of potash. The benzoate of tin is precipitated, which is soluble in water, with the assistance of heat.

15. Succinate of Tin.

The oxide of tin is dissolved by succinic acid with the assistance of heat. When the solution is evaporated it affords thin transparent crystals of succinate of tin.

II. Action of Alkalies, &c. on Tin.

1. Tin in the metallic state is little changed by the action of the alkalies; but the oxides of tin readily combine with these bodies. The combination of the oxide of tin with the fixed alkalies is effected, either in the dry or humid way; and with the assistance of heat the oxide of tin combines with liquid ammonia. This combination takes place most readily when the oxide is recently precipitated, when it is in the state of minute division. 1811 Alkalies.

2. The oxide of tin combines with the earths by fusion; and with the addition of a fixed alkali, forms an opaque vitreous mass, which is employed for the purposes of enamel. 1812 Earths.

3. Most of the salts are decomposed by means of tin, in consequence of the strong affinity of this metal for oxygen. 1813 Salts. All the sulphates, when heated with this metal, are more or less rapidly converted into sulphurets. Equal parts of sulphate of potash and tin, heated together in a crucible, afford a greenish coloured mass, which has no metallic appearance, and which seems to be a sulphuret of potash and tin. 1814 Sulphates. The nitrates produce 1815 Nitrates.

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duce deflagration with this metal, with the assistance of heat. If the tin be melted in a crucible, and brought to a red heat, and dried nitre in powder be projected into it, a white brilliant flame is produced, and when the detonation has entirely ceased, the tin is found to be oxidated. This experiment may be also made, by mixing together tin filings with three parts of nitre in
1816 Muriates. powder, and projecting the mixture into a red-hot crucible. Muriate of ammonia is decomposed by tin; and by adding sulphur, the sulphurated oxide of tin, or *aurum musivum*, is obtained. Eight parts of tin united to eight parts of mercury, with six of sulphur, and four of muriate of ammonia, afford, according to the process of Pelletier, a very beautiful *aurum musivum*.

It was observed by this philosopher, that during the process, sulphurated hydrogen gas, sulphuret of ammonia, and muriate of tin, were produced; that the tin oxidated and united to the sulphur, formed aurum musivum; and that a part of this matter, composed of the different substances, in a state of vapour, was deposited in lamellated, hexangular crystals, in the upper part and in the neck of the retort.

The alkaline hyperoxymuriates, but especially that of potash, produce a violent detonation with this metal. Three parts of this salt, mixed with one of tin in fine powder, rapidly deflagrates when brought into contact with a burning body. During this combustion, there is a brilliant and sudden flame, and the metal is reduced to the state of vapour. The same mixture by percussion produces a violent detonation with a considerable flame in the dark.

Many of the metallic solutions and metallic salts are decomposed by means of tin, and are either reduced to the metallic state, or deprived of a considerable portion of their oxygen.

III. Alloys.

1817 Arsenic. 1. Tin and arsenic form an alloy by fusion. The compound, when the proportion of arsenic is considerable, is white, brittle, more sonorous and harder than tin. In the proportion of 15 parts of tin and one of arsenic, the alloy crystallizes in large plates, is more infusible than tin, and more brittle than zinc. By exposure to the air, and with the assistance of heat, the arsenic is driven off.

1818 Cobalt. 2. With cobalt tin forms an alloy which is in small grains, and of a light violet colour.

1819 Bismuth. 3. Tin combines with bismuth. The tin is then harder, more sonorous and brighter. The compound in certain proportions becomes more fusible than either of the two metals. The alloy of equal parts of tin and bismuth melts at 280°. Eight parts of tin and two of bismuth melt at 390°, and two of tin and one of bismuth at 330°.

1820 Antimony. 4. Tin combines with antimony, and forms an alloy which is white and brittle, and has a specific gravity less than that of the two metals taken separately. The antimony gives hardness to the tin, and changes its texture. This alloy is employed in many arts, and particularly for the plates on which music is engraved.

1821 Mercury. 5. Tin combines very readily with mercury, and in all proportions. The tin is even dissolved when the quantity of mercury is considerable. This union takes place in the cold, but it is greatly promoted by means of heat. The heated mercury is poured upon the tin in fusion. The amalgam of tin is susceptible of crystallization in the form of cubes. Sage observed the crystals of this amalgam in gray brilliant plates, thin towards the edges, and leaving between them polygonal cavities.

This amalgam is employed for covering mirrors. In applying it, tinfoil is spread on a smooth flat stone or table, and mercury, in which a certain proportion of tin has been already dissolved, is poured upon it. It is then spread equally over the whole with a feather or a piece of cloth. The plate of glass, one side of which is to be covered, is then applied to the edge of the table, and cautiously moved along the tinfoil, so that the redundant part of the mercury may be carried before it. What remains enters into union with the tin. The glass is then to be equally loaded with weights, to press out any part of the mercury which may yet remain uncombined with the tin. In the course of a few hours the amalgam of the two metals adheres so firmly to the glass, that the weights may be removed. 1822

6. Zinc readily forms an alloy with tin by fusion. Zinc. The compound affords a hard metal with small grains, the ductility of which corresponds to the quantity of tin. The alloy of tin and zinc forms part of the compound which is known by the name of *pewter*. 1823

Tin is applied to a great many important purposes. Uses. In the arts and domestic economy, it is formed into a great variety of vessels and instruments. The alloys of tin with other metals are not less important. It forms a component part of type metal, and bell metal. The oxides of tin are employed for the purpose of polishing glass and metallic substances, and combined with the earths and alkalies for the fabrication of enamels. The salts of tin are employed for the preparation of colours in dyeing, or as a valuable mordant for fixing certain colours. Tin in the metallic state has been exhibited as a remedy against worms. It is then granulated by constant agitation while it cools after fusion; but it is supposed, if it produces any effect as a vermifuge medicine, that it is merely by its mechanical action.

Sect. XIX. *Of Lead and its Combinations.*

1824

1. Lead has been known from the earliest ages. History. Pliny speaks of it under the name of black lead, probably to distinguish it from tin, with the properties of which he was also acquainted, for he observes that it was sometimes the practice to contaminate tin with lead. 1825

2. Lead is found in great abundance in many parts Ores. of the world, and in a great variety of forms and combinations. Lead has rarely, if ever, been found native, and it is doubted whether it has yet been discovered in the state of oxide. The most common form of lead is in the state of sulphuret, when it is combined with sulphur. In this state it is of a gray, brilliant colour, of a lamellated texture, very brittle, and breaks into cubes. This is the most frequent combination of lead, and it is generally found in this state in veins. Lead is also frequently met with combined with several of the acids. The carbonate, phosphate, and arseniate of lead are not uncommon productions in the cavities of the veins of sulphuret of lead. The chromate, molybdate, and sulphate of lead, are more rare.

3. The sulphuret of lead, which is the most common ore, is reduced by roasting, and then fusing with black
1826 Analysis. flux. The other ores of lead are to be analyzed according to the nature of the acid with which they are combined. To obtain lead in a state of purity, it may be dissolved in nitric acid, and precipitated by means of sulphate of soda. The precipitate, which is sulphate of lead, is well washed, and reduced in a crucible, by fusing it with three times its weight of black flux.

1827 Properties. 4. Lead is of a grayish or bluish white colour. It has considerable brilliancy, but it soon tarnishes when exposed to the air. The specific gravity of lead is 11.352. It gives out a peculiar odour when it is rubbed; it has at first scarcely any perceptible taste; but a disagreeable impression after some time remains on the tongue. When it is taken internally, it produces violent effects on the animal economy, even in very small quantity. The colica pictonum or dry belly-ach of the West Indies, or, as it is called in this country, *mill-reek*, which is a violent affection of the bowels, is occasioned by this metal being taken internally, either combined with some liquid, or in the state of vapour. This terrible disease often terminates in palsy. Lead stains the finger or paper of a bluish colour. It is one of the softest of the metals. It may be scratched with the nail or cut with a knife. It possesses considerable malleability, and may be reduced to plates thinner than paper. It has no great ductility, and its tenacity is less than that of the other metals. A lead wire of about $\frac{1}{11}$ of an inch in diameter can support only a
1828 weight of about 18 ℔.

Action of heat. 5. Lead is very fusible. It melts at the temperature of 540°, or, according to the estimation of Guyton, at 594°. When it is kept a long time melted, and at a red heat, it sublimes, and evaporates in the air. By slow cooling it crystallizes in quadrangular
1829 pyramids composed of octahedrons.

Oxidation. 6. When lead is exposed to the air, it soon tarnishes, is deprived of its lustre, and becomes first of a deep gray, and afterwards of a grayish white colour; but this process is extremely slow, for the white crust which is formed on the surface defends the metal from the action of the air, and its farther oxidation by absorption of oxygen.

When lead is melted in the open air, and heat continued, an iridescent pellicle is formed on the surface, which afterwards assumes a uniform gray colour. When
1830 this is removed, another pellicle is formed, and in this
Gray oxide. way the whole may be converted into an oxide. When these pellicles are heated and agitated together, the whole is converted into a grayish powder, mixed with yellowish or greenish spots. This is the gray oxide of
1831 lead, which is the first state of its oxidation.

Yellow. When the gray oxide of lead is more strongly heated in contact with air, it absorbs a greater quantity of oxygen, and is converted into a yellow oxide, which is known in the arts by the name of *massicot*. It contains about nine parts of oxygen in the hundred. This oxide, which is much employed in some of the arts, is prepared in the large way, by constantly agitating it while heated, in contact with air, without applying so great a heat as to reduce the metal to the
1832 state of the next oxide.

Red. If this oxide of lead be reduced to a fine powder, and exposed to a strong heat in a furnace for about 50 or 60 hours, it is converted into a red powder, which is well known by the name of *minium*, or *red lead*. The heat necessary for this conversion is that of a cherry-red, in a reverberatory furnace. 1833

Lead is susceptible of combining with another portion of oxygen, and of forming another oxide. If a quantity of red oxide of lead, according to the process of Proust and Vauquelin, be put into a vessel with water, and oxymuriatic acid gas be passed through it, the oxide assumes a deeper colour, and is dissolved. By adding potash to the solution, the lead is precipitated of a brown colour, which is the brown oxide of lead. It is of a shining brown colour, and is composed of Brown.

Lead	79
Oxygen	21
	100

By the action of the blow-pipe it becomes yellow, and melts. On burning coals it is reduced, and when heated in a retort, gives out pure oxygen gas, and is converted into a vitreous matter. It inflames sulphur by triturating it with the oxide, and gives out a bright flame. 1834

7. When lead has been converted into an oxide, and when this oxide is exposed to a more violent heat, it melts into a kind of glass, or semivitrified matter. In this state it is known by the name of *litharge*. It consists of small reddish brilliant scales, which from the colour is called *litharge of gold*. When it has been exposed to a greater degree of heat, and is more vitrified, it is distinguished by the name of *litharge of silver*. Litharge.

8. There is no action between lead and azote, hydrogen or carbon. Water has no action on lead, but it seems to promote the oxidation of this metal, when it is in contact with air. Leaden vessels which are frequently moistened with water, are covered with a white crust when exposed to the air. 1835

9. Lead combines with phosphorus, and forms with it a phosphuret. This may be prepared by projecting phosphorus on lead melted in a crucible, or by distilling phosphorus with lead in a retort. The phosphuret of lead is of a silvery white colour, with a little of a bluish shade. It is of a lamellated structure, and may be separated in plates by hammering. It is so soft that it may be cut with a knife. It is somewhat less fusible than the component parts. During its fusion, a small quantity of phosphorus separates, and takes fire on the surface. The component parts of this phosphuret are, Phosphuret. 1836 Composition.

Lead	88
Phosphorus	12
	100

10. Sulphur combines readily with lead, either by melting sulphur and lead together in a crucible, or by throwing sulphur on melted lead. A black matter is thus obtained, of a brilliant appearance, fibrous texture, and less fusible than lead. This compound is brittle, and resembles the native sulphuret of lead, or *galena*. The component parts of this sulphuret are, 1837 Sulphuret.

 Lead

Lead, &c.

Lead	86.8
Sulphur	13.2
	100.0

11. Lead enters into combination with the metals,
1838 Affinities. and forms alloys, and with the acids, and forms salts. The order of the affinities of lead and of its oxide is the following:

LEAD.	OXIDE of LEAD.
Gold,	Sulphuric acid,
Silver,	Saclactic,
Copper,	Oxalic,
Mercury,	Arsenic,
Bismuth,	Tartaric,
Tin,	Muriatic,
Antimony,	Phosphoric,
Platinum,	Sulphurous,
Arsenic,	Suberic,
Zinc,	Nitric,
Nickel,	Fluoric,
Iron,	Citric,
Sulphur.	Lactic,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

I. Salts of Lead.

1. Sulphate of Lead.

1839 Preparation. Sulphuric acid has no action on lead in the cold; but when lead is boiled with the acid concentrated, it decomposes it, and sulphurous acid gas is disengaged with effervescence. The lead is converted into a white thick mass, which remains at the bottom of the vessel. Sulphate of lead may also be obtained by adding sulphuric acid or an alkaline sulphate to acetate of lead. This salt is precipitated in the state of a white powder. The white mass obtained by the first process, being washed with water, separates into two portions, one of which is oxide of lead containing a little sulphuric acid, and the other portion, which is sulphate of lead, is soluble in water, and may be obtained crystallized in needles. The specific gravity of this salt is 1.8742. It has scarcely any taste. It is found native, and cry-
1840 Composition. stallized in regular octahedrons, or four-sided pyramids, or transparent tables. The component parts of native sulphate of lead are, according to

	Kirwan.	Klaproth.
Oxide	75.00	70.50
Acid	23.37	25.75
Water	1.63	2.25
	100.00*	98.50†

This salt is deprived of great part of its acid by means of the alkalies.

* *Min. Wat.* p. 274.

† *Essays*, ii. 131. *Transl.*

2. Sulphite of Lead.

1841 Preparation. Sulphurous acid has no action on lead; but it combines readily with the oxide of lead, with a smaller proportion of oxygen. The red oxide of lead, added to liquid sulphurous acid, soon becomes white; the acid is deprived of its colour, and there is formed a saline mass of sulphate and sulphite of lead. The sulphite of lead cannot be obtained separately, but by treating the white oxide of lead separated from the nitrate by means of sulphurous acid. The sulphite of lead is tasteless and insoluble. By the action of the 1842 Action of heat.
blow-pipe on charcoal, it melts, gives out a phosphoric flame, and becomes of a pale yellow colour on cooling. When it is heated for a longer time, it swells up, and is entirely reduced to the metallic state. When distilled in close vessels, it gives out water, sulphurous acid, and sulphur, and there remains behind, sulphate of lead of a greenish yellow colour. It is decomposed with effervescence and the evolution of sulphurous acid, by 1843 Decomposition.
means of sulphuric and muriatic acid. It is not decomposed by nitric acid, but is converted into a sulphate, and red fumes of nitrous gas are given out. If, in place of treating the red oxide with sulphurous acid, this oxide be exposed to a red heat, along with sulphite of soda, the oxide is reduced, and the sulphite of soda is converted into a sulphate, but with excess of soda, because the sulphuric acid formed, cannot saturate the same quantity of soda. Hence it appears, that the red oxide of lead gives up part of its oxygen to the sulphurous acid when it is uncombined, and the whole of its oxygen to the acid, when it is in combination with potash or soda*.

* Fourcroy viii. 86.

3. Nitrate of Lead.

1. Nitric acid, a little diluted with water, acts upon 1844 Preparation.
lead, oxidates it, and dissolves it with effervescence. If the acid be too strong, there remains behind a dry oxide. This oxide is equally soluble in nitric acid. No precipitate is formed in the solution by the addition of water. It has at first a sweetish, then an astringent, acid taste. By evaporating the solution, it affords on cooling, regular crystals in the form of flat triangles; and by slow, spontaneous evaporation, the angles are truncated. Sometimes six-sided truncated 1845 Properties.
pyramids are obtained, with the faces alternately broad and narrow. These crystals decrepitate strongly on burning coals, and give out brilliant sparks. The salt is decomposed, and a yellow or red oxide of lead remains behind. Nitrate of lead is decomposed by the alkalies, and precipitated in the form of white oxide. It is precipitated of a black colour, by means of the sulphurets and hydrosulphurets; it is also decomposed by sulphuric acid and the sulphates, which form a thick, white, soluble precipitate of sulphate of lead. Sulphurous acid also precipitates this salt in the form of sulphate of lead.

2. The former salt is a compound of nitric acid and 1846 With the white oxide.
the yellow oxide; but when nitric acid combines with the white oxide, the salt crystallizes in yellow coloured brilliant scales, which are very soluble in water. This salt may also be prepared by boiling together a quantity of nitrate of lead with the yellow oxide, along with lead in the metallic state. The lead deprives the yellow oxide of part of its oxygen, and the whole is converted into the white oxide, and combines with the acid.

3. But if nitric acid be poured on the red oxide of 1847 Action on red oxide.
lead, heat is produced, the oxide becomes white, part is dissolved, and part falls to the bottom in the form of

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 a black powder. This powder is the brown oxide of lead, with the greatest proportion of oxygen, part of which it has derived from the red oxide, which is then converted into the white. About $\frac{6}{7}$ of the red oxide are dissolved in the acid, but are previously reduced to the state of white oxide, and the oxygen which has been given out, combines with the remaining $\frac{1}{7}$, and converts it to the state of brown oxide. Thus it appears, that the red and the brown oxides of lead do not form compounds with nitric acid. They must be deprived of a portion of their oxygen, and converted into the white or yellow oxides, before they are soluble in this acid.

4. Muriate of Lead.

1847 Preparation. 1. Muriatic acid acts feebly on lead or its oxide; but when it is heated with the latter, part of the oxide combines with the acid, becomes soluble with excess of acid, and affords crystals in the form of shining silky needles, which are not deliquescent in the air, but are soluble in water, and have an astringent taste. This salt may be formed by adding an alkaline muriate to a solution of nitrate of lead. A white thick precipitate is immediately formed. The muriate of lead thus obtained, has a sweetish taste, and is soluble in about 30 times its weight of water. When heated, it readily melts, and gives out a white vapour, which condenses into a crystalline powder. When this salt is melted, it assumes the appearance of a semivitreous, shining, grayish mass, which has been called *plumbum corneum*, or *horny lead*.

1848 Composition. This salt is decomposed by sulphuric acid. Its component parts are, according to

	Klaproth.	Kirwan.
Acid	13.5	18.23
Oxide of lead	86.5	81.77
	100.0	100.00

1849 With red oxide. 2. When muriatic acid is slightly heated with the red oxide of lead, the acid is converted into oxymuriatic acid; while the oxide, deprived of part of its oxygen, unites to another portion of the acid, and forms muriate of lead in the state of white powder.

5. Hyperoxymuriate of Lead.

1850 Preparation. When oxymuriatic acid gas is made to pass through water, having a white, yellow, or red oxide of lead, it is absorbed. The oxide becomes at first black or brown, and is then dissolved. The hyperoxymuriate which is formed, remains in solution of a yellow colour. This solution being precipitated with potash or soda, the oxide of lead is deposited, of a reddish brown colour. This salt may be obtained by pouring oxymuriatic acid on nitrate of lead. No precipitate is at first formed, but in the end a brownish red powder appears. This salt is more soluble than muriate of lead, and is readily decomposed. The brown oxide of lead, which is obtained by decomposing this salt, according to the experi-

1851 Properties. ments of Vauquelin, possesses very different properties from those of the other oxides of this metal. It is of a deep, shining, velvet-brown colour. Heated with the blow-pipe, it becomes yellow, and melts. On red-hot coals it is reduced; it gives out pure hydrogen gas, when it is heated in a retort, and there remains behind a litharge of lead. It dissolves in nitrous acid, but is insoluble in nitric acid. The addition of sugar, honey, or some vegetable matter, by depriving it of part of its oxygen, renders it soluble in this acid.

6. Fluate of Lead.

This salt may be formed by pouring a solution of an alkaline fluate into a solution of nitrate of lead. An insoluble insipid salt is thus formed, which is decomposed by sulphuric, nitric, and muriatic acids.

7. Borate of Lead.

This salt is formed in the same way as the last, and is in the state of white powder. It melts before the blow-pipe, into a colourless glass.

8. Phosphate of Lead.

1. Liquid phosphoric acid acts very slowly upon lead, and converts it into a white, insoluble phosphate. 1852 Preparation.
It may be formed, however, by adding an alkaline phosphate to the nitrate of lead. With an excess of acid this salt becomes fusible by heat, and when it cools, assumes the form of regular polyhedrons. It is decomposed by red-hot charcoal, which converts it into phosphorus and lead, while the carbon of the charcoal is converted into carbonic acid. It is decomposed by sulphuric, nitric, and muriatic acids, and by the alkaline carbonates.

2. This salt is frequently found native, crystallized in six-sided prisms, of a green or yellow colour. 1853 Native. It is soluble in pure soda, but insoluble in water. The component parts of a phosphate of lead from Wanlockhead in Scotland, according to the analysis of Klaproth, are the following:

Oxide of lead	80.00
Phosphoric acid	18.00
Muriatic	1.62
	99.62 *

* Essays, ii. 125. Transl.

9. Carbonate of Lead.

1. Carbonic acid which has no action on lead, combines with its oxide; which is converted into the carbonate of lead; or this salt may be prepared by the decomposition of a soluble salt of lead by an alkaline carbonate. 1854 Preparation. Thus precipitated, it is in the state of white powder, which has neither taste nor smell, and is insoluble in water, but it is soluble in pure potash.

2. This salt is frequently found native, of a whitish colour, and crystallized in tables, in six-sided prisms, 1855 Native. or in regular octahedrons. The specific gravity is 7.2357. It is insoluble in water. By the action of the blow-pipe on charcoal, the acid is driven off, and the lead is revived. The component parts of carbonate of lead are, according to

	Bergman.	Klaproth.
Acid	16	16.33
Yellow oxide	84	83.67
	100	100.00

3. Ceruse, or white lead, which is employed as a paint, is a carbonate of lead, combined with a certain 1856 White lead.
proportion

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proportion of oxide. It is prepared by exposing thin plates of lead to the vapour of vinegar. A range of pots are placed on tanners bark or horse dung, that they may receive a moderate heat. These are covered with plates of lead, which are full of holes. Another range of pots is placed above these, covered in like manner with plates of lead, and so on, till the whole chamber is filled. The acid is decomposed; part of the lead remains in the state of oxide, while the greatest proportion is converted into a carbonate, which is the white lead of commerce.

10. Arseniate of Lead.

When lead is digested in a solution of arsenic acid, the surface is blackened, and becomes covered with a white powder. When lead filings are distilled with double their weight of solid arsenic acid, the mixture melts into a transparent mass. A small quantity of arsenious acid is separated, and there remains behind a whitish glass, which being diluted with water, lets fall a white powder, whilst part of the arsenic acid is dissolved. The lead in this case has deprived the arsenic acid of part of its oxygen, and in the state of white oxide has combined with another portion of the acid. The arseniate of lead is not soluble in water. By heat it fuses into a white glass. This salt is found native,
1857 Composition. and by the analysis of Mr Chenevix it is composed of

Acid	33
White oxide	63
Water	4
	100

11. Tungstate of Lead.

Tungstic acid separates the oxide of lead from its solution in nitric acid, and forms a tungstate of lead, in the form of a white powder.

12. Molybdate of Lead.

When molybdic acid is added to the solution of lead in nitric acid, it forms a copious white precipitate, which is molybdate of lead. This salt is found native, and crystallized in cubes or rhomboidal plates. It is of a yellow colour, insoluble in water, but soluble in fixed alkalies and nitric acid. It is decomposed by muriatic acid. The component parts, as ascertained by Klaproth, are,

Acid	34.7
Oxide	65.3
	100.0

13. Chromate of Lead.

An alkaline chromate mixed with the solution of nitrate of lead, forms a precipitate in the state of red powder, which is chromate of lead. This salt is found native, of a reddish yellow colour, and crystallized in four-sided prisms, terminated by four-sided pyramids. The specific gravity is about 6. It is soluble in the fixed alkalies, but insoluble in water. It is decomposed by muriatic and sulphuric acids, but dissolves without decomposition in nitric acid. According to the analysis of Vauquelin, it is composed of

Acid	34.9
Oxide	65.1
	100.0

14. Acetate of Lead.

1858 Name. 1. The combination of acetic acid and lead was formerly known by the names of *extract of Saturn*, *salt of Saturn*, *sugar of Saturn*, or *sugar of lead*. This acid oxidates lead, and dissolves the oxides with great facility. It is formed by dissolving carbonate of lead or ceruse in acetic acid, or by exposing thin plates of lead to the action of acetic acid in earthen vessels. After the acid has been sufficiently saturated, and the solution concentrated by evaporation, the acetate of lead is deposited in small crystals. 1859 Preparation.

1860 Properties. 2. This salt is in the form of small crystals, which are flat, four-sided prisms, terminated by two-sided summits. It has an astringent sweetish taste. The specific gravity is 2.345. It is not very soluble in water, without an excess of acid. It undergoes no change by exposure to the air. By its solution in water, a small quantity is deposited in the form of white powder, which is a carbonate of lead, formed by the carbonic acid which exists in the water.

1861 Decomposition. 3. Acetate of lead is decomposed by sulphuric, muriatic, fluoric, and phosphoric acids. It is decomposed by heat. By distillation it affords, according to the experiments of Proust, from 160 parts of the salt 12 parts of slightly acidulated water; with a greater heat, 72 parts of a yellow liquid, having the odour of alcohol, which had something of an empyreumatic smell. Ammonia was disengaged, by adding lime to the liquid; and when the liquid was saturated with potash, and remained at rest for 24 hours, a third part of oil separated, and floated on the surface. This oil, which had a strong odour, was removed, and the liquid distilled with a moderate heat. The first part that came over mixed with water like alcohol, and was almost as volatile as ether. When it was brought into contact with a burning body, it gave out a white flame.

15. Oxalate of Lead.

Oxalic acid very readily tarnishes lead, and at last corrodes it. It readily dissolves the oxide; and when it is saturated, the solution becomes thick, and deposits small shining crystals, which becomes readily opaque by exposure to the air. This salt may be formed by pouring oxalic acid into the solutions of nitrate, muriate, or acetate of lead. It is scarcely soluble in water, without an excess of acid. The component parts are,

Acid	41.2
Oxide	58.8
	100.0

16. Tartrate of Lead.

Tartaric acid combines with the oxide of lead, or forms a precipitate in the state of an insoluble white powder,

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Lead, &c. powder, from the solution of lead in nitric and muriatic acids. It is composed of

Acid	34
White oxide	66
	100*.

* Ann. de Chim. xxxviii. 37.

17. Tartrate of Potash and Lead.

This triple salt is obtained by boiling the oxide of lead in tartar with water. It is insoluble, and is not decomposed by the alkalies.

18. Nitrate of Lead.

By adding citric acid to a solution of acetate of lead, a citrate of lead precipitates in the form of powder, which is scarcely soluble in water.

19. Malate of Lead.

This salt is obtained by adding malic acid to a solution of the nitrate or acetate of lead. The malate of lead precipitates in the form of fine light flakes. It is soluble in acetic and diluted nitric acids.

20. Benzoate of Lead.

Benzoic acid has but a feeble action on lead. By evaporating the solution, crystals of a brilliant white colour are obtained, which are benzoate of lead. This salt undergoes no change by expsoure to the air, is soluble in water and alcohol, is decomposed by heat, and by the sulphuric and muriatic acids.

21. Succinate of Lead.

Succinic acid combines with the yellow oxide of lead, and yields slender foliated crystals, which are nearly insoluble in water, but soluble in nitric acid.

22. Saccolate of Lead.

When saclactic acid is added to solution of nitrate of lead, a white precipitate is obtained, which is saccolate of lead.

23. Suberate of Lead.

Suberic acid forms a precipitate when added to the solution of lead in acetic and nitric acids.

24. Lactate of Lead.

Lactic acid, after it has been digested upon lead for some days, dissolves a portion of it. The solution has a sweet, astringent taste, but it does not crystallize.

II. Action of the Alkalies, &c. on Lead.

1862 Promote its oxidation. 1. The alkalies and earths have no action whatever on lead. The alkalies, however, promote its oxidation by the air, on account of the attraction which they possess for the oxide of lead.

1863 Combine with the oxide. 2. The alkalies and alkaline earths unite readily with the oxide of lead. Lime water digested some time with oxide of lead in the state of litharge, dissolves this oxide better than the red. When the solution is evaporated, it affords small, transparent, iridescent crystals, not more soluble than lime. The alkaline sulphates decompose this compound of oxide of lead and lime. It is also decomposed by sulphurated hydrogen gas, and by sulphuric and muriatic acids, which latter convert the lead into a sulphate and muriate. This solution blackens wool, the nails, hair, the white of an egg; but has no action, and produces no change, on silk, on the skin, or the yolk of an egg. It has been observed, that the simple mixture of red oxide of lead and of lime, which latter converts it to white, produces a black colour on animal matters. It is sometimes employed for dyeing the hair. It had formerly been observed by Bergman, that the caustic fixed alkalies dissolve the oxide of lead, which takes place when these bodies are added in excess to the precipitate of this metal from its solution.

1864 Earths. 3. The earths, but especially alumina and silica, readily combine with the red oxide of lead, by the action of heat; and, when the proportion of oxide is considerable, the compound is a heavy, uniform, vitreous mass, which has been called *glass of lead*. It is on account of the strong tendency of the oxide of lead to vitrification, and which it communicates to earthy matters, that it is employed in the composition of glass in the proportion of from $\frac{1}{3}$ to $\frac{1}{5}$. This oxide was only employed formerly, for the preparation of enamels, and for glazing pottery and stone ware; but it is now generally used after the example of the English manufacturers, in the fabrication of glass, in most countries of Europe.

1865 Sulphates, &c. 4. Lead has no action on the sulphates. It burns slowly with the assistance of the nitrates. When nitre, in the state of fine powder, is thrown into melted lead, raised to a red heat, there is scarcely any perceptible flame; and, when the action has ceased, the oxide is found in small yellowish semivitrified scales, similar to those of litharge.

1866 Muriates. 5. There is a perceptible action between lead and the muriates, some of which have given rise to several important processes in chemistry, and in the arts. It had been long observed, that a plate of lead immersed in water, saturated with muriate of soda, was soon covered with a crust of white oxide. It was also known, that the red oxide of mercury and litharge became white when kept in contact with muriate of soda dissolved in water. This process, which is promoted by agitation, is one of the great desiderata of modern chemistry, to be able to decompose common salt for the purpose of obtaining the soda. It was at first supposed, that this was a partial decomposition, from which a small quantity of muriate of lead only was obtained; that the decomposition was aided by heat; and that it was by this process that a brilliant yellow muriate of lead, much employed in painting under the name of *English yellow*, was prepared.

1867 Decomposition of muriate of soda. This subject has been greatly elucidated by the experiments and researches of Vauquelin. He took seven parts of litharge reduced to powder, and one of muriate of soda, mixed together, and moistened with a sufficient quantity of water, to reduce them to the liquid state, and then agitated the mixture for several hours to promote the reciprocal action. The oxide became white, and increased in volume, and the mixture absorbing the water, became of a more solid consistence. Having added new quantities of water during four days, and diluted the whole in seven or eight parts of this

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 this liquid, it was filtered. The liquid, which was now sensibly alkaline, contained a little muriate of lead, but no trace of muriate of soda. When it was evaporated to $\frac{1}{10}$ of its bulk, it yielded crystals of carbonate of soda, which were opaque, by being contaminated with muriate of lead. The oxide of lead which remained, had increased about $\frac{1}{8}$ of the weight; it became of a fine citron-yellow colour, with a moderate beat, and lost 0.025 of its weight. It was insoluble in water. Soda dissolved a portion of this oxide, as did also diluted nitric acid. By this means the muriate of lead was separated pure and crystallized; and the mass which remained after the action of muriate of soda and lead, exhibited the characters of a muriate of lead containing an excess of oxide.

From these experiments Vauquelin concludes, that the litharge which has been employed in the decomposition of sea salt, is a muriate of lead with excess of oxide; that the caustic alkalies dissolve this salt, but do not decompose it; that the affinity of muriate of lead for an excess of the oxide of this metal, is the cause of the decomposition of muriate of soda by means of litharge; that the excess of oxide gives to the muriate of lead the property of assuming a brilliant yellow colour by heat, a property which the simple muriate of lead does not possess; that the same excess of lead renders it insoluble in water, and that this excess may be taken up by the nitric acid, which reduces it to the state of ordinary muriate of lead. The same philosopher has confirmed these inferences, by shewing that caustic soda decomposes the common muriate of lead, only by bringing it to the state of muriate with excess of oxide, which is characterized by being in the form of powder, and the yellow colour, which is communicated by heat, and its decomposition by nitric acid, which converts it into nitrate of lead, and simple muriate of lead. Thus, it appears, that the oxide of lead decomposes the muriate of soda, by double affinity; namely, by the affinity of the oxide for muriatic acid, and that of the muriate of lead for an excess of oxide. A considerable quantity of the latter, therefore, is necessary for the complete decomposition. Five-sixths, at least,
1868 are required to form the muriate with excess of oxide.
Muriate of ammonia. Litharge then decomposes sea salt completely, when in sufficient quantity, while soda only decomposes the muriate of lead partially, and reduces it to the state of muriate with excess of oxide; but the carbonate of soda effects the entire decomposition of this salt.

6. The decomposition of muriate of ammonia by lead, and especially by its oxide, has been long known. The oxides of lead triturated with this salt in a mortar in the cold, disengage ammonia, which is very perceptible by its smell. By distilling a mixture of one part of red oxide of lead and two of muriate of ammonia in a retort, very pure caustic ammonia is obtained. If the red oxide has remained for any length of time exposed to the air, it gives out, during the process, a little carbonate of ammonia. The hyperoxymuriate of potash produces a detonation with lead. A mixture of three parts of this salt with one of lead, gives out a vivid flame by percussion. The other salts, as the phosphates, fluates, &c. have no effect on lead. By the action of the blow-pipe, they combine with its oxides, and form yellowish, or gray, opaque, or transparent glasses.

III. Alloys.

1. Lead combines with arsenic by fusion, and the compound is a brittle lamellated alloy. When the oxides of these metals are combined together by means of heat, a vitreous mass of a red colour is formed. 1869 With arsenic.

2. The alloys of lead with tungsten, molybdena, and the newly discovered metals, are not known.

3. Cobalt seems to have little affinity for lead. 1870 Cobalt. Equal parts of the two metals being fused together, were found, when the mass cooled, to be in separate masses. The heaviest metal occupied the inferior part of the vessel, and the lighter the upper part. An alloy of lead and cobalt has been formed by introducing cobalt in powder within plates of lead, and covering them with charcoal, to exclude the air. A brittle mass, which assumed a better polish than lead, was obtained from equal parts of the two metals, by the application of heat. The two metals in different proportions afforded an alloy which differed in hardness, specific gravity, and malleability, according as the one or the other metal predominated.

4. Lead forms with bismuth an alloy of a close grain, 1871 Bismuth. and a dark gray colour. This alloy, when the bismuth is not in great proportion, possesses considerable ductility. Bismuth has the property of increasing the tenacity of lead. The specific gravity of the alloy of lead and bismuth is greater than the mean.

5. When lead is combined with one-eighth of its 1872 Antimony. weight of antimony, it forms an alloy which possesses great tenacity. When they are combined in equal parts, the alloy is very brittle. Two parts of lead with one of antimony, give a brittle alloy in small grains similar to those of iron. Four parts of lead with one of antimony, afford an alloy of greater ductility, and in larger grains. Four parts of lead with one-half of antimony, give a very soft metal in fine grains like steel, and having the same colour. The alloy of 16 parts of lead and one of antimony, differs only from lead in hardness. This alloy has a greater specific gravity than the mean, and possesses considerable tenacity. It is employed in the fabrication of printing types.

6. Mercury combines with lead very readily, and 1873 Mercury. in all proportions. An amalgam of lead and mercury may be formed by triturating the former in filings with the latter; or, by adding heated mercury to lead in fusion. This amalgam varies in solidity, according to the proportion of the two metals. It is of a white colour, is altered by exposure to the air, and affords crystals by cooling. The mercury is driven off by strong heat, and when it is triturated with water, a black powder, which is oxide of lead, separates. The amalgam of lead and mercury becomes very liquid, when it is triturated with the amalgam of bismuth. 1874 To equal parts of lead and bismuth melted in and bismuth. an iron vessel, half the quantity of the whole mass of hot fluid mercury was added, and the mixture was agitated till it cooled. A fluid amalgam was thus obtained, which does not become solid by rest, or exposure to the air, and which almost entirely passes through leather like mercury itself. This liquidity of lead and bismuth is ascribed to their increased capacity for caloric in a state of combination. When mercury is thus sophisticated, it may be detected by observing the

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 the smaller specific gravity, and subjecting it to the test formerly mentioned, of pouring it along a smooth surface, when it is found to *drag a tail*.

1875 Zinc. 7. An alloy of zinc and lead in equal parts is harder and whiter than lead, and is malleable. The lead is rendered volatile by the zinc, while the latter is in the proportion of 10 or 12 parts to one of the former; but if the zinc be in smaller proportion, it separates from the lead. The specific gravities of the alloys of zinc and lead are said to be greater than the mean of the two metals.

1876 Tin. 8. Lead combines with tin in all proportions. Lead, in general, is found to increase in density and hardness, when alloyed with tin. Three or four parts of tin with one of lead, according to Muschenbroek, form an alloy which possesses twice the hardness of pure tin. The alloy of three parts of tin and one of lead possesses the greatest tenacity of any proportion of these metals. Two parts of lead and one of tin

1877 Solder. compose an alloy which is more fusible than either of the metals. This is the composition of common solder. Tinfoil is a compound of tin and lead; and the sheet lead employed for lining the boxes in which tea is brought from China to Europe, contains a certain portion of tin, which gives it hardness. This, however, is also found to be alloyed with zinc and bismuth.

1878 Tin and bismuth. One of the most singular alloys of lead is that with bismuth and tin, which has been called, from its easy fusibility, the *fusible alloy*. Eight parts of bismuth, five of lead, and three of tin, are the proportions proposed by Darcet for this alloy, which is so fusible, that it remains liquid at the temperature of boiling water. This alloy crystallizes by slow cooling.

1879 Uses of lead, &c. Lead and its various preparations are applied to a great variety of purposes in the arts. In the metallic state it is employed in the construction of numerous vessels. In the state of oxide it is used as a paint, and in the fabrication of enamels for porcelain and pottery, and in the preparation of coloured glass and artificial precious stones. Some of its salts are of great importance in the arts, as the acetate in dyeing, and the carbonate or ceruse in painting.

The greatest caution ought to be observed, however, in the use of leaden vessels in domestic economy, in which substances are preserved which are to be taken internally, particularly those which contain acids that are apt to dissolve the lead; and as the effects of lead are so deleterious to the animal economy when taken internally, this caution cannot be too strictly observed.

Sect. XX. *Of Iron and its Combinations.*

1880 History. 1. Iron is one of the most important and most useful of the metals, and it is fortunately one of the most abundant. It is supposed that it was not so early known as some of the other metals, which, on account of their scarcity and durability, have been held in higher estimation, and dignified with the name of *precious metals*. But perhaps the difficulty of extracting and working iron prevented it from being so generally applied to those purposes to which, on account of its valuable properties, it is peculiarly appropriated.

1881 Very abundant. 2. Iron, as it is the most useful of the metals, so, as it has been observed, it is the most abundant, and at the same time the most universally diffused. Iron exists in five different states, but in these it exhibits the greatest variety of any other of the metals. It is found in the metallic state; in that of alloy with other metals; in the state of sulphuret; in the state of oxide, and combined with the acids forming salts. 1882 Ores.
1. Iron has only been found native in insulated masses, one of which, discovered by Pallas in Siberia, and another, which was found in South America, long occupied the attention of philosophers in speculations and discussions concerning their origin. This point remained unsettled till the discovery of numerous other facts with regard to similar productions, which have proved, whatever may have been their origin or mode of formation, that these metallic masses have fallen from the atmosphere. 2. Iron is frequently found in the state of alloy with other metals; but in this state it is generally in very small proportion. 3. Combined with sulphur. This compound, or sulphuret of iron, which is known to mineralogists by the name of *pyrites*, is a frequent production among the ores of iron. Sulphuret of iron is found crystallized in a great variety of forms. Iron is also frequently found combined with carbon. This compound, now distinguished by the name of *carburet of iron*, was formerly known by the name of *black lead*, or *plumbago*. 4. But the most ordinary state of iron is that of oxide, and in this state it exhibits a great variety of forms. It is sometimes in irregular and insulated masses; sometimes regularly crystallized, and disposed in veins. 5. The native salts of iron are very numerous. It has been found in the state of sulphate, phosphate, carbonate, tungstate, and prussiate, and there is reason to believe, that it exists in combination with many other acids.

3. The method of assaying iron ores, or of extracting the metal from these substances with which it is combined, varies according to the nature of the ore. It is first reduced into powder, and exposed to heat, to separate the moisture or sulphur, or other volatile matters. Four parts of the ore are then to be mixed with an equal quantity of decrepitated muriate of soda, and the same quantity of a mixture of equal parts of fluor spar and lime, with one-half part of charcoal. This mixture is exposed to a red heat in a crucible nearly an hour, after which the iron is found in the metallic state at the bottom of the crucible. In the humid way, a given quantity of iron ore may be reduced to powder, and digested with six parts of muriatic acid, which combines with the iron, and other substances soluble in that acid, but leaves the sulphur and siliceous earth behind. The solution is then to be saturated with potash, by which the iron is precipitated in the state of oxide, along with the earths with which it had combined. The precipitate is to be well dried, and subjected to a red-heat. It is then to be reduced to powder, and digested with diluted nitric acid. The acid combines with the earths, but leaves the iron, because it is too highly oxidated to be soluble in this acid. The oxide, after being well washed, is mixed with charcoal, and exposed to a strong heat in a crucible, by which the oxygen is driven off, and the iron remains behind in the metallic state. 1883 Analysis.

4. Iron has a peculiar metallic brilliancy. It is of a grayish or bluish-white colour. The specific gravity of 1884 Properties.

Iron, &c. of iron is from 7.6 to 7.89, and according to some, even 8.16. It has an astringent taste, and when it is rubbed, gives out a peculiar smell. One of the singular properties of iron, is that of possessing the magnetic virtue, or of being attracted by the magnet. Iron possesses a considerable degree of malleability, but in this property it is inferior to gold or silver. It is extremely ductile. It may be drawn out into wire almost as fine as hair. The tenacity of iron is very great. A wire .078 of an inch in diameter will support a weight, without breaking, equal to more than 500lbs. avoirdupois *. The texture of iron seems to be fibrous, and to this, it is supposed, are owing its great ductility and tenacity.

* Annal. de Chim. 25. 9.

1885 Action of heat. 5. Iron is one of the most infusible of the metals. It is said that it requires a temperature equal to more than 150° Wedgwood for its fusion. It becomes red long before it melts, and different degrees of temperature are distinguished by the different shades of red which it exhibits. The first is called a *dull red*, the second a *cherry red*, the third a *bright red*, and the fourth a *white heat*, or *incandescence*.

1886 Oxidation. 6. When iron is exposed to the air, the surface soon becomes tarnished, and is covered with a brown powder, which is called *rust*. This process is greatly promoted by the moisture of the atmosphere. This is the oxidation of the metal, and its conversion into an oxide, by combining with the oxygen of the atmosphere. The process of rusting, then, is the oxidation of the iron, and it is owing to the strong affinity which exists between iron and oxygen. But rust is not merely a compound of oxygen and iron. It has combined with a certain proportion of carbonic acid. This was formerly called *saffron of mars*.

1887 Oxides two. 7. There are two oxides of iron; the first, or that which contains the greatest proportion of oxygen, is

1888 Red oxide. common rust, or, as it is denominated from its colour, brown or red oxide of iron. This oxide may be formed by exposing iron filings in an open vessel to a red heat, and agitating them till they are converted into a red powder. This oxide consists of

Oxygen	48
Iron	52
	100

The red oxide of iron cannot be decomposed by heat; but when it is exposed to heat with its own weight of iron filings, there is no evolution of any gas, but the

1889 Black. iron filings are converted into a black powder, and the red oxide is converted into a similar powder. This is the black oxide of iron, which contains the smaller proportion of oxygen. This oxide is composed of

Oxygen	28
Iron	72
	100

This oxide may also be obtained by heating iron filings for some time in water at a temperature not under 70°; or by making the vapour of water pass through a red-hot tube containing iron wire, or small fragments of iron. The water in these cases is decomposed, the hydrogen escapes in the form of gas, and the oxygen combines with the iron. This oxide was formerly called *martial ethiops*. It is this oxide which is obtained by burning iron wire in oxygen gas. Iron, &c.

8. There is no action between iron and azote. Hydrogen gas, which is obtained from the decomposition of water by means of iron filings and sulphuric acid, holds a small quantity of iron in solution. When hydrogen gas is brought into contact with the red oxide of iron, it deprives it of that proportion of oxygen which it contains above the black oxide, and converts it into this oxide.

9. Iron combines very readily with carbon, and forms a carburet. 1890 Carburet. When the charcoal combines with one-tenth of its weight of iron, it constitutes a carburet, which is found native, and distinguished by the name of *plumbago*, or *black lead*. This compound has a metallic lustre, is of a bluish or dark-gray colour, has a greasy feel, and stains the fingers. It is well known as the substance of which black-lead pencils are composed. But there is another combination of iron with carbon, which forms one of the most important compounds, on account of its valuable properties, and the numerous uses to which it is applied. This is steel. The different states of iron are owing to its being perfectly free from contamination with other substances, or to its combination with carbon in different proportions. In these different states it is distinguished by the names of *cast* or *crude iron*, *wrought iron*, and *steel*.

Crude or *cast iron*.—When iron is first extracted 1891 Process for obtaining. from its ores, it is in the state of what is called crude iron. Iron is generally obtained from ores in the state of oxide, and this is frequently mixed with clay. It must therefore be separated from these substances. This is accomplished by reducing the ore to small pieces, and mixing it with a flux composed of limestone and charcoal. It is then exposed to a very strong heat. For this process, furnaces are constructed in such a way, that the heat can be raised to a very high temperature. The nature of the process must be obvious. The carbon of the charcoal combines with the oxygen of the iron, and forms carbonic acid, which is driven off in the state of gas. By the strong heat to which the lime and the clay are subjected, they are fused together, and form a vitreous matter, which, being lighter than the iron, rises to the surface. The iron also is in a state of fusion at the bottom of the furnace. When the process is finished, a hole is opened, through which the fluid iron flows, and is received into moulds. This is crude or cast iron, or, in the language of the workmen, *pig iron*. In this state it is extremely brittle and hard, and possesses scarcely any malleability. It still contains a considerable proportion of carbon, and it is not entirely free from oxygen.

Wrought Iron.—The next process in the manu- 1892 Soft iron. facture of iron, is to deprive it of those substances which alter its properties, and prevent its application to the purposes of pure or malleable iron. The crude iron is again introduced into a furnace, where it is melted by the flame of combustible substances, which is directed to its surface; and while it is in the state of fusion, it is constantly stirred, that the whole of it may be uniformly brought into contact with the air. At last it swells, and gives out a blue flame, and when this is continued for about an hour, the iron begins to acquire some consistency, and at last becomes solid. While it is hot, it is removed from the furnace, and hammered

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hammered by the action of machinery. It is then in the state of wrought or soft iron.

Steel.—This is soft iron or wrought iron combined with a certain portion of carbon. There are different processes for the preparation of steel; and the steel prepared by these processes has received different

1893 Natural steel. rent names. What is called natural steel, is prepared by exposing cast iron to a strong heat in a furnace, while its surface is covered with scoriæ. In this process, part of the carbon of the crude iron combines with the oxygen, from which it is not entirely free, and is driven off in the state of carbonic acid gas. The iron remains combined with a small portion of carbon. The steel prepared in this way is of no inferior quality.

1894 Of cementation. Steel of cementation is prepared by arranging bars of pure iron and charcoal in powder in alternate layers, in large troughs or crucibles, which are carefully closed up with clay. These are exposed to heat in a furnace for the space of eight or ten days, when the bars of iron are found converted into steel. This is sometimes called *blistered steel*, from blisters which appear on the surface, or tilted steel, when it is drawn out into smaller bars by the hammer. By breaking it into pieces, and repeated welding in a furnace, and afterwards drawing it out into bars, it is converted into what is called *German* or *sheer steel*. Steel formed in this way is generally of a superior quality to natural steel.

1895 Cast. *Cast steel* is prepared by fusing natural steel with charcoal powder, and pounded glass, in a close crucible; or by melting together 30 parts of iron, one of pounded glass, and one of charcoal. By this process the best kind of steel is obtained, and it is this which is generally used for the finer kinds of cutting instruments. Different opinions have been entertained concerning the proportions of iron and carbon in the composition of steel. According to some, the proportion of carbon amounts to $\frac{1}{18}$ part, though, according

1896 Properties of steel. to others, it does not exceed $\frac{1}{140}$ part.

Steel possesses very different properties from iron. It is extremely hard and brittle, does not yield to the file, and retains the magnetic virtue for any length of time. When it is hammered, its specific gravity is greater than that of iron. It is not malleable when cold, but it has this property when red hot, and it may be reduced to thinner plates than iron.

1897 Distinguished from iron. There is a very easy test by which steel may be distinguished from iron. If a drop of diluted nitric acid be let fall on steel, and allowed to remain for a few minutes, it leaves behind, after it is washed off, a black spot, which is owing to the conversion of the carbon of the steel into charcoal, by combining with the oxygen of the acid. But if nitric acid is dropt on iron, a whitish gray spot remains.

1898 Phosphuret. 10. Iron combines with phosphorus, and forms with it a phosphuret. It may be formed by melting in a crucible 16 parts of phosphoric glass with 16 parts of iron, and one-half part of charcoal in powder. The phosphuret of iron is of a white colour when it is broken, and it is observed crystallized in some points in rhomboidal prisms. It is of a striated and granulated texture, and is magnetic. This phosphuret may be formed, also, by dropping small bits of phosphorus into iron filings heated red-hot. This is the *siderite* of Bergman, in which he supposed he had discovered a new metal, to which he gave the name of *siderum*. 1899 Cold short iron.

What is called *cold short iron*, from its being brittle when cold, but malleable when it is heated, contains a certain portion of phosphate of iron, to which this property is owing. It was in the investigation of the nature of this iron, that Bergman obtained, by means of sulphuric acid, a white powder, which was converted into a brittle metal of a dark-gray colour. By the experiments of Klaproth and Scheele it was proved, that cold short iron is a compound of phosphoric acid and iron.

11. Iron combines with sulphur by different processes. 1900 Sulphuret. A sulphuret of iron may be prepared by fusing together in a crucible equal parts of powdered sulphur and iron filings. This is a mass which is remarkably brittle and hard, and of a deep gray colour. If this mass be reduced to powder, and moistened with water, the water is decomposed, its oxygen combines with the sulphur, which is converted into sulphuric acid, and the iron is oxidated. If equal parts of sulphur and iron-filings be well mixed together by trituration, and a sufficient quantity of water be added, to form the whole into a paste, and if this mixture be exposed to the air, it soon becomes hot, swells up and cracks, exhaling the vapours of sulphurated hydrogen gas, and sometimes is spontaneously inflamed. During this action the water is decomposed, the iron is oxidated, and the sulphur is converted into sulphuric acid, while the hydrogen of the water combines with a portion of sulphur, and forms sulphurated hydrogen gas. By observing the phenomena of this process, which also takes place, it is said, when the mixture is buried under ground, Lemery supposed that he could explain the nature and cause of volcanic eruptions.

If a mixture of three parts by weight of iron filings, and one of powdered sulphur, be put into a glass vessel on burning coals, a sulphuret of iron is obtained, with some remarkable phenomena. It first melts, and then all at once becomes red-hot, and sometimes, when the quantity is considerable, is accompanied with an explosion, at the moment when the combination takes place. According to the experiments of Proust, the component parts of sulphuret of iron are,

Sulphur	60
Iron	40
	100

According to the experiments of the same chemist, 1901 Pyrites.
pyrites, which is found in great abundance in nature, and usually crystallized in cubes, is sulphuret of iron combined with an additional portion of sulphur. The component parts of pyrites are,

Sulphuret of iron	80
Sulphur	20
	100

12. Iron enters into combination with the acids, and forms salts, and with the metals, and forms alloys.

The affinities of iron and its oxides are, according to 1902 Affinities.
Bergman, in the following order.

 IRON,

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Iron.	Oxide of Iron.
Nickel,	Oxalic acid,
Cobalt,	Tartaric,
Manganese,	Camphoric,
Arsenic,	Sulphuric,
Copper,	Saclactic,
Gold,	Muriatic,
Silver,	Nitric,
Tin,	Phosphoric,
Antimony,	Arsenic,
Platinum,	Fluoric,
Bismuth,	Succinic,
Lead,	Citric,
Mercury.	Lactic,
	Acetic,
	Boracic,
	Prussic,
	Carbonic.

I. Salts of Iron.

1. Sulphate of Iron.

1903 Preparation. 1. Concentrated sulphuric acid has scarcely any action on iron. When it is heated, the acid is decomposed, part of its oxygen combines with the iron, and sulphurous acid gas is evolved. But when diluted sulphuric acid is added to iron filings, a violent effervescence takes place, and hydrogen gas is disengaged. In this process, the water, with which the acid is diluted, is decomposed, the oxygen of which combines with the iron, and converts it into an oxide, while the hy-

1904 Properties. drogen escapes in the state of gas. The solution is of a green colour, and, by evaporation, it affords crystals of sulphate of iron, which are transparent, of a fine green colour, in the form of rhomboidal prisms, and having an acrid astringent taste. This salt almost always reddens vegetable blues. It is very soluble: two parts of cold water, and less than its weight of boiling water, are sufficient for its solution.

1905 Found native. 2. This salt is, in many places of the world, a natural production. It is obtained from the decomposi-

1906 Manufacture. tion of pyrites, which it is sometimes found necessary to promote by art. This is done by throwing them together into heaps, and watering them occasionally. Sometimes previous roasting is necessary, either to render them more brittle, and to separate the additional portion of sulphur above what is necessary to constitute a sulphuret. After a certain time an efflorescence takes place, and the surface is covered with the sulphate of iron, which is dissolved in water, concentrated by boiling, and evaporated, and then allowed to cool and crystallize. This salt, which was known to the

1907 Names. ancients, was denominated *misy*, *sory*, and *calchantum*. It is distinguished in commerce by a great variety of names, as *martial vitriol*, *Roman vitriol*, and most commonly by the name of *green copperas* or *green vitriol*.

1908 Action of heat. 3. When sulphate of iron is strongly heated, it melts, and is deprived of its water of crystallization. Sulphurous acid gas is then given out, it assumes a red colour, and is reduced to the state of powder. This was formerly called *colcothar*, and *colcothar of vitriol*. It is the salt almost entirely decomposed. Part of the iron is strongly oxidated, and to this the red colour is owing. It is also mixed with sulphate of iron; but the iron in this case is also converted into the red oxide with the greater proportion of oxygen. This change, it is obvious, depends on the strong affinity of iron for oxygen; for by the action of heat, the sulphate of iron, of which the green oxide forms the base, is decomposed; the oxygen of the acid combines with the iron, and converts it into the red oxide; part of which, as it is formed, unites with the acid, before the whole of it is decomposed; and in this way the product of this process is the red oxide of iron mixed with the red sulphate.

The component parts of this salt are, according to Bergman, 1909 Composition.

Acid	39
Oxide	23
Water	38
	100

These properties vary, according to the estimation of Mr Kirwan, who makes this salt to be composed of

Acid	26
Oxide	28
Water of composition	8
of crystallization	38
	100

This distinction made by Mr Kirwan between the water of composition and that of crystallization, is, that the former is combined with the oxide, and the latter with the salt.

4. When this salt is exposed to the air, it becomes of a yellowish colour, opaque, and a powder forms on the surface. The same thing takes place, if the salt in solution in water be exposed to the air. From a fine transparent green colour, it becomes turbid and is converted into a yellowish red liquid, and there is precipitated a powder of the same colour. This change is owing to the absorption of oxygen, and the conversion of the green oxide with the smaller proportion of oxygen, into the red oxide with the greater proportion. This process is greatly promoted by the direct combination of oxygen, or by the addition of those substances which are readily decomposed, and give out their oxygen. When oxymuriatic acid is added to the solution, it becomes instantly yellow, and there is formed a red precipitate. The same change takes place when the salt is dissolved in water impregnated with carbonic acid. The iron decomposes the acid, and combines with its oxygen. Thus it appears, that the decomposition of the sulphate of iron is owing, in all these cases, to the absorption of oxygen, and to the higher degree of oxidation of the metal. 1910 Action of air.

5. The sulphate of iron is converted into the red sulphate by means of nitric acid. It is decomposed by the alkaline earths and the alkalies, which precipitate it in the form of oxide. The pure fixed alkalies and lime separate an oxide of a deep green colour, which, being exposed to the air, is converted into the red oxide. Ammonia affords a precipitate of a deeper green colour. The sulphurets and hydrosulphurets precipitate from the solution of green sulphate of iron, a black sulphurated or hydrosulphurated oxide. Most of the salts decompose the sulphate of iron. When equal 1911 Decomposition.

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parts of nitrate of potash and sulphate of iron are distilled together in a retort, a weak nitric acid at first passes over, then a nitrous acid, and at last a very small quantity of sulphurous acid. The muriate of soda is decomposed by the sulphate of iron, in consequence of the disengagement of sulphuric acid, which separates the muriatic acid from its base. Sulphate of soda, combined with the oxide of iron in the state of a vitreous mass, remains in the retort. The hyperoxymuriate of potash converts the green sulphate of iron into the red. This salt is also decomposed by the alkaline phosphates, borates, and carbonates.

1912 Preparation. *Red sulphate of iron.*—In the detail which has been given of the properties of the green sulphate of iron, it appears, that it has a strong affinity for oxygen. The oxide of the green sulphate contains 27 parts of oxygen; but by absorbing another portion of oxygen, it is converted into the red oxide, which contains 48 parts of oxygen. This salt may be obtained by the direct combination of the red oxide of iron with concentrated sulphuric acid, with the assistance of heat. The salt remains in the solution from which the green sulphate of iron has been crystallized. This solution has been called the *mother water of vitriol*. The red sulphate of iron is very different in its properties from the green sulphate. It does not afford crystals; it is distinguished by its red colour, and it deposits the oxide of iron, when brought in contact with the air, or by
1913 Properties. the action of heat. It deliquesces in the air, and at last becomes liquid. It is more soluble in water than the green sulphate; and also soluble in alcohol, by which it may be separated from the green sulphate, which is not affected by the alcohol. When iron filings are added to a solution of red sulphate of iron, part of the oxide is separated, another part gives up a portion of its oxygen to the iron, and is converted into the green sulphate. The same effect is produced, as M. Proust, by whom this subject has been greatly elucidated, observes, by means of other metals, as mercury, zinc, and tin. The two sulphates of iron are distinguished by other properties. The infusion of nut-galls produces no change in the green sulphate of iron, but gives a fine black precipitate with the red sulphate.

1914 Action of prussiate of potash. Prussiate of potash occasions no change of colour on the green sulphate of iron, but produces a deep blue precipitate with the red sulphate; from which it appears that there are two prussiates of iron, corresponding to the two oxides. The white prussiate contains the green oxide with the smaller proportion of oxygen; the blue prussiate, the red oxide with the greater proportion. Another characteristic property is, that the green sulphate of iron absorbs nitrous gas in considerable quantity, and assumes a yellowish colour; but no such absorption is effected by the red sulphate.

2. Sulphite of Iron.

1915 Preparation. 1. Sulphurous acid is decomposed by iron, and the portion of sulphur which is separated, remains in combination with the salt as it is formed. When liquid sulphurous acid is added to iron filings, it assumes a deep yellow colour; some hydrogen gas is evolved, with a production of heat, and the yellow colour soon changes to a greenish shade. Sulphuric or muriatic acid, added to this solution, produces an effervescence, but without any precipitation. It is necessary to add the acid in considerable quantity to obtain a precipitate of sulphur in white powder. Fuming nitrous acid separates the sulphur of a yellow colour, and in the form of a ductile mass. From these facts it appears, that the first portion of acids acts only on the simple sulphite of iron; but when a greater quantity is added, the sulphurated sulphite is decomposed, and the sulphur is deposited.

2. The solution of iron in sulphurous acid, exposed 1916 Properties.
to the air, deposits a reddish-yellow powder, and affords crystals which are surrounded with this reddish powder. By adding water to this mass, it dissolves the crystallized part, and leaves the red powder, which being dissolved in muriatic acid, gives up its iron, and deposits sulphur, which is still mixed with a little iron. 1917 Sulphurated sulphite.
This precipitate, dissolved in water, affords a sulphurated sulphite of iron, with a smaller quantity of sulphur than the first solution. Exposed to the air after the first precipitate is formed, the surface is soon covered with a red pellicle. A red powder is deposited, and afterwards crystals of sulphite of iron.

3. The sulphurated sulphite of iron remains perma- 1918 Properties.
nent by exposure to the air. Its simple sulphite absorbs oxygen. The sulphurated sulphur deposits sulphur by the action of the acids. The sulphite gives out sulphurous acid. The sulphurated sulphite is soluble in alcohol; the sulphite is insoluble.

4. The red sulphate of iron with the greater proportion of oxygen, does not produce the same effect on sulphurous acid, by converting it into sulphuric acid, and thus to form a sulphate of iron, as the oxide of manganese, because iron has a stronger affinity for oxygen 1919 Strong affinity of iron for oxygen.
than sulphurous acid. Thus we have seen, in consequence of the same affinity of iron for oxygen, that it decomposes sulphuric acid, and converts part of it into sulphurous acid, and that it even decomposes sulphurous acid, by separating its sulphur, which combines with the oxide as it is formed, and constitutes the sulphurated sulphite of iron. Neither of these sulphites of iron give a black colour with the infusion of nut-galls, nor a blue colour with the prussiate of potash; from which it is inferred that the iron is in its minimum state of oxidation, or in that of a green sulphate of iron.

3. Nitrate of Iron.

Nitric acid acts with great violence on iron; a great 1920 Preparation.
quantity of nitrous gas is disengaged, especially when the acid is a little diluted with water. When diluted 1921 Properties.
acid has been employed, the solution is of a yellowish green colour, and when it is exposed to the air, it assumes a pale colour, in consequence of the nitrous gas which it holds in solution, combining with oxygen, and being converted into nitric acid. When it is exposed to the air, or concentrated by evaporation, a precipitate of the red oxide of iron is formed, because it combines with another portion of oxygen, and is converted from the green to the red oxide. By means of the alkalies, the green oxide is precipitated from this solution.

Red nitrate of iron.—This is the salt formed with 1922 Preparation.
nitric acid and the red oxide of iron. It is prepared by exposing the green nitrate of iron to the air, which absorbing oxygen, is converted into the red nitrate.

If

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Iron, &c.

1923 Properties. If iron be dissolved in concentrated nitric acid, the iron is converted into the red oxide, and this combining with the undecomposed acid, also forms the red nitrate of iron. The solution of this salt, which is of a brown colour, does not crystallize; when it is evaporated, it assumes the form of a jelly, or deposits a red powder.

1924 Action of nut-galls, &c. When this salt is heated, the acid is driven off, and the red oxide remains behind. The red nitrate of iron gives a black colour with the infusion of galls, and a blue precipitate with prussiate of potash, from which it appears, that the iron is in its highest degree of oxidation. This has been fully demonstrated by an experiment made by Vauquelin. Concentrated nitric acid was kept for some months on black oxide of iron, without any apparent change. The nitric acid, however, lost its acidity, and acquired a neutral taste. The liquid had assumed a brown colour; and large crystals, transparent and white, with a slight tinge of violet by looking through them, were formed. The crystals were in square prisms, terminated by two-sided ridges. This salt was extremely deliquescent, and had a pungent inky taste. The solution in water becomes red, as is also the precipitate, by means of ammonia and potash. Prussiate of potash gives a fine blue precipitate.

4. Muriate of Iron.

1925 Action of muriatic acid in the state of gas. 1. When iron filings are exposed to muriatic acid gas they soon become black, and are converted into the state of red oxide. This is owing to the decomposition of the water which the gas holds in solution. The bulk of the gas is increased by the addition of hydrogen gas, from this decomposition of water. When the whole of the muriatic acid is absorbed by the iron in the state of oxide, hydrogen gas only remains in the vessel in which the process has been conducted. When a little water is added, it assumes a green colour, having combined with the muriate of iron in the liquid state.

1926 In the liquid state. 2. Liquid muriatic acid acts upon iron in proportion to its degree of concentration, and the action is the more violent as it is less concentrated. An effervescence takes place, with the disengagement of hydrogen gas. As the iron is oxidated by the decomposition of the water, it is dissolved in the acid. This solution is of a pale yellowish colour, and of a strong styptic taste. When it is evaporated to the consistence of syrup, it forms, on cooling, a viscid mass, in which are found needle-shaped, deliquescent crystals. When this solution is exposed to the air, or strongly heated, it assumes a brown colour, and deposits oxide of iron.

Red muriate of iron.—When the red oxide of iron is treated with muriatic acid, the acid dissolves the iron, and forms a solution of a deep brown colour. During the solution, oxymuriatic acid is formed and given out, which is owing to the combination of a portion of the oxygen of the oxide with the muriatic acid. The oxide, thus deprived of a portion of its oxygen, combines with the muriatic acid, and forms red muriate of iron. When this solution is evaporated to dryness, it affords a yellow coloured mass, which is deliquescent in the air. This salt does not absorb nitrous gas, and it is converted into muriate of iron by the action of sulphurated hydrogen gas. When it is precipitated by the alkalies, the oxide is not farther changed, by exposure to the air. The infusion of nut-galls gives a black colour, and the prussiate of potash a blue.

5. Hyperoxymuriate of Iron.

This salt was formed by Mr Chenevix, by directing a stream of oxymuriatic acid gas into water, having red oxide of iron diffused in it; but its properties have not been ascertained.

6. Fluate of Iron.

Fluoric acid has a very powerful action on iron, which is owing to the evolution of hydrogen gas, and the decomposition of water. The iron is oxidated, and dissolves in the acid, forming a fluate of iron. The solution has a styptic, metallic taste, does not afford crystals by evaporation, but assumes a gelatinous form. Evaporated to dryness, it becomes hard and solid; and when strongly heated, the acid is driven off, and there remains behind the red oxide of iron, so that this salt is the red fluate of iron. The red oxide of iron is also soluble in fluoric acid, and communicates to it, according to Scheele, an aluminous taste. The fluate of iron is decomposed by sulphuric acid, and is precipitated by the alkalies and the earths.

7. Borate of Iron.

Boracic acid promptes the oxidation of iron by water very slowly. The borate of iron may be obtained by precipitating the sulphate of iron by means of the borate of soda, or borax. The borate of soda is precipitated in the form of a whitish powder. It is insoluble in water; but its other properties have not been ascertained.

8. Phosphate of Iron.

Phosphoric acid combines very slowly with iron, 1927 Preparation.
but after the oxidation of the metal has taken place, it forms with its oxide an insoluble salt. The phosphate of iron may be prepared by adding a solution of an alkaline phosphate to a solution of sulphate or nitrate of iron. The alkali leaves the phosphoric acid, and combines with the sulphuric or nitric; while the phosphoric acid combines with the iron, and forms a phosphate of iron, which is in the state of white precipitate. Phosphoric acid combines with both oxides of iron, and constitutes either a green or a red phosphate. The red phosphate of iron may be obtained by precipitating the red muriate of iron in solution, by means of phosphate of potash or soda; and when this latter salt is treated with pure fixed alkalies, a brownish red powder is precipitated, which is the red phosphate of iron, with excess of base. It is nearly insoluble in acids and in water, but is soluble in the serum of blood, and the white of an egg, communicating to 1928
them a brown colour. This salt exists in the blood of Colours the
animals, and to it the red colour of the blood is blood.
owing.

9. Carbonate of Iron.

Carbonic acid combines readily with the oxide of iron. This is the case when iron rusts in the air; for in proportion as the oxidation of the iron is effected, it combines with the carbonic acid of the atmosphere, and

Iron, &c. and forms a carbonate of iron. This acid dissolved in water, when brought in contact with iron, acts upon it slowly; and there is disengaged, but without effervescence, a perceptible odour of hydrogen gas, and the water acquires in the course of a few hours an astringent taste. When this solution is exposed to the air, as Bergman observed, it becomes covered with an iridescent pellicle, and is decomposed by lime and the alkalies. But the alkaline carbonates have no such effect. This solution of the carbonate of iron converts the syrup of violets to a green colour. When it is evaporated, it deposits the salt in the form of a reddish ochre. It is this carbonate of iron which exists in mineral waters, to which, for this reason, the name of *chalybeate* has been given to waters.

1929 Rust. Rust is a carbonate of iron, mixed with the oxide. Fourcroy found by distilling it, that it yielded carbonic acid gas and a little water, and there remained black oxide of iron; and distilled with muriate of ammonia, it afforded carbonate of ammonia. The component parts of this carbonate, according to Bergman, are,

Acid	24
Oxide	76
	100

10. Arseniate of Iron.

1930 Preparation.

1. When iron is digested with arsenic acid, it is dissolved, and towards the end of the process the solution assumes the form of a jelly. But if it be conducted in a close vessel, no coagulation takes place. By exposing it to the open air for some hours, the surface becomes so solid, that the vessel may be inverted without any part of it dropping out. The solution which has not been exposed to the air, affords a precipitate with potash, of a greenish-gray colour, from which there is disengaged by heat, arsenious acid, and there remains behind a red oxide of iron. One part of iron-filings distilled with four of concrete arsenic acid, swell up and inflame; the metallic acid is sublimed, and brown spots appear on the sides of the retort. From this experiment it appears, that the iron has carried off the oxygen from the acid.

2. Arsenic acid does not precipitate iron from its solutions, but the arseniates or arsenites form a very soluble precipitate, which becomes yellow or red in contact with the air. This precipitate, which is fusible at a high temperature, exhales the odour of arsenic when it is melted, is converted into black scoriæ when it is treated with charcoal, gives out a considerable quantity of arsenic, and is reduced to the state of black oxide of iron.

1931 Green arseniate.

3. Arsenic acid combines with both the oxides of iron. The green arseniate of iron may be obtained by adding a solution of arseniate of ammonia to a solution of sulphite of iron. The arseniate precipitates in the form of powder which is insoluble in water. The component parts of this salt, according to Chenevix, are

Acid	38
Oxide	43
Water	19
	100

Red Arseniate of Iron.—This salt is prepared, either by boiling arseniate of iron in nitric acid, or by adding arseniate of ammonia to a solution of red sulphate of iron. It is composed of

Acid	42.4
Oxide	37.2
Water	20.4
	100.0

Both these salts have been found native.

11. Tungstate of Iron.

Tungstic acid has no great effect on iron in the cold. Iron immersed in a solution of this acid in muriatic acid, communicates to it a beautiful blue colour, which is owing to the decomposition of the tungstic acid, and to its reduction to the metallic state by means of the iron. Tungstic acid precipitates from the solution of iron in sulphuric acid tungstate of iron. Tungstate of iron exists native under the name of wolfram.

12. Molybdate of Iron.

The alkaline molybdates which are soluble precipitate iron from its solution in acids of a brown colour.

13. Chromate of Iron.

If chromic acid, combined with an alkali, be added to a solution of the red sulphate of iron, a precipitate is immediately formed, of a brown colour; but if an alkaline chromate be added to the green sulphate of iron, the precipitate is green, because the chromic acid is deprived of a portion of its oxygen, and is converted to the state of green oxide *.

14. Columbate of Iron.

The columbate of iron is found native, and from the only specimen which has yet been discovered, Mr Hatchet extracted a new metal, which has been described under the name of columbium. It is of a dark brownish gray colour, has a vitreous lustre, and a lamellated structure. According to Mr Hatchet, it is composed of

Columbic acid	77.5
Oxide of iron	21.0
	98.5

15. Acetate of Iron.

1. Acetic acid dissolves iron with effervescence, with the evolution of hydrogen gas. The liquid assumes a reddish-brown colour, and by evaporation becomes a gelatinous mass, in which are found long brown crystals. This salt has a sweetish styptic taste. It is decomposed by heat, and is deliquescent in the air. When it is heated till it no longer gives out the odour of vinegar, it lets fall a yellowish oxide, which is easily reduced, and is attracted by the magnet. The alkalies separate the iron nearly in the state of black oxide. This solution affords a black precipitate with the infusion of nut-galls, and a blue with the alkaline prussiates. 1932 Preparation.

2. The

* Fourcroy Connais. Chim. vi. p. 217.

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Iron, &c.

1933 In the large way. 2. The solution of this salt is prepared in the large way with old iron, and vinegar obtained from grain or molasses. They are exposed to the air in large vessels, and as the fermentation of the liquid goes on, it is converted into acetic acid, the iron is oxidated, and dissolved by the acid. This solution is employed in dyeing and calico-printing.

Green acetate of iron.—This salt has been formed by dissolving sulphuret of iron in acetic acid. It affords crystals by evaporation, in the form of prisms, and of a green colour. The taste is styptic and sweetish. It gives a white precipitate with the alkaline prussiates, and no change is effected by the infusion of galls. When the solution of this salt is exposed to the air, it very readily absorbs oxygen, and is converted into red acetate of iron*.

* *Jour. Roy. Instit.* i. p. 308.

16. Oxalate of Iron.

1934 Preparation. Oxalic acid produces a violent action on iron, with the evolution of hydrogen gas. This solution has a very styptic taste, and forms by evaporation prismatic crystals of a greenish yellow colour. When this solution is exposed to the air, or, when it is heated, it assumes a red colour, which is owing to the absorption of

1935 Composition. oxygen, and its conversion into red oxalate. The oxalate of iron is composed of

Acid	55
Oxide	45
	100

Red oxalate of iron.—Oxalic acid precipitates the red oxide of iron from the solution in sulphuric acid, and forms an oxalate of iron of a fine red colour. The red oxalate of iron does not crystallize, and has little solubility in water. This has been proposed to be employed as a pigment. None of the acids dissolve the oxides of iron more readily than oxalic acid, and especially the gallate of iron. On this account it answers well for removing spots of ink, for which purpose also the acidulous oxalate of potash, or salt of sorrel, is also employed.

17. Tartrate of Iron.

1. Tartaric acid dissolves iron with effervescence, and the evolution of hydrogen gas. The solution becomes of a red colour, and assumes the form of a gelatinous mass, but does not crystallize. This is the red tartrate of iron.

2. But when tartaric acid is added to the solution of sulphate of iron, and heat applied, a precipitate is formed, which is not very soluble, but affords lamellated crystals. This is the compound of tartaric acid with the green oxide of iron, for it does not form a precipitate with the alkaline prussiates, without the addition of nitric acid.

18. Tartrate of Potash and Iron.

This triple salt, which was formerly called *chalybeated tartar*, and *tartarised tincture of Mars*, is prepared by forming into a paste with water, six parts of iron filings with 16 of tartar in powder. The mixture is left at rest for 24 hours; and being diluted with 192 parts of water, is boiled for two hours, when crystals are deposited of tartrate of potash and iron.

19. Citrate of Iron.

Citric acid acts upon iron with effervescence, occasioned by the emission of hydrogen gas. The solution becomes of a brown colour; it deposits by spontaneous evaporation, small crystals of citrate of iron. By evaporating with heat, it becomes black as ink, and ductile while it is hot, but falls to powder, and becomes very black when it is cold. This salt has a very astringent taste, and is very soluble in water. It is composed of

Acid	69.62
Oxide	30.38
	100.00

The crystals which were obtained by spontaneous evaporation, were probably the green citrate; and the black mass, by the action of heat, is probably converted into the red citrate of iron.

20. Malate of Iron.

Malic acid gives a brown solution by its action on iron, but it does not crystallize.

21. Gallate of Iron.

It has frequently been mentioned, in describing the salts of iron, that the infusion of nut-galls, or gallic acid, produces no precipitate or change of colour, when it is added to salts of iron in solution, of which the black or green oxide constitutes the base; but when the acid is added to a solution of a salt of iron, having the red oxide for its base, a black precipitate is immediately formed. From this it appears, that the black precipitate can only be obtained from the red oxide of iron, or it is the gallate of iron in the highest degree of oxidation. Writing ink is a compound of the solution of gallate of iron and the tanning principle. The important qualities of good ink are, that it shall be durable, and have a black colour. On this subject Professor Robison observes, in his Notes on Dr Black's Lectures, that "the great art in ink-making is to have a superabundance of astringent matter to counteract the disposition of the iron to a farther calcination, which renders the ink brown. It would be a great improvement in the manufacture of writing paper, if some astringent matter could be introduced. A little ardent spirits effectually prevents the spoiling of ink by keeping, but makes it sink and spread.

1936 Gallic acid gives a black colour only with the red oxide.

1937 Ink.

A good Proportion for Writing-Ink.

Rasped logwood, 10 ounces;
Best gall-nuts in coarse powder, 3 ounces;
Gum arabic in powder, 2 ounces;
Green vitriol, 1 ounce;
Rain water, 2 quarts;
Cloves in coarse powder, 1 drachm.

Boil the water with the logwood and gum to one half; strain the hot decoction into a glazed vessel; add the galls and cloves; mix and cover it up. When nearly cold, add the green vitriol, and stir it repeatedly. After some days, decant or strain the ink into a bottle, to be kept close corked in a dark place*.

* Black's Lect. v. ii. p. 4[illegible]

Ink

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Iron, &c.

Ink is sometimes of a very pale colour when first used, but becomes black by exposure to the air. This
1938 Reason of the pale colour. is owing to the absorption of oxygen. The green vitriol or sulphate of iron, which is employed in making ink, has not its base fully saturated with oxygen, or is not in the state of red oxide. It is the conversion of the green into the red oxide, which takes place when it is exposed to the air. The use of gum in the composition of ink is to prevent the precipitation of the black particles, and also, it is supposed, to act as a varnish, to defend it from the air, which might give it a brown colour by farther oxidation.

22. Benzoate of Iron.

Benzoic acid readily dissolves the oxide of iron, and forms with it yellowish crystals, which are sweet to the taste, effloresce in the air, and are soluble in water and in alcohol. Gallic acid produces a black precipitate, and the prussiates give a blue. It is decomposed by the alkalies, and by the carbonates of lime and barytes. The acid is driven off by heat *.

* Ann. de Chim. ix. p. 316.

23. Succinate of Iron.

Succinic acid combines with the oxide of iron; and the solution, by evaporation, affords small radiated crystals, which are transparent and of a brown colour. This salt is insoluble in water. It may be formed by adding an alkaline succinate to the solutions of iron in acids.

24. Suberate of Iron.

Suberic acid decomposes the sulphate of iron, and produces a deep yellow colour †.

† Ibid. xxiii. p. 48.

25. Mellate of Iron.

Mellitic acid produces a copious precipitate of an Isabella-yellow colour, in the solution of iron in nitric acid. This precipitate is readily dissolved in muriatic acid ‡.

‡ Klaproth, Essays, ii. p. 102. Transl.

26. Lactate of Iron.

Lactic acid combines with iron, and forms with it a salt which does not crystallize. The solution is of a brown colour.

27. Prussiate of Iron.

1. Prussic acid combines with both the oxides of iron. When the prussiate of potash is added to a solution of the green sulphate or muriate of iron, a white precipitate is obtained. This shews, as has been already observed, that the base of these salts is in its lowest degree of oxidation. It is in the state of green or black oxide. But if the prussiate of potash be poured into a solution of the red sulphate of iron, a fine blue precipitate is formed, which is Prussian blue, or a prussiate of iron in the state of red oxide.

1939 Prussian blue. 2. When the white precipitate of iron is exposed to the air, it gradually absorbs oxygen, and is converted into the blue prussiate, or Prussian blue. On the other hand, the blue prussiate may be converted into the white, by preserving it in a close vessel, with plates of iron or tin. The metallic substance deprives the iron of part of its oxygen, and makes it pass to the state of green oxide; in which state, combined with prussic acid, it is colourless. Sulphurated hydrogen gas produces a similar effect, by depriving the iron of its oxygen. Nitric and oxymuriatic acids convert the white prussiate into blue, by giving up their oxygen, which combines with the iron, and forms the red oxide.

II. Action of the Alkalies, &c. on Iron.

1. Iron, in the metallic state, has a very feeble action on the alkalies and earths. The alkalies, in their pure and concentrated state, promote the decomposition of water by means of iron. Hydrogen gas is disengaged, and the metal is converted into the state of black oxide, or *martial ethiops;* but there seems to be no perceptible solution of the oxide of iron, which is thus formed in the liquid alkalies. 1940 Alkalies.

2. The brown oxides of iron readily combine with the earth suspended in water. This combination has been long employed on account of its properties of assuming a great degree of solidity and hardness, as a cement, and especially as a cement or mortar to be employed under water. Hence volcanic productions, as *pouzzolana earths,* which contain a considerable proportion of oxide of iron, are often employed for this purpose. The oxide of iron combines also with the earths by means of fusion, and communicates to them various shades of colour, according to the degree of oxidation, and the proportion of oxide employed. In this state it is used in the fabrication of enamels and coloured glass. 1941 Earths.

3. The alkaline sulphates are decomposed by iron at a high temperature. The iron deprives the sulphuric acid of its oxygen, and reduces it to the state of sulphur. Fourcroy heated for an hour in a covered crucible, one part of sulphate of potash, with two of iron filings. He obtained a kind of granulated scoria, which had swelled up, and was of a deep green on the surface. It was extremely hard, and exhibited in some of the internal cavities, shining six-sided plates of black oxide of iron. It had a hot, acrid taste. When reduced to powder, it exhaled the fetid odour of sulphurated hydrogen gas. It was not deliquescent in the air; and diluted with 10 parts of water, it was of a deep green colour. This was a solution of hydrosulphuret of potash, holding a small quantity of iron in solution. Sulphur was precipitated by the addition of acids, with the evolution of sulphurated hydrogen gas. 1942 Sulphates.

The nitrates are also decomposed by means of iron heated to redness. Two or three parts of nitre, with one of clean iron filings, well triturated together, and projected into a red-hot crucible, give out at each projection a great number of vivid sparks. After the detonation, a half-fused mass remains, of a reddish yellow colour, which, by washing with water, affords pure potash, and there remains an oxide of iron in its highest degree of oxidation. Steel also detonates with nitre, and gives out a very brilliant red flame. These mixtures are employed in artificial fire-works. 1943 Nitrates.

5. Some of the muriates are also decomposed by iron. The experiment of Scheele, in which the muriate of soda was decomposed by means of iron, has already been mentioned. The muriate of ammonia is readily decomposed by iron with the assistance of heat. Hydrogen and ammoniacal gases are disengaged. A preparation formerly known by the name of *martial* 1944 Muriates.

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Iron, &c. *ammoniacal flowers*, was made with 16 parts of muriate of ammonia and one of iron filings. This mixture is sublimed in two earthen vessels, the one being inverted over the other. A small quantity of the muriate of ammonia only is decomposed, and the salt assumes a yellowish colour, with a small portion of muriate of iron. The muriate of ammonia is also decomposed by triturating the red oxide of iron with this salt. Ammonia is disengaged, and the oxide combines with the acid.

6. Hyperoxymuriate of potash produces a violent detonation with iron. Two parts of this salt with one of iron filings, detonate strongly, and with a vivid red flame, by percussion, or even by sudden pressure, or by being brought in contact with a burning body.

7. There is no action between the fluates, borates, phosphates, or the carbonates, and iron, in the cold.

III. Alloys.

1945 Arsenic. 1. Iron combines with arsenic by fusion, forming a brittle alloy of a white colour, analogous to the native compound of arsenic and iron, known by the name of *mispickel*. It is more fusible than iron, and is therefore employed, on account of its lustre and fine polish, for different purposes to which iron is not applicable.

1946 Tungsten. 2. The alloys of iron with tungsten, molybdena, chromium, columbium, titanium, and uranium, are scarcely known. With titanium iron affords an alloy of a gray colour, which is extremely infusible.

1947 Cobalt. 3. The alloy of iron and cobalt possesses some of the properties of steel. It is extremely hard, its texture is fine-grained, and it is attracted by the magnet.

1948 Nickel. 4. Iron combines with nickel, and the affinity between these metals is so strong, that it is extremely difficult to deprive nickel entirely of iron.

1949 Manganese. 5. Manganese is frequently found in combination with iron, to which it communicates a white colour, and renders it brittle.

1950 Bismuth. 6. Bismuth forms a brittle alloy with iron. It is attracted by the magnet, even when the proportion of bismuth amounts to three-fourths of the whole. Twenty parts of iron and one of bismuth, were broken by a weight of 151 lb.; but four parts of iron and three of bismuth only supported 35 lb. These were the experiments of Muschenbroeck. Gellert has observed, that the alloy of iron and bismuth has an inferior specific gravity to the mean.

1951 Antimony. 7. Iron combines readily with antimony by fusion. An alloy of equal parts of these metals is not attracted by the magnet, has no ductility, and scarcely any malleability. This alloy was formerly called *martial regulus*. It is brittle and hard, and has a less specific gravity than the mean. Iron has a stronger affinity for sulphur than for antimony, for when the sulphuret of antimony is heated with iron, it is decomposed, and the iron combines with the sulphur.

1952 Mercury. 8. Iron, it has been long supposed, has no action on mercury; but by triturating together the amalgam of zinc and mercury with iron filings, and by adding to the mixture a solution of iron in muriatic acid, and afterwards by kneading this mixture and heating it, Mr Aiken obtained an amalgam of iron and mercury, having the metallic lustre *.

1953 Zinc. 9. Zinc forms an alloy with iron, but combines with it in very small proportion. It has been observed that zinc may be applied to the surface of iron by fusion, so as to defend it from the action of the air, and thus to prevent it from rusting.

1954 Tin. 10. Iron combines with difficulty with tin. Bergman made a number of experiments on the alloy of iron and tin. He put a quantity of tin into a crucible, and covered it with iron filings. The crucible was then filled with charcoal, and closely covered. He exposed the apparatus to the heat of a forge for half an hour, and he always obtained two distinct alloys, corresponding to the weight of the metals which he had employed.

The one was iron combined with a small quantity of tin, and the other tin united to a small portion of iron. Tin alloyed with $\frac{1}{22}$ of iron was very malleable, might be cut with a knife, had lost a little of its lustre, and was a little harder. With the fusible phosphates it gave a brown glass, which was less fusible; and by the addition of nitric acid, it became black, and there was separated an insoluble powder. Iron combined with half its weight of tin, exhibits some of the properties of the latter. It is slightly malleable, cannot be cut with a knife, unites with difficulty with mercury and with the phosphates, and in fusion with the latter, gives out brilliant sparks, which do not appear from the iron or tin alone. This inflammation is still more brilliant when the quantity of tin is increased to $\frac{11}{100}$.

1955 Tin-plate. Tin combines with iron, and adheres strongly to its surface, forming a thin covering. This is one of the most useful combinations of tin, for it renders the iron fit for a great many valuable purposes, for which, otherwise, on account of its strong tendency to oxidation or rusting, it would be totally inapplicable. This is well known by the name of *tin-plate*, or *white iron*. 1956 Process of tinning. The process of tinning iron is the following: The plates of iron being reduced to the proper thickness, are cleaned by means of a weak acid. For this purpose the surface is first cleaned with sand, to remove any rust that may have formed. They are then immersed in water acidulated with a small quantity of sulphuric acid, in which they are kept for 24 hours, and occasionally agitated. They are then well rubbed with cloths, that the surface may be perfectly clean. The tin is fused in a pot, the surface of which is covered with an oily or resinous matter, to prevent its oxidation. The plates of iron are then immersed in the melted tin, and are either moved about in the liquid metal, or are dipped several different times. They are then taken out, and rubbed with saw-dust or bran, to remove the impurities from the surface.

It is said by some chemical writers, that the tin not only covers the surface, but penetrates the iron completely, so as to give the whole a white colour. This seems to be quite a mistake, which may be very easily proved by the test of experiment. If the surface of a piece of tin-plate be scraped with a knife, the metallic particles which are at first separated, are not attracted by the magnet. As the process is continued, some of the particles are magnetic, which shows that they are particles of iron, scraped off, after the coating of tin is separated, and this coating may be so completely removed that the whole of the particles are attracted by the magnet. This, perhaps, it may be said, would take

* Phil. Mag. xiii. 406.

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Copper, &c.

take place, even though the iron were alloyed with a certain proportion of tin; but when the coating of tin is entirely removed, and the iron is moistened, it is soon covered with rust, in the same way as if it never had been combined with a particle of tin.

1957 Lead. 11. Guyton has shewn, that an alloy may be formed of iron and lead, which it was formerly supposed could not be effected. By melting together equal parts of lead and filings of iron, he obtained two separate metallic buttons, of which the lead occupied the lower part of the crucible, and the iron the upper part. When these were subjected to the test of experiment, it appeared that the lead contained a small proportion of iron, and the iron a small proportion of lead *.

The uses of iron are extremely numerous and important, but they are so well known, that it is altogether unnecessary to enumerate them.

* Ann. de Chim. xliii. 48.

Sect. XXI. *Of Copper and its Combinations.*

1958 History. 1. Copper seems to have been known in the remotest periods of antiquity. It is among the first metals which were employed by the early nations of the world; and indeed this might have been expected, as it is not one of the scarce metals, is easily extracted from its ores, and not difficult to work. The Egyptians applied it to a great variety of uses, as it appears, from the earliest period of their history. The Greeks were acquainted with the mode of working copper, and employed it in many of the arts. It was the basis of the celebrated Corinthian metal. The Romans knew the uses of this metal, and it is generally supposed that of it they fabricated the greatest number of their utensils. The alloys which they made with copper, after the example of the Egyptians and Greeks, were very numerous, and applied to a great variety of uses.

1959 Ores. 2. Copper exists in considerable abundance in nature; it is found native, alloyed with other metals, combined with sulphur, in the state of oxide, and in that of salt. It is not unfrequently met with in the native state, sometimes crystallized in an arborescent form, and sometimes in more regular figures. Copper exists native, alloyed with gold and silver. The most abundant ores of copper are the sulphurets, and of these there is a considerable variety, exhibiting various colours, and various forms of crystals. In the state of oxide, it has been found in Peru, of a greenish colour, mixed with white sand. In the state of salt, copper is combined with the sulphuric and carbonic acids, forming native sulphates and carbonates of copper. The latter present many varieties, but may chiefly be referred to the blue and green carbonates.

1960 Analysis. 3. The extraction of the ores of copper is to be conducted according to the nature of the combination in which they exist. The following process is recommended for the treatment of the sulphurets of copper. The ore is first reduced to powder, and then boiled with five parts of concentrated sulphuric acid. The solution is evaporated to dryness, and the residuum well washed with warm water, to remove all soluble matters. The solution being sufficiently diluted, a plate of copper is immersed in it, which precipitates the silver, and afterwards a plate of iron to precipitate the copper. It is boiled with the plate of iron, till no farther precipitate takes place. The copper which is thus obtained, is dried with a gentle heat, so that it may not undergo oxidation. It is supposed that the copper is mixed with iron, the whole may be dissolved in nitric acid, and the process is again repeated by introducing the plate of iron. In this way it is easy to discover the quantity of copper in the sulphurets of this metal.

4. Copper is a very brilliant metal, of a fine red colour, different from every other metallic substance. 1961 Properties.
The specific gravity of copper is 8.584. When it is hammered, it acquires a greater density. It possesses a considerable degree of hardness, and some elasticity. It is extremely malleable, and may be reduced to leaves so fine that they may be carried about by the wind. It has also a considerable degree of ductility, intermediate, according to Guyton, between tin and lead. The tenacity of copper is also very great. A wire .078 of an inch in diameter, will support a weight without breaking equal to more than 300 lbs. avoirdupois. Copper has a peculiarly astringent and disagreeable taste. It is extremely deleterious, when taken internally, to the animal economy, and indeed may be considered as a poison. It is distinguished by a peculiarly disagreeable odour, which it communicates to the hands by the slightest friction.

5. Copper does not melt till the temperature is elevated to a red heat, which is about 27° Wedgwood, or by estimation 1450° Fahrenheit. When it is rapidly cooled after fusion, it assumes a granulated and porous texture, but if it be cooled slowly, it affords crystals in quadrangular pyramids, or in octahedrons, which proceed from the cube, its primitive form. When the temperature is raised beyond what is necessary for its fusion, it is sublimed in the form of visible fumes. 1962 Action of heat.

7. When copper is exposed to the air, especially if it be humid, it is soon deprived of its lustre. It tarnishes, becomes of a dull brown colour, which gradually deepens, till it is converted into that of the antique bronze, and at last is covered with a shining green crust, which is well known under the name of *verdigris*. This process is the oxidation of the metal by the absorption of oxygen from the atmosphere; and it is promoted and accelerated, either by being moistened with water, or by the water which exists in the atmosphere. As this oxide is formed, the carbonic acid of the atmosphere combines with it, so that it is to be considered as a mixture of oxide and carbonate of copper. 1963 Oxidation.

7. But when copper is subjected to a strong heat, the oxidation proceeds more rapidly. If a plate of copper be made red-hot in the open air, it loses its brilliancy, becomes of a deep brown colour, and the external layer, which is of this colour, may be detached from the metal. This is the brown oxide of copper. This oxide may be obtained by immersing a plate of red-hot copper into cold water. The scales which are formed on the surface fall off by the sudden contraction of the heated copper. This may be repeated till the whole is converted into this oxide. The copper in this state is in the highest degree of oxidation. Sometimes it assumes a black, and sometimes a green colour, which, according to Proust, are owing to the combination of carbonic acid with the oxide. This oxide of copper may also be obtained by dissolving

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Copper, &c.

1964 Black oxide. dissolving copper in nitric or sulphuric acid, and then by precipitating with an alkali, which precipitate is to be dried, to separate the water. The component parts of this oxide are,

Oxygen	25
Copper	75
	100

But copper combines with a smaller proportion of oxygen, forming an oxide of an orange colour. If the black oxide of copper be mixed with less than an equal proportion of metallic copper in fine powder, triturated in a mortar, and introduced into a close vessel with muriatic acid, the whole of the copper is dissolved with the emission of heat, and the oxide is precipitated of an orange colour, by means of potash.
1965 Yellow. This is the oxide of copper with the smaller proportion of oxygen. The component parts of this oxide, according to Mr Chenevix, are

Oxygen	11.5
Copper	88.5
	100.0 *

* *Phil. Trans.* 1801, p. 235.

This oxide changes colour the moment it is exposed to the air, by the absorption of oxygen, for which it has a very strong affinity.

8. There is no action between azote, hydrogen, or carbon, and copper.

1966 Phosphuret. 9. Phosphorus readily combines with copper, and forms with it a phosphuret, which is prepared by fusing equal parts of copper and phosphoric glass, with $\frac{1}{8}$ of the whole of charcoal in powder. Or, it may be formed by projecting phosphorus on red-hot copper in a crucible. The phosphuret of copper is of a whitish gray colour, with a metallic lustre, and of a close texture. It is much more fusible than copper; it melts by the action of the blow-pipe; the phosphorus burns with deflagration on the surface, and the copper remains behind in the state of black scoria. Exposed to the air, it loses its brilliancy, blackens, and is converted into a kind of efflorescence, which is phosphate of copper. It is composed of 20 parts of phosphorus, and 80 of copper.

1967 Sulphuret. 10. Copper combines with sulphur by different processes. If sulphur in powder and filings of copper are mixed together, and formed into a paste with a little water, when they are exposed to the air, the mass swells up, becomes hot, and is converted into a brown matter, which effloresces slowly in the air, and is converted into sulphate of copper. This sulphuret may be also formed by heating together in a crucible equal parts of sulphur and copper filings. A deep-coloured mass is thus obtained, which is brittle, and more fusible than copper. This substance, which is employed in dyeing, is prepared by stratifying in a crucible plates of copper and sulphur. When the whole is melted, it is afterwards reduced to powder, and was formerly known by the name of *æs veneris*.

1968 Singular experiment. A singular and splendid experiment was first made by the society of Dutch chemists at Amsterdam, in the formation of sulphuret of copper. If three parts of flowers of sulphur, by weight, and eight parts of copper filings, be mixed together, introduced into a lass matrass, and then placed upon red-hot coals, the mixture melts, and afterwards, with a kind of explosion, becomes almost instantaneously red-hot. If it be then removed from the fire, it continues red-hot for some time, and is converted into a sulphuret of copper. The singular part of this experiment is, that it succeeds equally well without the access of oxygen; or even it may be performed, when the mixture is under water. It seems, therefore, at first sight, to be a case of combustion, or apparent combustion, without oxygen. Various opinions have been entertained concerning the nature of this process, and different theories have been proposed to account for the phenomena, which are seemingly irreconcileable with the present theory of combustion. Indeed it was at first held up as an objection to the Lavoisierean theory. It has been explained by some, by supposing that a small quantity of air may have remained within the apparatus, or mixed with the materials; or that the quantity of air necessary might be supplied from the moisture, from which the materials and the apparatus may not have been sufficiently freed. But this affords no satisfactory explanation; for the quantity of air or water which could remain when the experiment has been carefully performed, is not sufficient to furnish the necessary portion of air for the support of such a vivid combustion. Fourcroy considers it as a case of simple phosphorescence, a change or sudden increase of capacity for caloric, or as merely the separation of light, or the conversion of caloric into light; and in support of this opinion he states, that the compound is always sulphuret of copper, which would not have been the case, had real combustion been effected, for then it would have been a sulphate of copper. But it is explained by others according to the principles of the theory of combustion, which has been given by Gren, and which we have already detailed, in treating of heat. According to this theory, the light exists in combination with the combustible, which in this case is the copper. When heat is applied to the mixture, the sulphur melts, and therefore combines with a great quantity of caloric; but, when the sulphur combines with the copper, it returns to the solid state, and therefore gives out a quantity of caloric. The light from the metal at the same time combines with the caloric, and both appear in the form of fire. It is at the instant of combination that the mass becomes red-hot, in consequence of the sudden extrication of heat and light from the two substances which form the compound.

Copper &c. — 1969 Of different explanations.

Copper combined with sulphur is one of the most common ores of this metal. According to the experiments of Proust, the natural production, known by the name of copper pyrites, is a sulphuret of copper, combined with an additional portion of sulphur. It is distinguished by its brittleness, metallic lustre, and yellow colour. Copper pyrites.

11. The order of the affinities of copper and its oxide, is, according to Bergman, the following: 1971 Affinities.

Copper.	Oxide of Copper.
Gold,	Oxalic acid,
Silver,	Tartaric,
Arsenic,	Muriatic,
Iron,	Sulphuric,
Manganese,	Saclactic,
Zinc,	Nitric,

Copper.

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Copper, &c.

COPPER.	OXIDE of COPPER.
Antimony,	Arsenic,
Platina,	Phosphoric,
Tin,	Succinic,
Lead,	Fluoric,
Nickel,	Citric,
Bismuth,	Lactic,
Cobalt,	Acetic,
Mercury,	Boracic,
Sulphur,	Prussic,
Phosphorus.	Carbonic.

I. Salts of Copper.

1. Sulphate of Copper.

1972 Preparation.

1. Sulphuric acid has no action on copper in the cold; but when it is concentrated, and at a boiling temperature, it is decomposed by the copper, with the disengagement of sulphurous acid gas. By evaporating the liquid, and by slow cooling, crystals of a fine blue colour are obtained. This salt, which is a sulphate of copper with excess of acid, reddens vegetable blues, has a strong styptic, metallic taste, and is at the same time extremely acrid and caustic. Its specific gravity

1973 Properties.

is 2.1943. It is soluble in 4 parts of cold, and in 2 of boiling water. It effloresces slightly in the air, loses its water of crystallization when it is heated, and is converted into a bluish white powder. By increasing the heat the acid is driven off, and the oxide remains

1974 Composition.

behind. The component parts of this salt are, according to Proust,

Acid	33
Oxide	32
Water	35
	100

1975 Native.

2. This salt is generally found in great abundance in nature, and is obtained either by evaporating the water which holds it in solution, or by expressing the sulphuret of copper to air and moisture, by which it is converted into sulphate of copper. This salt is known in commerce by the name of *blue vitriol*, *blue copperas*, and *vitriol of copper*.

3. None of the acids have any action on the sulphate of copper. It is decomposed by the alkalies and earths, and precipitated in the form of a bluish-gray oxide, which becomes green when exposed to the air, by absorbing carbonic acid from the atmosphere. Ammonia decomposes and precipitates the sulphate of copper, and, with an excess of alkali, dissolves the oxide, which assumes a rich, brilliant blue colour. It is also partially decomposed by muriate of ammonia. Equal parts of this salt and sulphate of copper in a heated solution, appear of a yellow colour, but when the solution cools, it is converted into green. This solution has been employed as a sympathetic ink. Paper moistened with it appears of a yellow colour when it is heated, but, in the cold, the colour entirely disappears.

1976 Sympathetic ink.

4. When a small quantity of caustic potash is added to a solution of sulphate of copper, a greenish-coloured precipitate is formed, which is diffused in the solution. This is a sulphate of copper with excess of base, and, according to Proust, is composed of

Acid	18
Oxide	68
Water	14
	100

1977 Composition of.

Copper is reduced to the metallic state from its solutions in acids, by several metallic substances, as iron, zinc, tin. If a plate of iron be introduced into a solution of copper in an acid, the iron is in a short time covered with metallic copper. It is in this way that copper is obtained from its natural solutions in water.

2. Sulphite of Copper.

Sulphurous acid has no action whatever on copper; 1978 Preparation.
but the oxide of copper readily combines with this acid. Or, the sulphite of copper may be formed by adding a solution of sulphite of soda, to a solution of sulphate of copper. An orange-yellow precipitate is formed, and small crystals of a greenish white are deposited. These become deeper coloured by exposure to the air. Both the yellow precipitate and the greenish white salt have been proved by experiment to be sulphites of copper. The first contains a greater proportion of copper, and therefore has an excess of base, to which its colour and insolubility are owing. The second is a saturated sulphite, which is soluble and crystallizes. When these salts are heated by the blow-pipe, they melt, blacken, assume a grayish colour, and are at last reduced to the metallic state. By the addition of nitric acid they are converted into sulphate of copper. By the sulphuric acid the sulphurous acid is driven off, and there remains behind a brownish-coloured matter in the state of powder, which is the oxide of copper mixed with a portion of that metal in the metallic state.

3. Nitrate of Copper.

1. Nitric acid is decomposed by copper with great 1979 Preparation.
rapidity. Nitrous gas is given out in great abundance, the metal is oxidated, and dissolved in the acid. The solution, which is at first of a pale blue, assumes a deep colour, and by slow evaporation yields crystals in the form of long parallelopipeds. This salt has an acrid styptic taste, is extremely caustic, and corrodes the skin. It is deliquescent, and very soluble in wa- 1980 Properties.
ter. This salt exposed to a heat, even under 100°, melts; by increasing the heat, the water of crystallization is driven off; it detonates slightly on red-hot coals, and when mixed with phosphorus, by percussion.

2. If a quantity of this dried salt, reduced to pow- 1981 Violent action on tin.
der, be spread on a sheet of tinfoil, it remains without any action; but if it be moistened a little with water, and wrapped up, a violent action takes place. The salt is decomposed, and nitrous gas is disengaged with a great degree of heat. The tinfoil is burst to pieces, and sometimes it is even inflamed. In this process, the nitric acid of the nitrate of copper is decomposed, in consequence of the strong affinity of the tin for the oxygen of the acid. The tin is oxidated, nitrous gas is given out, and the copper is partly reduced to the metallic state.

3. The alkalies and earths precipitate the solution 1982 Decomposition.
of

Copper, &c.

of nitrate of copper in the form of a bluish-white oxide, which becomes green by exposure to the air. When it is precipitated by means of potash, if the potash predominate, a bulky precipitate is formed, of a fine blue colour. The precipitate is composed of the oxide of copper and water, from which Proust, who particularly examined it, has denominated it *hydrate of copper*. Lime thrown into this solution has the property of giving it a deeper shade of blue. It is by this process that the blue pigment known in commerce by the name of *verditer*, and which is employed for painting paper, is prepared.

4. If nitrate of copper be distilled in a retort, the salt becomes thick, and forms a green crust on the retort. It is then in the state of nitrate with excess of base, or *subnitrate*, which is insoluble in water.

1983 Composition.

5. The component parts of this salt are, according to Proust,

Acid	16
Oxide	67
Water	17
	100

4. Muriate of Copper.

1. Concentrated muriatic acid, with the aid of heat, acts on copper and dissolves it. It produces a

1984 Preparation.

slight effervescence, with the evolution of hydrogen gas. The solution is of a fine green colour, by which it is distinguished from the sulphate and nitrate of copper. This salt may be formed by the direct combination of the green oxide of copper with muriatic acid, a little diluted with water. By evaporation and slow cooling, crystals may be obtained in the form

1985 Properties.

of long small needles, or rectangular parallelopipeds, which are of a fine grass-green colour. This salt is extremely acrid and caustic; it melts with a moderate heat; it is deliquescent in the air, and is soon converted into a thick liquid like oil. The salt fuses at a moderate heat, and becomes of a uniform mass by cooling. It is not decomposed by sulphuric or nitric acids. The alkalies precipitate a bluish white oxide, which becomes

1986 Composition.

green in the air; the copper is precipitated by zinc and iron. The component parts of this salt, according to Proust, are,

Acid	24
Black oxide	40
Water	36
	100

This salt is therefore the muriate of copper with the

1987 Submuriate.

oxide in the highest degree of oxidation.

2. This salt, according to the experiments of Proust, may be distilled to dryness without any change; but by increasing the heat, a part of its acid is driven off in the state of oxymuriatic acid, and the copper remains behind in its lowest state of oxidation, and forms a muriate of copper of a white colour. This muriate may also be obtained by dissolving copper in nitro-muriatic acid. A greenish powder appears, which is a muriate of copper with excess of base. The component parts of this salt are,

Acid	12.5
Oxide	79.0
Water	8.5
	100.0

3. Muriatic acid also forms a salt with the oxide of copper in its lowest degree of oxidation. Proust obtained this salt by mixing salts of copper with muriate of tin, which latter deprived the copper of a portion of its oxygen, and afforded a salt of a white colour. It may be formed also by introducing a plate of copper into a bottle filled with muriatic acid. This salt crystallizes in tetrahedrons. It may be precipitated in the state of white powder; by diluting the solution with water, and by repeated washings, the orange oxide of copper is obtained. When it is exposed to the air, it soon combines with oxygen, and is converted into muriate of copper with the oxide in its maximum state of oxidation. This salt is soluble in ammonia, and forms with it a colourless solution, which, after being for some time exposed to the air, assumes a fine blue colour by the absorption of oxygen.

5. Hyperoxymuriate of Copper.

The oxide of copper diffused in water, is dissolved when a stream of oxymuriatic acid gas is directed through it. This salt is of a bluish green colour, difficult of crystallization. Paper impregnated with it is easily kindled, and burns with a remarkably fine green flame.

6. Fluate of Copper.

Fluoric acid readily oxidates and dissolves copper; but the properties of this salt are little known. It forms a gelatinous solution, and affords by evaporation cubical crystals.

7. Borate of Copper.

This salt is most readily formed by adding a solution of an alkaline borate to the solution of nitrate or sulphate of copper. A greenish precipitate is formed, which has very little solubility in water.

8. Phosphate of Copper.

Phosphoric acid is not decomposed by copper; but when it remains for some time in contact with the metal, it promotes the oxidation, and there is thus formed a phosphate of copper, which has little solubility. Or it may be obtained by pouring an alkaline phosphate into a solution of sulphate or nitrate of copper. The phosphate of copper is formed, which is almost insoluble. When it is heated with charcoal in a crucible it affords a gray phosphuret of copper, which has some brilliancy. The component parts of phosphate of copper, as they have been ascertained by Mr Chenevix, are,

Acid	35.0
Oxide	61.5
Water	3.5
	100.0

The above oxide is composed of 49.5 brown oxide, and 12 of water.

9. Carbonate

Copper, &c

9. Carbonate of Copper.

1992 Preparation. Carbonic acid has no action on copper, either in the gaseous or liquid state; but it is very readily absorbed by the blue or green oxides of this metal. It may be formed by adding an alkaline carbonate to any of the solutions of copper in the other acids. To prepare this salt of the most brilliant and uniform colour, it should be precipitated with boiling water, washed carefully, and the vessel which contains it placed in the sun. The carbonate of copper is found native, and is known by the name of *malachite*. It contains the same proportions as the artificial carbonate. Its component

1993 Composition. parts are,

Acid	25.0
Brown oxide	69.5
Water	5.5
	100.0

10. Arseniate of Copper.

This salt may be formed by adding a solution of an alkaline arseniate to nitrate of copper; or by digesting arsenic acid on copper. A green solution is obtained, and the arseniate of copper is precipitated in the form of a bluish-white powder. The arseniate of potash added to a solution of sulphate of copper forms a precipitate of a very rich green, which was proposed by Scheele as a paint, because it is unaltered by the air, and hence it obtained the name of *Scheele's green*. It is the arsenite of copper. This salt may be formed by

1994 Scheele's green. the following process:

Dissolve a quantity of potash in water, and add white oxide of arsenic, till the potash is saturated. Filter the liquor, and add gradually a solution of sulphate of copper while it is hot, stirring the mixture during the addition. It is then left at rest for some time, after which the arsenite of copper precipitates in the form of a beautiful green powder. The precipitate is to be repeatedly washed with water, and dried. Several varieties of the arseniates of copper have been described, and analyzed by the Count de Bournon and Mr Chenevix, and an account of them published in the Philosophical Transactions for 1801.

11. Tunsgate of Copper.

Tungstic acid combines with oxide of copper, or forms a precipitate when added to a solution of sulphate of copper.

12. Molybdate of Copper.

Molybdic acid, added to a solution of nitrate of copper, produces a green precipitate.

13. Chromate of Copper.

This is formed by adding chromic acid to a solution of nitrate of copper. A red precipitate is obtained.

14. Acetate of Copper.

1995 Preparation. Copper is readily oxidated and dissolved in acetic acid. The solution is aided by heat, and gradually assumes a green colour. The oxide of copper, which is thus formed, is the verdigris of commerce. It is usually prepared by exposing plates of copper to the action of vinegar. The surface of the plates is covered with this bluish-green powder, which being dissolved in acetic acid affords a solution of a fine greenish blue colour. This solution by evaporation and cooling gives crystals of a deep blue colonr, and in the form of quadrangular, truncated pyramids. The specific gravity is 1.779. This salt has a strong disagreeable taste, and is poisonous. It effloresces in the air, and is very soluble in 1996 Properties. water. It is decomposed by all the alkalies; and by means of heat, or by distillation, it is decomposed, and gives ont acetic acid. This salt, according to the analysis of Proust, is composed of

Acid and water	61
Oxide	39
	100

15. Oxalate of Copper.

Oxalic acid readily acts upon copper, and forms with it needle-shaped crystals of a green colour. It readily combines with the oxide of copper, and is then in the state of a bluish green powder, which is little soluble in water. Oxalic acid precipitates the sulphate, nitrate, and muriate of copper, in the form of a bluish gray powder.

16. Tartrate of Copper.

Tartaric acid dissolves copper, when exposed to the air, and at last converts it into an oxide. It combines readily with the oxides of copper, and forms with them a salt of little solubility, and of a green colour. When this acid is added to the solution of sulphate or muriate of copper, it forms a tartrate of copper, which appears after some time in irregular greenish crystals.

17. Tartrate of Potash and Copper.

This triple salt may be prepared by boiling together oxide of copper and tartar in water. By evaporating the solution, blue crystals are obtained, which have a sweetish taste. If the same solution be evaporated to dryness, a bluish green powder remains behind, which 1997 Brunswick green. is employed as a paint, by the name of *Brunswick green*.

18. Citrate of Copper.

Citric acid dissolves the oxide of copper at the boiling temperature. The solution affords by evaporation greenish coloured crystals.

19. Benzoate of Copper.

Benzoic acid readily dissolves the oxide of copper. The solution yields small crystals of a deep green colour, which have little solubility in water. It is decomposed by the alkalies, the carbonates of lime, and barytes, and the acid is driven off by heat.

20. Succinate of Copper.

When succinic acid is long digested with copper, it dissolves a small portion, and the solution affords green crystals.

21. Suberate of Copper.

When suberic acid is added to a solution of nitrate

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Copper, &c.

trate of copper, it produces a green colour; but there is no precipitate.

22. Mellate of Copper.

When mellitic acid is added to a solution of acetate of copper, it affords a precipitate, and the colour of verdigris, but it produces no change on muriate of copper.

23. Lactate of Copper.

Lactic acid, after digestion with copper, first assumes a blue colour, then changes to a green, and is afterwards converted into a dark brown. The solution does not yield crystals.

24. Prussiate of Copper.

1998 Preparation.

The prussiates of potash precipitate the salts of copper of different colours. The prussiates obtained from sulphate, nitrate, and muriate of copper, Mr Hatchet observes, are very beautiful; but the finest and deepest colour he obtained from the muriate. He has proposed the prussiate of copper as a paint; and on trial with oil and water, it has been found to answer the purpose. The method which he recommends for the preparation of this pigment, is to take green muriate of copper with 10 parts of distilled or rain water, and to add prussiate of lime, which he thinks is preferable to prussiate of potash, until the whole is precipitated. The prussiate of copper is then to be well washed with cold water, and to be dried without heat *.

* *Journ. Roy. Inst.* i. 307.

II. Action of Alkalies, &c. on Copper.

1999 Fixed alkalies.

1. The fixed alkalies in solution in water, digested with copper filings, and allowed to cool, promote the oxidation of the metal. The liquid assumes a slight blue colour, as well as the copper, but the action of the air is necessary for this process. It scarcely succeeds in close vessels.

2000 Ammonia.

Liquid ammonia, treated in the same way, becomes of a brilliant blue colour, but it dissolves only a very small quantity of the oxide. By the slow evaporation of this solution, the greatest part of the ammonia is separated in the form of gas; a very small quantity only remains combined with the oxide of copper. This solution, it has been said, yields transparent crystals of a fine blue colour. The dried mass assumes a green colour when it is exposed to the air, as the ammonia is dissipated, and the oxide absorbs carbonic acid. The green oxide of copper is instantly converted to a blue. This action is promoted by heat, and when the heat is increased, azotic gas is disengaged; the hydrogen of the ammonia combines with part of the oxygen of the oxide, and forms water; the oxide becomes of a brown colour, and the metal is at last revived.

2001 Glass coloured.

2. There is no action between the earths and copper, excepting by fusion. With the vitrifiable earths and the oxides of this metal, a glass is formed, which is most commonly of a fine green colour, with different shades of brown or red, according to the degree of oxidation. The oxides of copper are frequently employed to colour glass, porcelain, and pottery.

2002 Sulphates.

3. Copper seems to have but a feeble action on most of the salts. The sulphates are not decomposed by this metal, even with the assistance of heat. When copper is boiled with the solution of alum, it is oxidated and partially dissolved, by the excess of sulphuric acid which this salt contains. The sulphate of copper thus formed, seems to combine in the state of triple salt with the sulphate of alumina and potash. It has been observed that alumina precipitated from alum, the solution of which has been kept for some time in copper vessels, is slightly tinged with a blue colour. 2003 Nitrates. The nitrates, especially the nitrate of potash, when fused together, give out sparks, but without inflammation or detonation. A brown oxide of copper is thus formed, mixed with potash. When it is washed with water, the alkali is dissolved, and there remains the pure oxide of copper, which is often prepared in this way for the fabrication of enamels.

2004 Muriate.

Muriate of ammonia is decomposed by copper with the assistance of heat. Hydrogen gas and ammoniacal gas are disengaged, and there remains behind a muriate of copper. The solution of muriate of ammonia also acts upon copper, and becomes of a blue colour, when it is kept in vessels of this metal. When muriate of ammonia is sublimed with about $\frac{1}{80}$ of its weight of green oxide of copper, a small quantity of the muriate of ammonia is decomposed, and the muriate of copper which is formed, combines with the undecomposed salt. This was formerly called *cupreous flowers of sal ammoniac*, or *ens veneris*. If a quantity of lime water, with about $\frac{1}{16}$ of its weight of muriate of ammonia, be kept in a copper vessel for 10 or 12 hours, the liquid assumes a fine blue colour. This was formerly called *celestial water*. In this process a small quantity of ammonia is disengaged by the lime, and it dissolves some portion of the copper, which communicates a blue colour to the whole solution. This compound may also be formed, by adding a small quantity of copper filings to a mixture of the solution of muriate of ammonia and lime water.

4. The phosphates, fluates, borates, and carbonates, have no other action on copper than by means of the water in which they are dissolved. This action is greatly promoted by exposure to the air.

III. Alloys.

1. Copper readily combines with almost all other metals, by means of fusion; and many of the alloys which are thus formed are of great importance in the arts.

2005 Arsenic.

2. When copper is combined with arsenic, by melting them together in a close crucible, and covering the surface with muriate of soda, to prevent oxidation, a white brittle alloy is formed, which has been called *white tombac*. With a certain proportion of zinc and tin, this alloy is employed in the fabrication of various utensils.

3. The alloys of copper with tungsten, molybdena, chromium, columbium, titanium, and uranium, are either altogether unknown, or have not been examined.

2006 Cobalt.

4. Little is known of the alloy of copper and cobalt. It is said that it resembles cobalt itself in texture and brittleness.

2007 Nickel.

5. Copper forms with nickel a white hard alloy, which has no ductility, and which is soon altered by exposure to the air.

2008 Manganese.

6. Copper unites with manganese, and gives an alloy of a red colour, which is very malleable.

7. Equal

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Copper, &c.

2009 Bismuth. 7. Equal parts of copper and bismuth, melted together, form a brittle alloy of a pale red colour. With one-eighth of bismuth, the alloy is extremely brittle, of a very pale red colour, and exhibiting in its texture nearly cubical fragments. The specific gravity of this alloy is exactly the mean of that of the two metals; and, as the proportion of bismuth is increased, the tenacity of the alloy is diminished.

2010 Antimony. 8. Copper combines readily with antimony by fusion. Equal parts of the two metals constitute an alloy of a beautiful violet colour, and of a greater specific gravity than the mean. This alloy is remarkable for its lamellated and fibrous texture. The alchemists gave it the name of *regulus of Venus*. A compound formed of equal parts of martial regulus and regulus of Venus, according to an alchemical prescription, the surface of which exhibits the appearance of meshes or cavities, was called *Vulcan's net*, because it seemed to envelope iron and copper, which were denominated *Mars* and *Venus*.

2011 Mercury. 9. Copper enters into combination with mercury with some difficulty. This alloy may be formed by triturating very thin plates of copper which have been rubbed with vinegar or common salt, with mercury; or, by triturating copper filings with the solution of mercury in nitric acid. It is also formed by other processes; but whatever be the process, this amalgam is of a reddish colour, and sufficiently soft to receive the most delicate impressions when it is a little heated. It becomes hard by exposure to the air. It is decomposed by heat, and the mercury is separated.

2012 Zinc. 10. The compound of copper and zinc constitutes one of the most important and useful alloys, of all the combinations of the metals. Muschenbroeck has given a particular description of several of these alloys. Equal parts of copper and zinc afforded a metal of a fine golden yellow, whose specific gravity was 8.047; one part of copper and half a part of zinc, formed a compound of a pale golden colour; one part of copper and three-fourths of zinc, composed an alloy of a golden colour, which yielded to the file; one part of copper and one-fourth of zinc, gave a compound of a finer colour than that of brass. According to the proportions of the metals which are employed, the alloys have received different names. The usual process for combining them, is either by fusing copper with a mixture of calamine, or native carbonate of zinc and charcoal; or by stratifying plates of copper with the same mixture, and exposing them to heat.

2013 Brass. The well known compound, distinguished by the name of *brass*, is an alloy of copper and zinc. The proportion of the zinc is about one-fourth of the copper. This alloy is of a fine yellow colour, less liable to tarnish, and more fusible than the copper. The density of this alloy is one-tenth more than the mean. It is malleable, and possesses considerable ductility.—A compound applied to a great variety of ornamental purposes, and known by the names of *Prince Rupert's metal*, *prince's metal*, or *pinchbeck*, is an alloy of zinc and copper in the proportion of three parts of the former to four of the latter. This alloy is less malleable than brass; but has a fine golden colour, which is pretty permanent, and little affected by exposure to air. 2014 Pinchbeck.

The compound of zinc and copper, called brass, it is supposed, was well known to the ancients. An ore of zinc was employed in the fabrication of it, although it does not appear that they were at all acquainted with zinc as a distinct metal. "It is probable," Professor Beckmann observes, after Pliny, "that ore containing zinc, acquired the name of *cadmia*, because it first produced brass." "Ipse lapis è quo fit æs, cadmia vocata." "When it was afterwards remarked, that calamine gave to copper a yellow colour, the same name was conferred on it also. It appears, however, that it was seldom found by the ancients, and we must consider cadmia in general as signifying ore that contains zinc. Gold-coloured copper or brass was long preferred to pure or common copper, and thought to be more beautiful the nearer it approached to the best *aurichalcum* (C). Brass, therefore, was supposed to be a more valuable kind of copper; and on this account Pliny says that cadmia was necessary for procuring copper, that is, *brass*. Copper as well as brass was for a great length of time called *æs*, and it was not till a late period, that mineralogists, in order to distinguish them, gave the name of *cuprum* to the former. Pliny says, that it was good when a large quantity of cadmia had been added to it, because it not only rendered the colour more beautiful, but increased the weight (D)*."

2015 Brass analyzed. To discover the proportions of the two metals in this alloy, Vauquelin dissolved a quantity of brass in nitric acid. When the solution is completed, he precipitates the two metals by means of potash, which is added in large quantity, to dissolve the whole of the oxide of zinc; and as the oxide of copper is not soluble by this alkali, it remains in the form of black powder, which is separated, washed, and dried. A fiftieth part of the weight of this precipitate is deducted for the oxygen with which it is combined; the remainder gives the weight of copper in the alloy. What is deficient of the whole weight of the alloy, is the weight of the zinc †.

11. Copper

* *Hist. of Invent.* iii. 74.

† *Fourcroy Connaiss. Chim.* vi. 159.

(C) According to Bishop Watson, the *aurichalcum*, or *orichalcum*, of the ancients, is to be considered as the same with our brass. *Manchest. Trans.* ii. 47.

(D) Mr Beckmann farther adds, "At first it was called *æs cyprium;* but in course of time only *cyprium*, from which at length was formed *cuprum*. It cannot, however, be ascertained at what periods these appellations were common. The epithet *cupreus* occurs in manuscripts of Pliny and Palladius, but we cannot say whether later transcribers may not have changed *cyprius* into *cupreus*, with which they were perhaps better acquainted. The oldest writer who uses the word cupreum, is Spartian, who says in the life of Caracalla, *cancelli ex ære, vel cupro;* but may not the last word have been added to the text as a gloss? Pliny, book xxxvi. 26. says, *addito cypro et nitro*, which Isidore, xvi. 15. p. 363, expressed by the words *adjecto cupro et nitro*." *History of Inventions*, iii. 75.

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Copper, &c.

2016 Tin. 11. Copper combines very readily with tin. This is a very important alloy in the arts. It is with this alloy that *bronze*, metals for casting statues and cannons, bell-metal, and metallic mirrors, are formed. Tin diminishes the ductility of copper, and increases its tenacity, hardness, and sonorous quality. According to Muschenbroeck, copper acquires the greatest solidity with the addition of one part of tin to five or six of this metal. By increasing the quantity of tin, the alloy becomes hard and brittle.

2017 For cannons. To form the alloy employed for cannons, 12 parts of tin are united to 100 of copper. In fusing the two metals for this alloy, it is necessary to stir or agitate the mixture, otherwise they remain uncombined. Bronze, or the metal which is used for statues, is not different from that of which cannons are made, excepting in the proportion of tin being either more or less, to vary the colour.

2018 Bell-metal. The component parts of bell-metal are usually 75 of copper and 25 of tin, or three of copper and one of tin. A small quantity of other metals is sometimes detected by analysis, in fragments of bells that have been examined, such as zinc, antimony, bismuth, and even silver. But these metals are not considered as essential to the alloy. Bell-metal is of a grayish white colour, of a close grain, and so hard as to be scarcely touched with the file. It is also elastic and sonorous. The specific gravity is considerably more than the mean, and it is more fusible than copper. A mixture of three parts of tin and one of copper, fused with a little arsenious acid, and black flux, gives an alloy of the colour of steel, very hard, and susceptible of a fine polish, which is employed in the fabrication of mirrors for telescopes. But other proportions, with the addition of other metals, are employed by different opticians. Bismuth, antimony, and silver, are added, to increase the reflecting property of the mirror.

2019 Tinning copper. Copper vessels which are employed for the purposes of domestic economy are apt to be corroded or oxidated by the substances which are boiled or preserved in them. To defend them from the action of these substances, and to prevent the terrible accidents which would otherwise happen to those who employ any of these matters as food, the inside of such vessels is covered with a thin coating of tin. This is performed by the following process. The surface to be covered with tin, is scraped very clean with an iron instrument, or it is scoured with wine lees, or weak nitric acid and sand. The tin is then applied in two ways; in the first way, the tin is in a state of fusion, and the surface is covered with some resinous or oily matter, to prevent oxidation, in the same way as in tinning iron. The surface to be tinned is first immersed in a solution of muriate of ammonia, and dried, and then dipped into the melted tin. Another method is, to heat the copper vessel on charcoal, and then to apply to the inside of it a quantity of tin, which is then melted; a little muriate of ammonia being thrown in at the same time in powder. The surface is then rubbed with tow. The muriate of ammonia is employed, both to clean the surface of the copper, and also to prevent the tin from being oxidated. The coating of tin which can be applied to copper is extremely thin; and it cannot by any means be increased, to bear a heat greater than that which melts tin. Bayen in his researches concerning tin, found, that a vessel nine inches in diameter, and three lines in depth, acquired, by having its surface covered with tin, only 21 grains of additional weight.

Silver, &c.

In using vessels thus tinned, care should be taken not to allow acid substances to remain for any length of time in contact with them, because the tin would be corroded, and part of the copper afterwards dissolved, which would inevitably act as a poison. Pure tin ought only to be employed, at least without any mixture of lead.

12. Copper combines very readily with lead by fusion. With an excess of lead, the alloy is of a gray colour, is ductile, but brittle when it is hot, on account of the great difference of fusibility of the lead and copper. This alloy is employed in the fabrication of printing types for large letters. According to Savary, the proportion for this purpose is 100 of lead and 20 or 25 of copper. 2020 Lead.

13. Copper combines with iron, but with much greater difficulty than with the other metals. As the proportion of iron is increased, the alloy becomes of a darker gray, loses its ductility, and is more infusible. The alloy of copper with iron has been supposed to constitute that variety called *hot short iron*, which possesses greater tenacity than other kinds of iron, and on account of some peculiar properties is more applicable to a variety of purposes. 2021 Iron.

Next to iron, copper is of the greatest importance, and most extensive utility, of all the metals. In the metallic state it is employed for a great variety of instruments and utensils; some of its oxides and salts are much used in painting, dyeing, and enamelling; and the alloys with other metals, especially with zinc and tin, are applied to many valuable purposes in the arts, and in domestic economy. But the uses of copper in its different states, and in its various combinations, are so familiar and well known, that it must appear quite unnecessary to enumerate them. 2022 Uses.

Sect. XXII. *Of Silver.*

2. Silver has been reckoned among the noble or perfect metals, and has been known from the earliest ages of the world. Its scarcity, beauty, and utility, have always rendered it an object of research among mankind, so that the nature and properties of this metal have been long studied and minutely investigated. In the midst of the rage for the transmutation of metals which for centuries fired the imaginations of the alchemists, silver occupied a great share of their attention and labour, with the hope of discovering the means of converting the baser and more abundant metals into this, which is more highly valued on account of its scarcity and durability. When the dawn of science commenced, and its light had dissipated the follies and extravagances of these pursuits, the earlier chemists were much employed in examining the properties and combinations of silver; nor has it been overlooked or neglected by the moderns. 2023 History.

2. Silver, which is neither in such abundance nor so universally diffused as many other metals, exists in nature in five different states; in the native state; in that of alloy with other metals, especially with antimony; in that of sulphuret, sulphurated oxide, muriate, and carbonate. 2024 Ores.

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Silver, &c. carbonate. 1. Native silver, which is characterized by its ductility and specific gravity, is frequently tarnished on the surface, of a gray or blackish colour, and appears under a great variety of forms. In this state it is not perfectly pure. It is usually alloyed with a little gold or copper. 2. The alloy of silver and antimony, which is the most frequent, is distinguished by its brittleness and lamellated structure from native silver, which it resembles in lustre and colour. It crystallizes in prisms which are six-sided and pretty regular. 3. The sulphuret of silver, which is known to mineralogists by the name of *vitreous silver ore*, is of a dark gray colour, and has some metallic lustre. It is usually crystallized in the form of cubes, octahedrons with angular facets, or sometimes in the form of the dodecahedron. 4. The sulphurated oxide of silver and antimony. In this ore of silver the sulphur is combined with the metal in the state of oxide; in the former, in the metallic state. This ore is called *red silver ore*. It is of a deep red colour, sometimes transparent, and sometimes nearly opaque, frequently having the lustre of steel on the surface. The primitive form of its crystals is the rhomboidal dodecahedron. 5. The muriate of silver, which has been long known to mineralogists by the name of *corneous silver*, is found in irregular masses of a grayish colour, frequently opaque, but sometimes semitransparent. It is soft and very fusible.

2025 Analysis. 3. The analysis of silver ore varies according to its nature and combinations. Native silver, after being broken down and washed, is rubbed with liquid mercury, which by strong trituration dissolves, and combines with the silver. This amalgam is subjected to pressure, to separate the excess of mercury. It is then distilled, and afterwards heated in a crucible, to volatilize the mercury, and the silver remains pure. When silver is combined with antimony and sulphur, the ore is to be strongly roasted, to separate the antimony or sulphur. It is then melted with a proper quantity of alkaline flux. The sulphurated oxide of silver and antimony may be treated in the same way.

2026 Silver purified by cupellation. But by these processes the silver is not in a state of perfect purity. To obtain it pure, by the separation of other metals, as copper or iron, it is subjected to the process called *cupellation*. This depends on the peculiar property of lead, when it is oxidated and afterwards vitrified, of combining with the metals, and leaving the silver in a state of purity. A small flat cup made of the powder of burnt bones, which has received the name of *cupel*, is employed for this purpose. The silver to be purified is included in a plate of lead, usually double the weight of the silver. The cupel is introduced under a *muffle* in the middle of the furnace. The use of the muffle is to increase the heat, by allowing the metal to be surrounded on all sides with coals, and at the same time preventing the admixture of any part of the fuel with the fused matter. The heat is then to be applied sufficiently great, that every part of the metal may be in fusion, but not such as to sublime the lead too rapidly. As the process advances, the lead is oxidated and vitrified, and having combined with all the other metals except the silver, sinks into the porous cupel, and leaves the silver pure. The lead, which is now in the state of litharge, is extracted from the cupel, and applied to the usual purposes.

4. Silver is of a fine white colour, and great brilliancy. The specific gravity is 10.474, and according to some, when it is hammered, 10.535, and sometimes nearly 11. The hardness of silver is intermediate between iron and gold. The elasticity of silver is considerable, and it is one of the most sonorous of the metals. It possesses very great ductility and malleability. It may be beaten out into leaves $\frac{1}{100000}$ of an inch thick, and a grain of silver may be so extended as to be formed into a hemispherical vessel of sufficient capacity to hold an ounce of water, or to be drawn out into a wire 400 feet in length. The tenacity of silver is very great. A wire .078 of an inch in diameter, will support a weight of 187 lbs. avoirdupois. Silver, &c. 2027 Properties.

5. Silver is a good conductor of caloric. Its expansive power is less than that of lead and tin, and greater than that of iron. When it is exposed to a white heat it melts. The temperature necessary to bring it to fusion has been calculated at the 1000° of Fahrenheit; but according to Kirwan, it requires a higher temperature than 28° Wedgwood to melt it, although at that temperature it continues in a state of fusion. When it is cooled slowly after fusion, it exhibits some marks of crystallization. It assumes the form of four-sided pyramids, or of octahedrons. If the heat be increased after the silver is melted, it boils and may be reduced to vapour. The surface of melted silver is so extremely brilliant, that it seems to throw out sparks, which is called *coruscation* by the workmen. 2028 Action of heat.

6. Silver is a good conductor of electricity. It has no perceptible taste or smell. 2029 Electricity, &c.

7. Silver is not altered by exposure to the air, although it is soon tarnished, which is owing, as Proust ascertained, to a thin covering of sulphuret of silver, which is formed by sulphureous vapours to which it is exposed; but when it is subjected to a strong heat for a long time, in an open vessel, it combines with the oxygen of the atmosphere, and is converted into an oxide. In the experiments of Macquer, the oxidation of silver was effected by exposing it for 20 times successively in a crucible, to the strong heat of a porcelain furnace. At last perceptible traces of oxidation were observed, and vitreous matter of an olive colour was obtained. In other experiments, silver being acted on by the heat of a burning glass, was covered with a white powder, which was afterwards converted into a crust of a green colour. Van Marum passed electric shocks through silver wire, which was instantly reduced to a kind of powder, with a greenish white flame, and the oxide which was formed was dissipated in vapour. The oxide of silver, which is formed by these processes, is of a greenish or yellow colour. It is composed of about ten parts of oxygen, and 90 of silver. The oxide of silver is very easily reduced, for the affinity of oxygen for this metal is very feeble. It is decomposed by the application of heat, and even when it is exposed to the light. By heating it in close vessels, pure oxygen gas is obtained, and the metal is converted to the metallic state, by melting it in a crucible. 2030 Of air. 2031 Oxidation.

8. Azote, hydrogen, or carbon, have no action whatever on silver.

9. Silver combines with phosphorus, forming a phosphuret. One part of silver in filings, with two of 2032 Phosphuret.

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phosphoric glass, and half a part of charcoal, exposed to heat in a crucible, yielded a phosphuret of silver which had acquired one-fourth of its primitive weight of silver. This phosphuret is of a white colour, brittle, of a granulated texture, and may be cut with a knife. By throwing pieces of phosphorus on silver red-hot in a crucible, the metal is instantly melted, and the phosphuret which is formed remains at the bottom. At the moment when the surface becomes solid, a quantity of phosphorus is thrown out with a kind of explosion, and the surface of the metal then exhibits a lamellated appearance. Pelletier, who first made this experiment, concludes from it, that silver is susceptible of retaining a greater proportion of phosphorus in combination with it, when it is in fusion than in the solid state, and that the separation of the phosphorus is owing to the sudden contraction of the silver. A hundred parts of silver in fusion retain 25 of phosphorus, but only 15 when it becomes solid. Phosphorus has the property of reducing the oxides of silver, and of precipitating them from this solution in acids, in the metallic form.

2033 Sulphuret.

9. Sulphur combines readily with silver, both in the dry and humid way. By stratifying in a crucible plates of silver alternately with sulphur, and melting them rapidly, a deep violet-coloured mass is obtained, which is more fusible than silver, brittle, crystallized, and has a metallic lustre. It may be cut with a knife, and has a good deal of resemblance to vitreous ore of silver. When this sulphuret of silver is exposed to heat for a considerable time, the sulphur is gradually dissipated, and the silver remains pure and ductile. Silver combines very readily with sulphur, when it is long exposed to those matters which gradually deposit this substance. This effect is immediately produced, when silver is brought into contact with sulphurated hydrogen gas, or when it is immersed in water impregnated with this gas, as in natural sulphureous waters. It is owing to the same cause that a silver spoon is tarnished by a boiled egg, and particularly if the egg has begun to spoil. Sulphurated hydrogen gas which is exhaled by the egg, is decomposed, the sulphur combines with the silver, and forms a thin layer of sulphuret of silver, which is of a dark or violet colour. The same thing happens, when silver is exposed in places that are much frequented, as in churches and theatres.

2034 Affinities.

10. Silver forms alloys with most of the metals, and salts with the acids. The order of the affinities of silver and its oxide, as they have been arranged by Bergman, is the following.

Silver.	Oxide of Silver.
Lead,	Muriatic acid,
Copper,	Oxalic,
Mercury,	Sulphuric,
Bismuth,	Saclactic,
Tin,	Phosphoric,
Gold,	Sulphurous,
Antimony,	Nitric,
Iron,	Arsenic,
Manganese,	Fluoric,
Zinc,	Tartaric,
Arsenic,	Citric,
Nickel,	Lactic,
Platinum,	Acetic,
Sulphur,	Succinic,
Phosphorus.	Prussic.
	Carbonic.

I. Salts of Silver.

1. Sulphate of Silver.

2035 Preparation.

1. Sulphuric acid has no action on silver in the cold; but three or four parts of the concentrated acid, boiled with one part of silver in filings or small pieces, produce an effervescence, with the evolution of sulphurous acid gas. A white powder is formed, which is entirely soluble in water acidulated with sulphuric acid. With excess of acid, a solution of sulphate of silver is obtained, which is colourless, very acrid and caustic. By evaporation it affords crystals, which are white and brilliant, and in the form of fine prisms or needles. When the solution is more concentrated, a deposition is formed as it cools, and then it crystallizes in large white, brilliant plates, which seem to be composed of compressed four-sided prisms.

2036 Properties.

2. This salt is not very soluble in water. When exposed to heat, it melts and swells up; at a higher temperature it blackens, gives out sulphurous acid, and oxygen gas, and is then reduced to the metallic state. It is slowly decomposed by the action of light. It is decomposed by phosphorus, and vapour of sulphur in the cold, and by charcoal at a red heat. It is not altered by the action of the acids, excepting the muriatic. All the alkalies and the alkaline earths precipitate the oxide of silver from its solution in sulphuric acid, of a dark gray or brown colour, and especially in contact with light. Lime causes a precipitate of a greenish gray colour. Ammonia re-dissolves the precipitate. 2037 Decomposition.
Sulphate of silver is decomposed by the muriates, phosphates, and fluates. The carbonates give a white insoluble precipitate of carbonate of silver. The alkaline sulphurets, sulphurated hydrogen gas, and water impregnated with this gas, decompose the sulphate of silver, and form in its solution a black precipitate of sulphuret of silver; for the oxide is reduced by the hydrogen, while the silver combines with the sulphur.

2. Sulphite of Silver.

2038 Preparation.

Sulphurous acid combines readily with the oxide of silver. It assumes the form of small shining grains, of a pearly-white colour. It is not altered by exposure to light. Sulphurous acid precipitates the solution of silver in nitric acid, in form of a white powder of sulphite of silver. The same salt is obtained by adding a solution of sulphite of ammonia to a solution of nitrate of silver. An excess of this sulphite re-dissolves the precipitate, and forms a triple salt. This sulphite of ammonia and silver, exposed to the sun's rays, is soon covered with a pellicle of silver, and the liquid contains sulphate of ammonia. Sulphurous acid, aided by the affinity of ammonia, deprives the oxide of silver of its oxygen, and is converted into sulphuric acid, which combines with the ammonia, and forms a sulphate. Sulphite of silver is decomposed by muriate of ammonia; and the precipitate, which is formed, assumes a black 2039 Decomposition.
colour, and is partly reduced. When sulphite of silver is exposed to the action of the blow-pipe, it gives out

Silver, &c. out sulphurous acid, melts into a yellow mass, and leaves behind a metallic button of pure silver. This salt has an acrid metallic taste; it is soluble in the caustic alkalies, and forms with them a triple salt.

3. Nitrate of Silver.

2040 Preparation. 1. Silver dissolves nitric acid with effervescence, in consequence of the evolution of nitrous gas. If the solution be made in a tall conical vessel, the nitrous gas, which is disengaged from the bottom, is dissolved in the acid, and communicates a green colour to the lower part of the liquid. If the green colour is permanent, or passes to a blue, the metal is contaminated with copper; but if it be mixed with gold, a purple-coloured powder is deposited at the bottom of the vessel.

2. Nitric acid dissolves more than $\frac{1}{2}$ of its weight of silver. This solution is nearly colourless, very heavy, and extremely caustic. It colours the skin, first of a reddish purple, and then of a deep black. It produces the same effect on the nails, the hair, and all animal substances. It is employed to dye the hair of a black colour, but this should be done with great caution. When it is diluted with water, so as to deprive it of its causticity, it has an astringent bitter taste. By evaporating the solution till a pellicle is just formed on the surface, and by slow cooling, it crystallizes in transparent brilliant plates, sometimes of a metallic lustre, when the liquid has been exposed to the sun during
2041 Properties. the crystallization. These crystals are not very regular. They are sometimes six-sided, sometimes square, and sometimes triangular; but they seem to be composed of very fine small prisms. The taste is so extremely bitter, that it has been denominated *the gall of the metals*. It is not deliquescent in the air. When exposed to the light of the sun, it gradually blackens, and the silver is reduced. When it is heated in a crucible, it readily melts into a brown liquid, which swells up, as it is deprived of its water of crystallization: and in this state of fusion, if it be allowed to cool, it
2042 Lunar caustic. assumes the form of a deep gray or black mass. When the nitrate of silver is thus fused, and cast into small cylindrical moulds, the cylinders thus formed, which exhibit a radiated fracture, are well known in surgery by the names of *lunar caustic* and *lapis infernalis*. This is generally prepared by evaporating the solution of nitrate of silver to dryness, without previous crystallization.

2043 Action of heat. 3. When nitrate of silver is heated in a retort, it first gives out nitrous gas, then very pure oxygen gas, which is afterwards mixed with azotic gas. The silver is reduced at the bottom of the vessels. When a plate or crystal of nitrate of silver, well dried, is put upon burning coals, it produces a brilliant detonation; the silver is reduced, and adheres to the surface of the charcoal.

2044 Decomposition. 4. The nitrate of silver is very soluble in water, and in this state it may be reduced by hydrogen gas and
2045 By hydrogen, phosphorus. By exposing paper or silk moistened with a solution of nitrate of silver to hydrogen gas, the paper or silk is coated with metallic silver, in consequence of the reduction of the salt by the hydrogen, which
2046 and phosphorus. has a stronger affinity for the oxygen than the silver. The same effect takes place, if a cylinder of phosphorus be immersed in a solution of nitrate of silver.' The phosphorus combines with the oxygen of the oxide, and the silver is deposited on the surface of the phosphorus in the metallic state. The phosphorus may be separated from the silver by melting it in boiling water. These experiments were made by Sage and Bouillon in France, and Mrs Fulham in England.

5. A mixture of this salt and phosphorus struck smartly with a hammer, produces a violent detonation. 2047 Detonation.
Nine grains of nitrate of silver and three of sulphur produce no detonation, but only an inflammation of the sulphur, when they are struck with a cold hammer; but with a hot hammer, a detonation takes place, with the reduction of the silver.

6. Nitrate of silver is decomposed by sulphuric acid, and forms a precipitate of sulphate of silver, in the state of white powder. It is also decomposed by sulphurous acid. Muriatic acid produces a copious white precipitate, which is very insoluble, and is deposited in the form of thick heavy flakes of muriate of silver.

7. Nitrate of silver is decomposed by all the alkaline and earthy matters. A white precipitate is at first formed, which afterwards passes to an olive green; but the carbonates of the alkalies give a white precipitate which remains unaltered. Ammonia occasions a sparing precipitate, which is re-dissolved by an excess of alkali, when there is formed a triple salt. But a very peculiar action takes place between ammonia and the oxide of silver, by which both the one and the other are decomposed with a violent detonation. This is the celebrated *fulminating silver*, which was discovered by Berthollet in 1788. It is prepared by the following process.

A solution of pure silver in nitric acid is precipitated by lime water. The precipitate is placed on gray 2048 Fulminating silver.
paper, which absorbs the whole of the water and the nitrate of lime. Pure caustic ammonia is then added, which produces an effect somewhat similar to the slaking of lime. The ammonia dissolves only part of this precipitate. It is left at rest for 10 or 12 hours, when there is formed on the surface a shining pellicle, which is re-dissolved with a new portion of ammonia, but which does not appear, if a sufficient quantity of ammonia has been added at the first. The liquid is then separated, and the black precipitate found at the bottom, is put in small quantities on separate papers. This powder is *fulminating silver*, which, even while it is moist, explodes with great violence, when it is struck with a hard body. When it is dry, it is sufficient to touch, or rub it slightly, to produce an explosion. If the liquid decanted off this precipitate be heated in a glass retort, it effervesces, gives out oxygen gas, and there are soon formed small, brilliant, opaque crystals, which have a metallic lustre, and which fulminate with the slightest touch, though covered with liquid, and break with violence the vessels containing them. In this action the most obvious circumstance is the tendency of the compound to decomposition. The oxygen of the oxide combines with the hydrogen of the ammonia, and forms water, while the azote of the ammonia escapes in the form of gas, and the silver remains behind in the metallic state. The violence of the explosion is owing to the sudden expansion of the azotic gas. The shining pellicle which appears on the surface, is part of the silver, from

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Silver, &c. from which the ammonia has been separated by the action of the air; and to have the full effect, another portion of ammonia is necessary to dissolve it. Carbonate of ammonia dissolves the oxide of silver precipitated by lime, with effervescence, and the evolution of carbonic acid; but there remains enough of this acid to form a triple salt, which, when dried, is in the form of a yellow powder, but has no fulminating property. The preparation of this dangerous powder frequently fails. A mixture of copper, the absorption of carbonic acid by the oxide of silver, precipitated by means of lime, and left too long exposed to the air, and ammonia containing a little of this acid, either diminish or destroy its fulminating property.

2049 Action of salts. 7. Many of the salts decompose the nitrate of silver. All the sulphates produce a precipitate of sulphate of silver in the form of powder. The same effect is produced by the other salts, and the effect is similar to that which takes place with the acids of which they are composed.

2050 Of metals. 8. Most metallic substances have a stronger affinity for oxygen than silver has; it is therefore precipitated from its solution in nitric acid, either partially or entirely deprived of its oxygen, and in the metallic state.

2051 Mercury. In the precipitation which takes place by means of mercury, the silver is reduced in an arborescent form,

2052 *Arbor Dianæ*, or silver tree. which has long retained the name of *arbor Dianæ*. Different processes have been recommended to effect this decomposition. One part of silver, according to Lemery, is dissolved in diluted nitric acid. The solution is then to be farther diluted with 20 parts of distilled water, and then to add two parts of mercury. It is said, that it requires, by this process, about 40 days for the formation of the metallic tree. Homberg gives a shorter process, which succeeds sufficiently well. It consists in making an amalgam in the cold of four parts of silver-leaf and two of mercury. This amalgam is then to be dissolved in a sufficient quantity of nitric acid, and the solution to be diluted with 32 times the weight of the metals of water. By introducing into part of this liquid a small ball of soft amalgam of silver, the formation of the tree immediately takes place. It may be formed also by putting a soft amalgam of silver into six parts of a solution of nitrate of silver, and four of a solution of nitrate of mercury. In these processes one part of the mercury of the amalgam attracted by that of the solution, and carrying off the oxygen of the silver, precipitates the latter in the metallic state. The precipitation of the silver is still favoured by the affinity between it and the portion of undissolved mercury, and also part of the silver of the amalgam. All these attractions conspire to effect the separation of the silver, when it is deposited in prismatic needles, which arrange themselves in an arborescent form.

2053 Copper. 9. Silver is precipitated from its solution in nitric acid, by means of copper. When a plate of copper is immersed in this solution, diluted with its weight of distilled water, the silver is immediately separated in whitish gray-coloured flakes. If this precipitate is scraped off, and well washed with water, afterwards fused in a crucible, and subjected to the process of cupellation with lead, pure silver may be obtained.

4. Muriate of Silver.

Silver, &c.

Muriatic acid has no action whatever on silver; but by adding muriatic acid to a solution of silver in sulphuric or nitric acid, the moment it comes in contact with these solutions it decomposes them, carries off the oxide of the silver, and forms with it a white insoluble salt, which is precipitated in a kind of coagulated state. The muriates also produce a similar precipitate, and hence it is that the nitrate of silver is employed as a re-agent, and a most delicate test of muriates or muriatic acid in mineral water. The muriate of silver, which is called *corneous silver* or *horny silver*, is extremely insoluble in water. Exposed to the light it becomes brown, violet, and black. By heating it gently in a matrass, it melts like tallow, and when it becomes solid by cooling, it assumes the form of a semitransparent gray substance, similar to some kinds of horn, from which it derived its name of *luna cornea*, or horn silver. If it be fused on a stone, it is converted into a kind of friable matter, crystallized in beautiful, brilliant, and as it were metallic needles. When it is strongly heated in a crucible, it filters through it, and is lost in the fire. The component parts of this salt, are, according to Proust,

Preparation. Composition.

Acid	18
Oxide	82
	100

This salt is not decomposed by any of the acids, or by the pure alkalies. It is decomposed by the alkaline carbonates. The muriate of silver is very soluble in caustic liquid ammonia. This solution, which is transparent and colourless, undergoes a remarkable change when it is exposed to the air. As the ammonia evaporates in the air, there is formed on the surface a pellicle which assumes a brilliant, bluish, or iridescent colour. This pellicle, which gradually increases in thickness, deepens in colour, and at last becomes of a dirty gray or black, by the contact of light. The substance thus separated is the muriate of ammonia, containing a small proportion of the metal reduced.

5. Hyperoxymuriate of Silver.

This salt may be prepared by passing oxymuriatic acid gas through water having the oxide of siver diffused in it. It is soluble in two parts of warm water, and crystallizes in cooling in the form of small rhomboids. It is decomposed by muriatic acid, and by nitric and acetic acids. The muriate of silver remains behind. Exposed to a moderate heat, it melts, oxygen gas is given out, and the salt is reduced to the muriate of silver. With one-half its weight of sulphur, it produces violent detonation, by slight percussion. It gives out a white vivid flash.

6. Fluate of Silver.

Fluoric acid dissolves the oxide of silver, and forms with it an insoluble salt. It is decomposed by sulphuric acid.

7. Borate of Silver.

Boracic acid combines with the oxide of silver, by adding

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Silver, &c. adding a soluble borate to the solution of nitrate of silver. The whole of the silver is precipitated in the form of a white, heavy, insoluble powder.

8. Phosphate of Silver.

Phosphoric acid dissolves the oxide of silver, and precipitates it from its solution in nitric acid. The precipitate is a white heavy powder; with considerable heat it melts into a kind of greenish enamel. It is not soluble in water without an excess of acid. When it is heated in a retort with charcoal, it gives out a little phospherus, and is reduced, in great part, to phosphuret of silver.

9. Carbonate of Silver.

Carbonic acid combines readily with the oxide of silver. It may be prepared by adding an alkaline carbonate to sulphate or nitrate of silver. The carbonate of silver is precipitated in the form of a white powder. This salt, which blackens by the action of light, readily gives out its carbonic acid by heat.

10. Arseniate of Silver.

Arsenic acid dissolved in water, and heated with silver, has no action upon it; but when the water is evaporated, and the heat is increased to produce vitrification, arsenic is sublimed, and there remains a white vitreous matter, which contains the silver oxidated, and is covered with a deep yellow coloured glass. By heating water on this glass reduced to powder, the solution becomes of a brown red colour; the arsenic acid is dissolved, and carries with it a little oxide of silver, which is precipitated by adding muriatic acid. The brown insoluble powder is fused at a high temperature, and becomes semitransparent. By continuing the heat in a crucible, the silver is reduced. Arsenic acid gives a brown precipitate in the solution of nitrate of silver.

11. Tungstate of Silver.

Tungstic acid does not seem to have any action on silver; but, when added to a solution of nitrate of silver, it occasions a precipitate in the form of white powder, but its properties have not been examined.

12. Molybdate of Silver.

2056 Molybdate. Molybdic acid produces a white, flaky precipitate in a solution of nitrate of silver. Nothing is known of the properties of this salt.

13. Chromate of Silver.

2057 Chromate. By adding chromate of potash to a solution of silver in nitric acid, a precipitate is formed, of a most beautiful crimson red, which the action of light changes to purple. The precipitate, which is the chromate of silver, is in the state of powder. When heated by the action of the blow-pipe, it becomes black, and is reduced in part to the metallic state. Reduced to powder in this state, it is still of a purple colour; but when it is heated with the blue flame of a candle directed by the blow-pipe, it becomes green, and the silver is separated in globules. The chromic acid, decomposed by the hydrogen of the blue flame, passes to the state of green oxide, and the oxide of silver is reduced.

14. Acetate of Silver.

Acetic acid dissolves the oxide of silver. The acetate 2058 Acetate.
of silver may be prepared, by adding acetate of potash to a solution of nitrate of silver. The solution affords, on cooling, small prismatic crystals. This salt is very soluble in water, and has an acrid metallic taste. When heated, it swells up, and is decomposed. The acid is driven off, and the oxide remains behind.

15. Oxalate of Silver.

Oxalic acid dissolves a small portion of the oxide of 2059 Oxalate.
silver, which is precipitated from nitric acid, by means of potash, or, by adding oxalic acid to a solution of nitrate of silver. A white, thick, insoluble precipitate is formed, which is oxalate of silver. This salt is soon changed by the action of light. When exposed to the rays of the sun, it becomes black; and when it is heated in a spoon, it undergoes a kind of detonation.

16. Tartrate of Silver.

Tartaric acid combines with the oxide of silver, and 2060 Tartrate.
forms with it a tartrate of silver, which becomes black by exposure to the air. This acid has no action on silver itself, nor does it produce a precipitate in the solution of nitrate of silver.

17. Tartrate of Potash and Silver.

When tartar is added to a solution of nitrate of silver, there is formed, according to Thenard, a triple salt, which consists of tartaric acid, oxide of silver, and potash.

It is decomposed by the alkalies and alkaline carbonates, and by the sulphates and muriates *.

18. Citrate of Silver.

Citric acid dissolves the oxide of silver, and forms 2061 Citrate.
with it an insoluble salt, which becomes black by being exposed to the sun. It has a harsh, strong, metallic taste. It affords by distillation concentrated acid, and leaves behind the silver reduced in an arborescent form, mixed with a little charcoal, at the bottom of the retort. This salt is decomposed by nitric acid. Its component parts are,

Acid	36
Oxide of sulphur	64
	100

19. Malate of Silver.

Malic acid, added to a solution of nitrate of silver, 2062 Malate.
produces a precipitate, the nature of which is unknown.

20. Benzoate of Silver.

Benzoic acid combines with the oxide of silver, and 2063 Benzoate.
forms with it a salt which is soluble in water, is not deliquescent in the air, but becomes brown by exposure to the sun's rays, and is decomposed by heat; the acid being driven off, and the oxide reduced to the metallic state.

21. Succinate of Silver.

Succinic acid has no action on silver, but it combines 2064 Succinate.
with

* Ann. de Chim. xxxiii. 36.

Silver, &c. with its oxide. The succinate of silver crystallizes in thin oblong prisms, which are arranged in a radiated form.

22. Saccolate of Silver.

2065 Saccolate. Saclactic acid poured into a solution of nitrate of silver produces a white precipitate, the nature of which has not been examined.

II. Action of the Alkalies, &c. upon Silver.

2066 Action of ammonia on silver. 1. The pure alkalies have no effect on silver. Its oxide is soluble in ammonia; but if this solution be long exposed to the light, the ammonia is decomposed, azotic gas is disengaged, water is formed by the combination of the hydrogen of the ammonia and the oxygen of the oxide, which is reduced to the metallic state.

2. Silver forms no compound with the earths; but in the state of oxide it combines with some of them, by vitrification, and in this state it colours glass and enamels of a yellow, olive green, or brownish shade. For this purpose the oxide of silver is employed in the arts.

3. None of the salts have any action on silver. It is not sensibly oxidated by the nitrates or hyperoxymuriates. The metals which are more easily oxidated, and with which silver is frequently contaminated, are acted on by these saline matters, and in this way, it has been observed, silver may be refined or purified by means of nitre.

III. Alloys.

1. There are few metallic substances with which silver does not enter into combination, and form alloys. Few of these, however, are applied to useful purposes. Arsenic combines with silver, and forms an alloy, which is externally of a yellow colour, but internally of a dark gray. It is brittle; and, when it is exposed to heat, the arsenic is sublimed, and the silver remains behind in a state of purity.

2067 Cobalt. 2. Cobalt is with difficulty alloyed with silver. When they are melted together in a crucible, they separate from each other, according to their specific gravities, each retaining a small proportion of the other.

2068 Bismuth. 3. Bismuth combines with silver very readily by fusion. The alloy is brittle, lamellated, and of an intermediate colour between bismuth and antimony. The specific gravity is greater than the mean. The two metals cannot be separated, but with difficulty. When this alloy is exposed to strong heat in the open air, the bismuth is oxidated, and vitrified at the same time that it is partially sublimed, so that it might be employed in place of lead for the cupellation of silver; and in some cases bismuth is preferred, on account of its more rapid oxidation.

2069 Antimony. 4. The alloy of antimony and silver is easily effected by fusion. It is heavier than the mean of the two metals. This alloy is brittle, and has not been applied to any use.

2070 Mercury. 5. Silver has a strong affinity for mercury. An amalgam may be formed of these two metals, by saturating silver leaf, or fine filings of silver, with mercury; or by adding to silver, while it is red-hot, heated mercury. The consistence of this amalgam varies according to the proportion of the two metals. In general it is white and soft, and the specific gravity is greater than the mean. It sinks to the bottom of liquid mercury. Exposed to a moderate heat for some time, it shoots out into a kind of vegetation, like the tree of Diana; and if, after fusion, it is allowed to cool slowly, it crystallizes in the form of small leaves, or in square prisms, terminated by four-sided pyramids. When it remains long exposed to the air, it becomes harder, and of a more solid consistence. This amalgam is much employed in gilding.

6. Silver combines readily with zinc, by means of fusion, and forms with it a brittle alloy, which has not been applied to any use. Zinc.

7. Silver combines easily with tin, and forms an alloy which is extremely brittle. The silver is entirely deprived of its ductility. This alloy, however, instead of being useful, is considered as one of the most troublesome in the working of silver, on account of the hardness and brittleness which it communicates, and it is found almost impossible to separate them entirely. Tin.

8. Lead, it has been already observed, readily combines with silver by means of fusion. It is employed for the purification of lead in the process of cupellation. This alloy is very fusible, resembles lead in colour, and is less sonorous, but not less ductile than silver. The specific gravity is greater than the mean. Lead.

9. An alloy of silver and iron in equal proportions has nearly the colour of silver. It is harder, has some ductility, and is attracted by the magnet. Steel is soldered with silver. Guyton fused together silver and iron, and obtained two buttons, which were placed by the side of each other, and strongly adhering, but sufficiently distinct. Each of the metals was found to be alloyed with a small proportion of the other. The silver renders the iron hard and compact, and the iron communicates to the silver properties which seem to render it applicable to many important uses. Iron.

10. Silver combines readily with copper, and forms with it one of the most useful alloys. This alloy gives hardness to the silver, and the colour of the latter is not diminished, unless the quantity of copper is considerable. These properties render it extremely useful in the fabrication of various utensils, and especially of money. The density of the alloy is less than the mean of the two metals. If 137 parts of silver be alloyed with 7 of copper, the mean specific gravity is 10.301, but it is only 10.175, which shews an increase of bulk of $\frac{1}{11}$ part. This is the alloy of the silver coin of France *. The standard silver, which is employed in the British silver coin, is composed of 11 parts of silver and one of copper. Copper.

The uses of silver are as important and extensive as any of the metals, except iron, and especially when it is alloyed with copper; as it is applied as the medium of commerce by all civilized nations, and for various instruments and utensils, most of which are so familiar as to require no particular enumeration. Uses.

Sect. XXIII. *Of Gold and its Combinations.*

1. Gold is spoken of in the earliest histories of the world. The peculiar properties of this metal, its scarcity, durability, and beauty, have rendered it always an object of pursuit, and have raised it high in the estimation History.

* Jour. des Mines.

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tion of mankind. The alchemists regarded gold as the purest, the simplest, the most perfect, and very justly the most indestructible of all the metals with which they were acquainted. Hence it was esteemed the noblest and most perfect of what they considered as perfect metals, and dignified with the pompous name of *king of the metals*. It was the object of all their labours and researches, to discover the means of transmuting the baser and more abundant metals into this precious metal.

2078 **Universally diffused, but in small quantities.**

2. Gold is supposed to be, next to iron, the most universally diffused of all the metals; but at the same time it is found in such small quantities, that it is one of the scarcest. It is most commonly found in the state of small grains, mixed with the sand or with the soil, almost in every part of the world. Gold is also found imbedded in stones, especially quartz, either in grains, or crystals, which are octahedrons; and it is probably from these that the grains found in the soil or in the sands in the beds of rivers, have been derived. Gold is, however, more abundant in the tropical regions of the earth, where it forms an article of commerce, under the name of *gold dust*. In this state it is found in the rivers of Africa, and exported to Europe. But although gold is always found in the metallic state, it is not absolutely pure. It is generally alloyed with copper or silver, and sometimes with iron and mercury.

2079 **Extraction from its ores.**

3. To separate gold from the metals with which it is alloyed, the process recommended by Bergman may be employed. It is first dissolved in nitro-muriatic acid; the silver is deposited spontaneously in the form of muriate of silver, which is insoluble; the gold is precipitated in fine powder by the sulphate of iron; the quantity of iron may be ascertained by prussiate of potash; and the copper is separated by means of iron. Each of these processes is performed on different portions of native gold, so that the quantity of gold, and the different metals with which it is alloyed, may be determined. In the large way, the extraction of gold is a very simple process. The auriferous sand of rivers is first washed to carry off all extraneous matters. It is triturated in a vessel with water, with 10 or 12 times its weight of mercury. The water is poured off, and carries with it the earthy matters. The amalgam is pressed in skins, to separate the excess of mercury, and the solid portion which remains is exposed to heat in stoneware retorts, to drive off the mercury, and the gold remains behind. To separate the gold from other metals, it is subjected to the process of cupellation, which has been already described in treating of the purification of silver.

2080 **Properties.**

4. Gold is of a reddish yellow colour. It possesses considerable lustre, although other metals have this property in a superior degree. Gold, next to platinum, is the heaviest body in nature, having a specific gravity of 19.3 and 19.4. It is not very hard, but is extremely ductile and malleable. It may be beaten out into leaves so thin as to equal $\frac{1}{282000}$ part of an inch. The method of extending gold, which is followed by the gold-beaters, is by hammering a number of thin rolled plates between skins or animal membranes. A single grain of gold may be beaten out in this way, so as to cover $56\frac{1}{4}$ square inches. The coating of gold which covers wire is still thinner. By computation it is found, from the diameter and length of the wire, and the quantity of gold employed, that it is only $\frac{1}{12}$ of the thickness of gold leaf. The tenacity of gold also is very considerable. A gold wire .078 of an inch in diameter will support a weight equal to more than 150 lbs. avoirdupois, without breaking. Gold has no perceptible taste or smell.

2081 **Action of heat.**

5. Gold melts, according to Guyton, at the temperature of 32° Wedgwood. It has been observed, that gold, in the state of filings or grains, melts with more difficulty than in larger masses; and that the small fragments, even after they are fused, remain in separate globules. To make them run into one mass, a little nitre or borax is thrown into the crucible. It has also been observed, that gold, which has only been subjected to the degree of heat necessary for its fusion, is brittle after cooling. To preserve its ductility, therefore, the temperature must be raised much higher. It is brittle also, when it is too suddenly cooled after fusion. By increasing the temperature while the gold is in fusion, it seems to become convex on the surface, and when it cools, it sinks, which is ascribed to the expansion and contraction of the metal. When it is slowly cooled, it crystallizes in the form of quadrangular pyramids, or regular octahedrons. If the heat be continued while it is in perfect fusion, it seems to be agitated, and to undergo a kind of ebullition. This was observed by Homberg and Macquer, by the action of the burning glass, or when a small globule of gold was acted on by the blow-pipe. According to Macquer, it rose in vapour to the height of five or six inches, and attached itself to the surface of a silver plate, which it gilded completely.

2082 **Of air.**

9. Gold is the most indestructible, and the least altered of all the metals, by exposure to the air. It preserves its lustre, its brilliancy, and colour, for any length of time.

2083 **Oxidation.**

7. The strongest heat of a furnace, which has been applied to gold in fusion, has been found incapable of producing the smallest change, or the least tendency to oxidation; but by the action of Tschirnhausen's powerful burning glass, Homberg having placed some gold in the focus, found that it rose in vapour; and that it was covered with a violet-coloured vitreous oxide. This change was at first ascribed to foreign bodies, particularly to the charcoal on which the gold was placed during the experiment. But Macquer repeated the same experiments with a more powerful glass, and obtained the same result. The vitrification after some time gradually extended, the gold diminished, and the support was impregnated with a purple-coloured matter. The effect of electricity on gold leaf, 2084 **By electricity.**
placed between two cards, was observed by Camus in 1773. The gold was converted into a violet-coloured powder, which adhered to the paper. This seeming oxidation was regarded by some as merely a minute mechanical division of the gold; but this objection has been removed by the experiments of Van Marum on the combustibility of gold by means of the powerful electrical machine at Haerlem. A strong electrical shock was passed through a golden wire suspended in the air. It kindled, burned with a perceptible green flame, and was reduced to fine powder, which was dissipated in the air. It was supposed by this philosopher, that the inflammation of gold might be effected

effected without the excess of oxygen gas, as he found it to take place in hydrogen gas and other elastic fluids, which are incapable of supporting combustion. But the force of this objection is removed by recollecting, that all gases hold in solution a quantity of water, and that water is very readily decomposed by electricity.

2085 By lightning.

A similar oxidation has been observed to take place on the gilding in the inside of houses, or on the furniture, which has been struck with lightning. The purple oxide of gold, thus obtained, contains about five or six parts in the hundred of oxygen. Gold combines with a greater proportion of oxygen, forming a different oxide of a yellow colour; but this oxide is incapable of combining with any farther portion of oxygen. It remains, therefore, unchanged in the air, and retains for a long time its brilliant rich colour. This oxide, however, is decomposed by the action of heat; the oxygen is driven off, and the gold remains behind in the metallic state.

2086 Yellow oxide.

When gold is dissolved in nitro-muriatic acid, or in a mixture of equal parts of nitric and muriatic acids, an effervescence takes place, and the solution becomes of a yellow colour. In this process the nitric acid is decomposed, its oxygen combines with the gold, and the oxide, as it is formed, is dissolved in the muriatic acid. By adding lime water, a precipitate is formed, which is the yellow oxide of gold, consisting of eight or ten parts of oxygen in the 100.

8. There is no action between gold and azote, hydrogen, carbon or sulphur. The oxides of gold, indeed, are readily decomposed by hydrogen.

2087 Phosphuret.

9. Phosphorus, according to the experiments of Pelletier, combines with gold, by heating together in a crucible a mixture of one part of gold in filings, with two parts of phosphoric glass, and one-eighth part of charcoal. Great part of the phosphorus is separated from the acid, and driven off, but there remains a small quantity united with the gold, forming a phosphuret of gold. This phosphuret is whiter and more brittle than the gold, and has some appearance of crystallization. It may be formed also by adding phosphorus to gold in a red heat in a crucible. It becomes pale coloured, granulated, brittle, and a little more fusible. This phosphuret contains $\frac{1}{24}$th part of phosphorus. It is decomposed by being kept some time in fusion; the phosphorus is driven off in the state of vapour, and inflamed.

2088 Affinities.

10. The order of the affinities of gold and its oxides, as they have been arranged by Bergman, is the following:

Gold.	Oxide of Gold.
Mercury,	Muriatic acid,
Copper,	Nitric,
Silver,	Sulphuric,
Lead,	Arsenic,
Bismuth,	Fluoric,
Tin,	Tartaric,
Antimony,	Phosphoric,
Iron,	Prussic.
Platinum,	
Zinc,	
Nickel,	
Arsenic,	
Cobalt,	
Manganese.	

I. Salts of Gold.

1. Nitrate of Gold.

When concentrated nitric acid is several times successively poured upon gold, boiled and distilled to dryness, the gold is dissolved, and the solution assumes a yellow colour. This effect was first observed by Brandt, in separating gold and silver, by means of this acid. But it appears from the observation of Deyeux on the solubility of gold in nitric acid, that the solution is more readily effected in proportion to the quantity of gas, or nitrous gas, which the acid contains. According to the experiments and observations of Fourcroy, gold leaf is dissolved in nitric acid, impregnated with nitrous oxide, and that it is owing to the nitrous oxide that the gold is oxidated, this oxide being more easily decomposed than nitric acid. Thus it happens that the acid is deprived of its colour as it acts on the gold, and the solution is more rapidly effected in the cold than with heat, because the nitrous gas is disengaged by heat. The acid which at first had been deprived of its colour, by the oxidation of the gold, as this oxide is dissolved, assumes an orange-yellow colour, holding in solution the nitrate of gold with excess of acid. The nitrate of gold cannot be obtained in crystals. It is decomposed by heat, or by exposure to the light of the sun. When this solution is filtered, it leaves on the paper a violet-coloured trace, which is the oxide of gold. The nitrate of gold is also decomposed by the alkalies, or by introducing a plate of tin or silver into the solution, and the purple oxide is precipitated in the form of powder. It is also decomposed by muriatic acid, which, at the instant of combination, converts the orange colour to a pure yellow.

2. Muriate of Gold.

1. Muriatic acid has no action whatever on gold, or on its purple oxide, but gold is immediately oxidated and dissolved by oxymuriatic acid; or if nitric acid be added to muriatic acid, the solution of gold is immediately effected. It is on account of this property that nitro-muriatic acid was distinguished by the name of *aqua regia*, because it dissolved gold, which was stiled by the alchemists, the *king of the metals*. The nature of the action is obvious. Gold is oxidated with great difficulty. This is effected by oxymuriatic acid, which readily parts with its oxygen, or by the addition of nitric to the muriatic acid, the former of which is decomposed, giving up its oxygen to the gold, which being oxidated, is dissolved in the muriatic acid, forming a muriate of gold. This solution of the muriate of gold is of a deep yellow colour, extremely acrid and caustic, has a very astringent, metallic taste, and stains the skin of a deep purple colour, which becomes darker by exposure to the air and the light. It continues permanent till the epidermis is renewed. It produces a similar effect on all vegetable and animal matters, and on marble and siliceous stones. By evaporating this solution, nitric acid is disengaged, and crystals are obtained, in the form of truncated octahedrons, or small quadrangular prisms, of a topaz colour. These crystals are easily procured by evaporating the solution to one half, and adding a little alcohol. They assume a red colour by the action of strong

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Gold, &c. strong light. They attract moisture from the air, and spontaneously become liquid. By gradually heating in a retort this solution of gold in nitro-muriatic acid, there passes over nitric acid, muriatic acid, which carries with it a portion of gold, and even reddish-yellow crystals of muriate of gold. To the nitro-muriatic liquid, which is of a high colour, and which rises during the distillation, the alchemists gave the name of *red lion*. By evaporating the solution to dryness, a dry muriate of gold is obtained, which may be reduced by a strong heat, previously giving out oxygen gas, and leaving the gold behind in the metallic state.

2093 Decomposition. 2. The muriate of gold is very soluble in water. It is decomposed by hydrogen gas. 2094 By hydrogen. If a piece of silk be moistened with a solution of muriate of gold, the salt is decomposed, and the gold, reduced to the metallic state, attaches itself to the silk. 2095 Phosphorus. Muriate of gold is also decomposed by phosphorus. If a stick of phosphorus be introduced into a saturated solution of muriate of gold, the salt is decomposed, and the gold being reduced to the metallic state, forms a cylindrical covering to the phosphorus, which may be separated by dissolving the latter in hot water. A similar effect is produced by burning sulphur, by sulphurated and phosphorated hydrogen gases, and by sulphurous acid.
2096 Sulphurous acid. If a solution of muriate of gold be cautiously added to sulphurous acid, a fine pellicle of gold appears on the surface, which is instantly precipitated in the form of small grains. These curious and interesting experiments were made by Mrs Fulham. It is easy to see the nature of the process. All the substances which have been enumerated, have a stronger affinity for oxygen than gold, so that the oxide of gold in combination with the acid is decomposed; the oxygen combining with the hydrogen, for instance, and forming water, or with the phosphorus or sulphur, and forming sulphuric or phosphoric acid. The reduction of muriate of gold, Mrs Fulham has observed, does not take place except in the liquid state, and she supposes that the decomposition of water is necessary to produce this effect. But the liquid state of the salt, it is supposed by others, is only necessary to expose it to the action of combustibles in a state of minute division, and that otherwise this theory does not account for the phenomena.

2097 Soluble in ether. 3. The muriate of gold is soluble in ether. It forms with it a solution of a golden yellow colour, which floats on the top of the fluid. By adding ether to a solution of gold, and agitating the mixture, as soon as it is left at rest, the two liquids separate, the ether rises to the top, and assumes a yellow colour, while the nitro-muriatic acid remains below and becomes white. By this process a tincture of gold, or what was formerly called *potable gold*, was prepared. The solution of gold in ether is not permanent. It is soon reduced to the metallic state, and is sometimes found crystallized on the surface.

2098 Action of alkalies. 4. The muriate of gold is decomposed by all the alkalies and earths, and is reduced to the state of yellow oxide. This decomposition is effected slowly by the fixed alkalies, and if the alkali be added in sufficient quantity, the precipitate is re-dissolved, and the liquid assumes a reddish colour. It is owing to this solution of the oxide of gold by these alkalies, that the precipitation is slow and difficult. Triple salts are formed, the nature of which is unknown. The oxide of gold, thus precipitated, becomes of a purple colour by exposure to the light; by the action of heat it gives out oxygen gas, and the gold is revived. 2099

The most singular precipitate from the muriate of gold is that by means of ammonia, which forms the compound called *fulminating gold*. Fulminating gold. It is prepared by the following process. To a solution of gold in nitro-muriatic acid, and diluted with three or four times its weight of distilled water, gradually add pure ammonia, as long as any precipitate is formed. No excess of alkali must be added, because the precipitate is re-dissolved. It is then washed and dried in the air on paper, and afterwards put into a phial, which should be covered only with a bit of cloth or paper, as the powder is apt to explode with the slightest friction. 2100

Fulminating powder may also be obtained, by dissolving gold in a solution of two parts of nitrate of ammonia, and one of muriatic acid. Another process. The oxygen of the nitric acid combines with the gold, and forms an oxide, which is dissolved in a portion of the muriatic acid; nitrous gas is disengaged, and there remain in the liquid, muriate of gold, and muriate of ammonia. By precipitating this solution by means of a fixed alkali, fulminating gold is obtained. The alkali combines with the muriatic acid of the gold and ammonia, and the oxide of gold, uniting with the ammonia, forms the fulminating gold. The precipitate is washed and dried as in the former process. Basil Valentine, who first described this singular preparation, had observed that it produced detonation equally by means of heat, by friction, and percussion. When a small quantity of fulminating powder is exposed to heat, it produces a violent detonation; or, if it be rubbed with a hard body, a similar effect takes place. It explodes also, by being smartly struck with a hammer. These astonishing effects long excited the attention of philosophers, but received no satisfactory explanation, till the nature of the composition of this substance was discovered by modern chemists. It was examined by Scheele and Bergman; and at last the theory of its violent action was fully developed by Berthollet. This compound consists of the oxide of gold and ammonia, and as the oxide performs the part of an acid, it is 2101
sometimes denominated *aurate of ammonia*. Theory. During the explosion which takes place, whether by the application of heat, or by friction or percussion, the hydrogen of the ammonia combines with the oxygen of the oxide of gold, and forms water. This water, being suddenly raised to the state of vapour, and the azote, the other component part of ammonia, being at the same time suddenly converted into gas, produce the explosion. The gold is reduced to the metallic state. 2101

This substance may be deprived of its fulminating property, by being exposed for some time to a very gentle heat. May be decomposed without explosion. It is then converted into a blackish brown powder. A similar effect is produced, by subjecting it for a long time to the temperature of boiling water. Its fulminating property is at least greatly diminished by the latter process. It appears, too, that the contact of air promotes this action: for when it was heated in an iron globe, in an experiment which

Gold, &c. which Birch performed before the Royal Society of London, or in a sphere of strong copper, in an experiment by Bergman, no detonation took place. Berthollet applied a gentle heat to a quantity of fulminating gold, in copper tubes; and he obtained ammoniacal gas, and the gold was reduced to the state of purple oxide. By these experiments it appears, that this substance is decomposed without detonation, when the sudden dilatation of the gases which are disengaged is resisted by strong vessels, or when the heat is so moderate as to separate the ammonia without decomposition.

2103 Action of metals. 5. The muriate of gold is decomposed by almost all metallic substances. Some metals decompose it completely, and reduce it to the metallic state, while others deprive it of a portion of oxygen, and reduce it to the state of purple oxide. Bismuth, zinc, iron, copper, and mercury, reduce the gold to the metallic state. Lead, silver, and tin, occasion a precipitate in the form of purple oxide. The most singular of all these precipitates, and which has long occupied the attention of chemists, is that which is produced by

2104 Purple powder of Cassius. means of tin. This is called the *purple precipitate*, or *powder of Cassius*. It was at first particularly described by Cassius, from whom it derived its name; but it was known long before, even so early as the time of Basil Valentine, by whom it is mentioned. If a plate of tin be immersed in a solution of muriate of gold, the surface of the metal is soon covered with a deep-coloured violet or purple powder, which is gradually diffused through the whole liquid. This is usually prepared by adding to a solution of gold in nitro-muriatic acid, a solution of muriate of tin recently prepared. The theory of this process is the following. The gold in solution is in the state of yellow oxide. It is deprived of part of its oxygen, and reduced to the state of purple oxide by the tin. The purple oxide is no longer soluble in the acid, and is therefore precipitated. The same effect is produced when a salt of tin is added, provided this salt be not fully saturated with oxygen, for in that case no precipitate is obtained. This is the reason, as Pelletier has shown, that muriate of tin, after it has been for some time exposed to the air, loses the property of producing the purple precipitate, because it has absorbed oxygen from the atmosphere, and is not susceptible of combining with a greater quantity. For the same reason no precipitate is obtained by the oxymuriate of tin, or the *smoking liquor of Libavius*, or the red sulphate of iron, because both these salts have their bases fully saturated with oxygen. Other metallic solutions have also the property of decomposing and precipitating the muriate of gold. The nitrate of silver produces a reddish precipitate, which is a mixture of white muriate of silver and purple oxide of gold. The nitrate of lead deposits a dark-coloured substance, composed of muriate of lead and oxide of gold.

2105 Metallic acids. 6. The metallic acids have no effect whatever on gold. Vauquelin found that chromic acid, mixed with muriatic acid, gave it the property of dissolving gold. This is owing to the chromic acid giving up part of its oxygen, which appears to be the case, from its passing from its natural colour, which is orange, to the state of green oxide.

II. Action of Alkalies, &c. upon Gold.

Gold, &c.

Alkalies. 1. None of the alkalies have any action upon gold or on its purple oxide; but the yellow oxide precipitated from its solution by means of the fixed alkalies, and digested for some time with ammonia, is readily converted into fulminating gold.

Earths. 2. The earths have no action on gold in the metallic state; but in the state of purple or yellow oxide, it combines with the earths which are vitrified by means of the alkalies, and forms with them enamels, which are of a violet or purple colour, or glass of a golden-yellow colour. It is on account of the latter property that the yellow oxide is employed in the fabrication of artificial topazes. It has been observed that glass coloured by means of gold, and which contains a considerable proportion of oxide of lead or of manganese, has a remarkable property of changing to a permanent purple or ruby-red colour, when it is slightly heated, and long before fusion. This is supposed to be owing to some change in the state of the oxidation of the different metals.

Salts. 3. The most powerful salts, as the nitrates, the hyperoxymuriates, have no action on pure gold. It has, however, been observed, that borax diminishes its colour, and that nitre, which is employed in its purification, renders it more brilliant.

III. Alloys of Gold.

With arsenic. 1. Gold is susceptible of combination with most metallic substances, which produce a very particular change on its properties. The alloy with arsenic is brittle, hard, of a granulated texture, and of a very pale colour. According to Mr Hatchet's experiments, arsenic readily combines with gold raised to a common red heat, when the former is in the state of vapour, and particularly when the combination is made in close vessels.

Tungsten, &c. 2. The alloys of gold with tungsten, molybdena, chromium, titanium, and uranium, have not been examined.

Cobalt. 3. The combination of gold and cobalt is not perceptibly different from pure cobalt. This alloy reduced to a fine powder, and heated in contact with air, gives, after its oxidation, and by strong heat, a deep blue glass. In Mr Hatchet's experiments, one part of cobalt and 14 of gold form a brittle alloy of a dull yellow colour. With $\frac{1}{81}$ of cobalt the alloy was brittle, but became ductile with $\frac{1}{110}$ part.

Nickel. 4. Gold forms with nickel a white and brittle alloy. In Mr Hatchet's experiments $\frac{1}{18}$ of nickel rendered the alloy brittle. It was scarcely, if at all, brittle with $\frac{1}{81}$ part, and with $\frac{1}{110}$ of nickel it was completely ductile. One part of nickel and 16 of gold give an alloy of the colour of brass.

5. Mr Hatchet formed an alloy of gold with manganese. It was of a pale yellowish-gray colour, had something of the lustre of polished steel, and some ductility, although it was very hard. It contained about one-ninth of manganese. Acids produced no effect, nor was it altered by exposure to the air *.

Bismuth. 6. Bismuth fused with gold, yields an alloy which is brittle in proportion to the quantity of bismuth employed. The specific gravity of this alloy is greater than

* Phil. Trans. 1803.

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 than the mean. In Mr Hatchet's experiments, this alloy was brittle, when the proportion of bismuth amounted only to $\frac{1}{1940}$ part.

2114 Antimony.

7. Antimony combines with gold, and renders it hard and brittle. Equal parts of these metals form an alloy not much different in appearance from gold itself. This compound was frequently employed by the alchemists in their researches. Antimony was called the *royal bath*. They pretended that the quantity of gold was increased when it was separated from the alloy, after having been fused with this metal. But it appears that this increase of weight was owing to part of the antimony, which was not separated from the gold. The sulphuret of antimony was formerly much employed for the purification of gold, to separate, by means of the sulphur, the metals which were combined with it; and from this property of acting on all the metals then known, excepting gold, the sulphuret of antimony was called by the alchemists, *the wolf of the metals*.

2115 Mercury.

8. Gold unites very readily with mercury. If gold be brought into contact with this metal, it is instantly covered with it; and if gold leaf be triturated with mercury, it totally disappears, and is dissolved in the mercury; so that even in the cold, mercury combines with the whole quantity of gold with which it can be alloyed. When the proportion of gold is increased, the amalgam becomes solid. When this operation is performed in the large way, the combination is promoted by means of moderate heat. This amalgam is of a yellowish-white colour; it is fusible at a moderate heat, and crystallizes in the form of quadrangular prisms. It is decomposed by a strong heat, and the mercury is dissipated. This amalgam is much employed in gilding.

2116 Zinc.

9. Gold combines with zinc by means of fusion. This alloy is paler than gold, has little malleability, and if the proportion of the zinc be considerable, is very brittle. An alloy consisting of equal parts of the two metals, is of a greater specific gravity than the mean, is very hard, susceptible of a fine polish, and is not much altered by the air. It has been recommended, on account of these properties, for the fabrication of the mirrors of telescopes.

2117 Tin.

10. Gold combines easily with tin by means of fusion. This alloy, it is said, is the dread of the workmen, because it deprives gold of its ductility. They are even cautious in preserving gold from the contact of the vapour of tin in fusion, which renders the gold so brittle, that it may be reduced to powder in a mortar. It is extremely difficult to purify gold after it has been alloyed with tin, for it does not pass into the cupel with lead or with bismuth. Nitre, borax, and even the hyperoxymuriate of mercury, which are often employed with this view, do not always succeed. The most successful method is by treating the alloy with sulphuret of antimony, or with muriatic acid, which dissolves the tin when it is in considerable proportion. But in the experiments of Mr Hatchet and Mr Bingley, it appears that the universal opinion which has hitherto prevailed, of tin being so injurious to the ductility of gold, is, to a certain extent, erroneous; and it appears probable, that the ductility of gold being destroyed, as was supposed, even by the fumes of tin, ought to have been ascribed to other metals, as bismuth, lead, antimony, or zinc, with which the tin was contaminated.

2118 Lead.

11. Lead very readily combines with gold by fusion; this alloy deprives the gold of its ductility, and diminishes the colour. So small a proportion as $\frac{1}{1920}$ part of lead destroys the ductility of gold. This alloy, it has been already stated, is made for the purpose of purifying gold from other metals, in consequence of the easy oxidation and vitrification of the lead.

2119 Iron.

12. Gold is easily alloyed with iron, and forms with it a hard brittle mass. Some of these alloys are so hard, that Dr Lewis found them fit for cutting instruments. Equal parts of iron and gold form an alloy of a gray colour. Four parts of iron and one of gold afford an alloy nearly of the colour of silver, and the specific gravity of this alloy has been ascertained to be less than the mean. One part of iron alloyed with 12 of gold, according to Mr Hatchet, was of a pale-yellowish gray colour, and was so ductile that it might be rolled and cut. When gold is fused, it adheres readily to iron; and hence it has been proposed to solder small pieces of steel with gold, which seems to be preferable to copper.

2120 Copper.

13. Gold readily combines with copper by fusion. This is one of the most important alloys, on account of the hardness which copper communicates to gold, without diminishing its colour. This alloy, according to Muschenbroeck, possesses the greatest hardness, without sensibly diminishing its ductility, when the proportions are one part of copper and seven of gold. This alloy is more fusible than gold, and on that account it is employed as a solder for that metal. The gold coin of most countries consists of this alloy. The proportions in the gold coin of Britain and France are 11 parts of gold to one of copper. According to Brisson, the specific gravity of this alloy is greater than the mean. It is 17.486, but it ought to be 17.153. But, according to Mr Hatchet's experiments, there is no mutual penetration in the alloy of these metals, and therefore no increase of density. On the contrary, some degree of expansion was observed. Four hundred and forty-two grains of gold of specific gravity 19.172, were alloyed with 38 grains of copper of specific gravity 8.875. The specific gravity of the alloy was found to be 17.157. The bulk of the alloyed mass amounted to 27.98, while the natural bulk of the two metals before combination was 27.32, which shews an increase of expansion of the alloyed mass equal to $\frac{66}{100}$. Mr Hatchet observes that Brisson's experiment was probably made on part of a large bar or ingot, in which it generally happens, that the two metals are very unequally diffused, and this inequality, which is greater according to the quantity of the metal, is found to vary with the form, nature, and position of the mould, and therefore to produce variations in the specific gravity *.

* *Phil. Trans.* 1803. p. 112.

2121 Silver.

14. Silver forms an alloy with gold. Homberg found, that equal parts of these metals fused together in a crucible, formed an alloy which contained $\frac{1}{7}$ of its weight of silver. One part of silver and two of gold, according to Muschenbroeck, give to the alloy the greatest degree of hardness. One-twentieth part of silver changes the colour of gold very sensibly. This alloy is employed for soldering gold, being more fusible than this metal.

15. Mr

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15. Mr Hatchet observes, that the obvious inference to be deduced from his experiments is, that only two metals are proper for the alloy of gold coin. These are silver and copper. All other metals either considerably alter the colour, or diminish the ductility of gold. According to the same philosopher, the ductility of gold is diminished by different metallic substances, nearly in the following decreasing order:

Bismuth,
Lead,
Antimony, } These are nearly equal in effect.
Arsenic,
Zinc,
Cobalt,
Manganese,
Nickel,
Tin,
Iron,
Platinum (E),
Copper,
Silver *.

* Phil. Trans. 1803, 95. 2122

Uses.

The uses of gold, many of which have been already detailed, in describing its properties and combinations, are too familiar to require particular enumeration (F).

Sect.

(E) Mr Hatchet supposes that the platinum not being quite pure, the place he has assigned to it is perhaps not precisely that which it ought to occupy.

(F) The metals which were earliest known, were long distinguished by particular names and characters, of which the following account is taken from the elaborate researches of Professor Beckmann. The following table exhibits their names and characters.

Metals.	Names.	Characters.
Gold,	Sun,	☉
Silver,	Moon,	☽
Mercury,	Mercury,	☿
Copper,	Venus,	♀
Iron,	Mars,	♂
Tin,	Jupiter,	♃
Lead.	Saturn.	♄

It cannot be doubted, Professor Beckmann observes, that these names were first given to the heavenly bodies; and the metals which were then known, amounting to the same number, were supposed to have some affinity or relationship to the planets, and with them to the gods, and were accordingly named after them. " To each god was assigned a metal, the origin and use of which was under his particular providence and government; and to each metal were ascribed the powers and properties of the planet and divinity of the like name; from which arose, in the course of time, many of the ridiculous conceits of the alchemists.

" The oldest trace of the division of the metals among the gods is to be found, as far as I know, in the religious worship of the Persians. Origen, in his refutation of Celsus, who asserted that the seven heavens of the Christians, as well as the ladder which Jacob saw in his dream, had been borrowed from the mysteries of Mithras, says, ' Among the Persians the revolutions of the heavenly bodies were represented by seven stairs, which conducted to the same number of gates. The first gate was of lead; the second of tin; the third of copper; the fourth of iron; the fifth of a mixed metal; the sixth of silver; and the seventh of gold. The leaden gate had the slow tedious motion of Saturn; the tin gate the lustre and gentleness of Venus; the third was dedicated to Jupiter; the fourth to Mercury, on account of his strength and fitness for trade; the fifth to Mars; the sixth to the Moon; and the last to the Sun.' ' Celsus de quibusdam Persarum mysteriis sermonem facit. Harum rerum, inquit, aliquod reperitur in Persarum doctrina Mithrasisque eorum mysteriis vestigium. In illis enim duæ cælestes conversiones, alia stellarum fixarum, errantium alia, et animæ per eas transitus quodam symbolo representantur, quod hujusmodi est. Scala altas portas habens, in summa autem octava porta. Prima portarum plumbea, altera stannea, tertia ex ære, quarta ferrea, quinta ex ære mixto, sexta argentea, septima ex auro. Κλιμαξ ὑψιπυλος, επι δ' αυτῃ πυλη ογδοη. Ἡ πρωτη των πυλων μολιβδου, ἡ δευτερα κασσιτερου, ἡ τριτη χαλκου, ἡ τεταρτη σιδηρου, ἡ πεμπτη κεραστου νομισματος, ἡ ἑκτη αργυρου, χρυσου δ' ἡ ἑβδομη. Primum assignant Saturno, tarditatem illius sideris plumbo indicantes: alteram Veneri, quam referunt, ut ipsi quidem putant, stanni splendor et mollities; tertiam Jovi, aheneam illam quidem et solidam; quartam Mercurio, quia Mercurius et ferrum, uterque operum omnium tolerantes, ad mercaturam utiles, laborum patientissimi. Marti quintam, inæqualem illam et variam propter mixturam. Sextam, que argentea est, lunæ; septimam auream soli tribuunt, quia solis et lunæ colores hæc duo metalla referunt.' *Contra Celsum*, lib. vi. 22. p. 161. Here then is an evident trace of metallurgic astronomy, as Borrichius calls it, or of the astronomical or mythological nomination of metals, though it differs from that used at present. According to this arrangement, tin belonged to Jupiter, copper to Venus, iron to Mars, and the mixed metal to Mercury. The conjecture of Borrichius, that the transcribers of Origen have, either through ignorance or design, transposed the names of the gods, is highly probable: for if we reflect that in this nomination men, at first, differed as much as in the nomination of the planets, and that the names given them were only confirmed in the course of time, of which I shall soon produce proofs, it must be allowed that the causes assigned by Origen for his nomination do not well agree with

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Platinum, &c.

Sect. XXIV. *Of Platinum and its Combinations.*

2123 History.

1. Platinum in most of its properties is equal to gold, but in others, it is superior. It was first clearly ascertained to be a distinct metal, by Scheffer, a Swedish chemist, in the year 1752. It had been indeed taken notice of at an earlier period. A quantity of it was brought from Jamaica in 1741, by Mr Wood. It is particularly mentioned by Antonio de Ulloa, a Spanish mathematician, in the account of his voyage to Peru with the French academicians, to measure a degree of the meridian, which was published in 1748. After this period numerous experiments were made upon this new substance, all of which tended to prove that it is a different metal from any formerly known; Scheffer

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with the present reading, and that they appear much juster when the names are disposed in the same manner as that in which we now use them. Borrichius arranges the words in the following manner: Secundam portam faciunt Jovis, comparantes ei stanni splendorem et mollitiem; tertiam Veneris æratam et solidam; quartam Martis, est enim laborum patiens, æque ac ferrum, celebratus hominibus; quintam Mercurii, propter misturam inæqualem ac variam, et quia negotiator est; sextam Lunæ argenteam; septimam Solis auream. *Ol. Borrichius de ortu et progressu chemiæ.* Hafniæ 1668, 4to. p. 29.

"This astrological nomination of metals appears to have been conveyed to the Brachmans in India; for we are informed that a Brachman sent to Apollonius seven rings, distinguished by the names of the seven stars or planets, one of which he was to wear daily on his finger, according to the day of the week. This can be no otherwise explained than by supposing that he was to wear the gold ring on Sunday; the silver one on Monday; the iron one on Tuesday, and so of the rest. Allusion to this nomination of the metals after the gods occurs here and there in the ancients. Dydimus, in his explanation of the Iliad, calls the planet Mars the iron star. Those who dream of having had any thing to do with Mars are by Artemidorus threatened with a chirurgical operation; for this reason, he adds, because Mars signifies iron. Heraclides says also in his allegories, that Mars was very properly considered as iron; and we are told by Pindar that gold is dedicated to the sun.

"Plato likewise, who studied in Egypt, seems to have admitted this nomination and meaning of the metals. We are at least assured so by Marsilius Ficinus; but I have been able to find no proof of it, except where he says of the island Atlantis, that the exterior walls were covered with copper and the interior with tin, and that the walls of the citadel were of gold. It is not improbable that Plato adopted this Persian or Egyptian representation, as he assigned the planets to the demons; but perhaps it was first introduced into his system only by his disciples. They seem, however, to have varied from the nomination used at present; as they dedicated to Venus copper, or brass, the principal component part of which is indeed copper; to Mercury tin, and to Jupiter electrum. The last-mentioned metal was a mixture of gold and silver; and on this account was probably considered to be a distinct metal, because in the early periods mankind were unacquainted with the art of separating these noble metals.

"The characters by which the planets and metals are generally expressed when one does not choose to write their names, afford a striking example how readily the mind may be induced to suppose a connection between things which in reality have no affinity or relation to each other. Antiquaries and astrologers, according to whose opinion the planets were first distinguished by these characters, consider them as the attributes of the deities of the same name. The circle in the earliest periods among the Egyptians was the symbol of divinity and perfection; and seems with great propriety to have been chosen by them as the character of the sun, especially as, when surrounded by small strokes projecting from its circumference, it may form some representation of the emission of rays. The semicircle is, in like manner, the image of the moon, the only one of the heavenly bodies that appears under that form to the naked eye. The character ♄ is supposed to represent the scythe of Saturn; ♃ the thunderbolts of Jupiter; ♂ the lance of Mars, together with his shield; ♀ the looking-glass of Venus; and ☿ the caduceus or wand of Mercury.

"The expression by characters adopted among the chemists agrees with this mythological signification only in the character assigned to gold.—Gold, according to the chemists, was the most perfect of metals, to which all others seemed to be inferior in different degrees. Silver approached nearest to it, but was distinguished only by a semicircle, which, for the more perspicuity, was drawn double, and thence had a greater resemblance to the most remarkable appearance of the moon; the name of which this metal had already obtained. All the other metals, as they seemed to have a greater or less affinity to gold or silver, were distinguished by characters composed of the characters assigned to these precious metals. In the character ☿ the adepts discover gold with a silver colour. The cross placed at the bottom, which among the Egyptian hieroglyphics had a mysterious signification, expresses, in their opinion, something I know not what, without which quicksilver would be silver or gold. This something is combined also with copper, the possible change of which into gold is expressed by the character ♀. The character ♂ declares the like honourable affinity also; though the semicircle is applied in a more concealed manner; for, according to the properest mode of writing, the point is wanting at top, or the upright line ought only to touch the horizontal, and not to intersect it. Philosophical gold is concealed in steel; and on this account it produces such valuable medicines. Of tin one half is silver, and the other consists of the something unknown; for this reason the cross with the half moon appears in ♃. In lead this something is predominant, and a similitude is observed in it to silver. Hence in its character ♄ the cross stands at the top, and the silver character is only suspended on the right hand behind it.

"The mythological signification of these characters cannot be older than the Grecian mythology; but the chemical

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Scheffer, gave it the name of *white gold*, because it resembled this metal in many of its properties. In the year 1754, Dr Lewis published an account of a very full and elaborate set of experiments on platinum, in the Philosophical Transactions. The properties of this new metal were still farther investigated by Margraaf in 1757, and by Macquer and Beaumé in 1758. It became afterwards the subject of research with many other philosophical chemists. Among these may be mentioned Buffon, Bergman, Sickengen, and more lately Guyton, Lavoisier, and Pelletier. It was at last denominated *platinum*, signifying *little silver*, from the Spanish word *plata*, *silver*.

2124 Where found.

2. Platinum has only been found among the gold ores of South America, and especially in the mine of Santa Fe near Carthagena, and in the district of Choco in Peru. It is found in the form of small grains or scales, of a white or grayish colour, intermediate between that of silver and iron. These grains are mixed with several other substances, as particles of gold, a black ferruginous sand, and some particles of mercury. Some of these grains extend under the hammer; others, which seem to be hollow, containing particles of iron and a whitish powder, break to pieces. To these grains of iron is ascribed the magnetic property which platinum seems to possess (G).

2125 Purification.

3. To obtain platinum in a state of purity, it is first separated from the substances with which it is contaminated. Mercury is driven off by exposing it to a red heat, and the particles of iron are separated by the magnet. The grains of platinum are then heated with muriatic acid, which dissolves the remaining part of the iron. By this process, Bergman has observed that the platinum diminishes in weight about 0.05. The platina is now only alloyed with gold, which is to be separated by dissolving both in nitro-muriatic acid, and by precipitating the gold by means of the green sulphate of iron. But even after these processes, the platinum is not in a state of absolute purity, as will appear afterwards (H).

2126 Properties.

4. This metal is of a white colour, but less bright than silver, and it possesses nothing of the brilliancy of either silver or gold. Platinum is the densest body, and therefore the heaviest yet known. Its specific gravity, when it is hammered, is 23; or, according to Chabaneau, 24. According to Guyton, it comes next to iron and manganese in hardness. It possesses very considerable malleability, for it may be hammered

mical may be traced to a much earlier period. Some, who consider them as remains of the Egyptian hieroglyphics, pretend that they may be discovered on the table of Isis, and employ them as a proof of the high antiquity, if not of the art of making gold, at least of chemistry. We are told also that they correspond with many other characters which the adepts have left us as emblems of their wisdom.

" If we are desirous of deciding without prejudice respecting both these explanations, it will be found necessary to make ourselves acquainted with the oldest form of the characters, which, in all probability, like those used in writing, were subjected to many changes before they acquired that form which they have at present. I can, however, mention only three learned men, Saumaise, Du Cange, and Huet, who took the trouble to collect these characters. As I am afraid that my readers might be disgusted were I here to insert them, I shall give a short abstract of the conclusion which they form from them; but I must first observe that the oldest manuscripts differ very much in their representation of these characters, either because they were not fully established at the periods when they were written, or because many supposed adepts endeavoured to render their information more enigmatical by wilfully confounding the characters; and it is probable also that many mistakes may have been committed by transcribers.

" The character of Mars, according to the oldest mode of representing it, is evidently an abbreviation of the word Θουρος, under which the Greek mathematicians understood that deity; or, in other words, the first letter Θ, with the last letter ς placed above it. The character of Jupiter was originally the initial letter of Ζευς; and in the oldest manuscripts of the mathematical and astrological works of Julius Firmicus the capital Z only is used, to which the last letter ς was afterwards added at the bottom, to render the abbreviation more distinct. The supposed looking-glass of Venus is nothing else than the initial letter, distorted a little, of the word Φωσφορος, which was the name of that goddess. The imaginary scythe of Saturn has been gradually formed from the two first letters of his name Κρονος, which transcribers, for the sake of dispatch, made always more convenient for use, but at the same time less perceptible. To discover in the pretended caduceus of Mercury the initial letter of his Greek name Στιλβων, one needs only look at the abbreviations in the oldest manuscripts, where they will find that Σ was once written as C; they will remark also that transcribers, to distinguish this abbreviation from the rest still more, placed the C thus ◡, and added under it the next letter τ. If those to whom this deduction appears improbable will only take the trouble to look at other Greek abbreviations, they will find many that differ still farther from the original letters they express than the present character ☿ from the C and τ united. It is possible also that later transcribers, to whom the origin of this abbreviation was not known, may have endeavoured to give it a greater resemblance to the caduceus of Mercury. In short, it cannot be denied that many other astronomical characters are real symbols, or a kind of proper hieroglyphics, that represent certain attributes or circumstances, like the characters of Aries, Leo, and others quoted by Saumaise." *Hist. of Invent.* iii. 53.

(G) Collet Descostils observes, that among the metallic substances which are usually found accompanying platinum, there are two kinds of ferruginous sand; of which one is attracted by the magnet, and soluble in acids. This contains titanium. The other has no magnetic property, and is only partially soluble in acids. This last contains a considerable proportion of chromic acid. *Ann. de Chim.* xlviii. 154.

(H) Several new metals have been discovered in platinum, by some late experiments. These will be mentioned in a future section.

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Platinum, &c. mered out, although with difficulty, into very thin plates; and it is so ductile, that it may be drawn out into wire $\frac{1}{1000}$ of an inch in diameter. The tenacity of platinum is very considerable. A wire of .078 of an inch in diameter will support a weight, without breaking, equal to more than 274 lbs. avoirdupois.

2127 Fusing point unknown. 5. Platinum is the most infusible of all the metals. The temperature at which it enters into fusion is unknown. But small particles of platinum have been fused by means of the blow-pipe, or by directing a stream of oxygen gas on red-hot charcoal. Guyton also succeeded in fusing it by means of a flux, composed of eight parts of pounded glass, one of calcined borax, and one-half part of charcoal in powder. When platinum has been exposed to a white heat, it may be welded by hammering, like iron.

2128 Oxidation. 6. As platinum is infusible in the strongest furnace heat, so it remains otherwise unchanged (1). It does not appear to undergo, like most other metals, any degree of oxidation; but if platinum be dissolved in 16 times its weight of nitro-muriatic acid, by boiling, the solution becomes at first of a yellow, and then

2129 Yellow oxide. changes to a brown colour. This solution is precipitated by means of lime, and the precipitate is in the form of a yellowish powder, which is the oxide of platinum. The proportion of oxygen in this oxide is supposed not to exceed .07. But according to the experiments of Mr Chenevix, it is composed of

Platinum	87
Oxygen	13
	100

2130 Green oxide. The same chemist also found, that in the reduction of this oxide of platinum, it became of a green colour, and remained for some time in that state. Ammonia assumes a green colour when it holds oxide of platinum in solution. This Mr Chenevix considers as a second oxide of platinum, and it contains.

Platinum	93
Oxygen	7
	100 *.

* Phil. Trans. 1803. 314.

Platinum has also been oxidated by means of electricity. In Van Marum's experiments, a wire of this metal through which electric sparks were sent, burnt with a white flame, and was dissipated in the form of fine powder or dust.

7. Azote, hydrogen, and carbon, have no action whatever on platinum.

2131 Phosphuret. 8. Phosphuret of platinum was formed by Pelletier, by mixing together equal parts of platinum and phosphoric glass, with one-eighth of charcoal. This mixture being exposed to the temperature of 32° of Wedgwood for an hour, yielded a small button of phosphuret of platinum, of a silvery white colour, part of which had assumed the form of cubic crystals. It was so hard as to strike fire with steel, and was not attracted by the magnet. It was covered with a dark-coloured glass, which afterwards became green, bluish, and white. By exposing this phosphuret to a strong heat, the phosphorus is separated, and burns on the surface, and the metal remains behind very pure and malleable. Pelletier has proposed this process for the purification of platinum from other metals. Platinum, &c.

9. Sulphur has been found in combination with native platinum. When native platinum is exposed to the action of the blow-pipe on charcoal, it exhales the penetrating odour of sulphur, accompanied with a vapour which does not render gold white, and which requires a higher temperature to sublime it than mercury*. 2132 Sulphuret.

* Ann. de Chim. xxxviii. 149.

I. Salts of Platinum.

1. Sulphate of Platinum.

By adding sulphuric acid to a solution of platinum in muriatic acid, Mr Chenevix obtained an insoluble salt, which he found to be composed of

Oxide of platinum	54.5
Acid and water	45.5
	100.0

2. Sulphate of Platinum and Potash.

This triple salt is formed by adding a solution of potash to sulphate of platinum. The component parts of this salt are, sulphuric acid, oxide of platinum, and potash; but the proportions have not been ascertained by Bergman, who examined it.

3. Sulphate of Platinum and Ammonia.

This triple salt is formed in the same way as the former, by adding ammonia to the sulphate of platinum.

4. Nitrate of Platinum.

Nitric acid has no action on platinum, but it dissolves the yellow oxide. Mr Chenevix precipitated the oxide of platinum from its solution in nitro-muriatic acid by means of lime, and although it was added in excess, a great portion of platinum remained in the liquor. The precipitate was re-dissolved in nitric acid, and evaporated to dryness. The result was, a subnitrate of platinum, which consisted of

Yellow oxide	89
Nitric acid and water	11
	100

5. Nitrate of Platinum and Potash.

When potash is added to a solution of nitrate of platinum, crystals are deposited, forming a triple salt, and composed of nitric acid, oxide of platinum and potash.

6. Nitrate of Platinum and Ammonia.

This triple salt is formed by adding ammonia to a solution of nitrate of platinum.

(1) Guyton proposes to construct a pyrometer of platinum. See *Ann. de Chim.* xlvi. 276.

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Platinum, &c.

7. Muriate of Platinum.

2133 Preparation. Muriatic acid has no action on platinum, but the muriate of platinum may be obtained by dissolving the metal in nitro-muriatic acid. Boiled in 16 parts of a mixture consisting of one part of nitric acid and three parts of muriatic acid, it is gradually dissolved with effervescence. It may be also dissolved in oxymuriatic acid. The solution of platinum in muriatic acid is of a reddish or deep brown colour. It is extremely acrid and caustic, corrodes and burns animal matters, and leaves a dark brown spot on the skin. When the solution is concentrated, it deposits, on cooling, small irregular crystals, nearly in the state of powder, and of

2134 Properties. a brownish-yellow colour. When these crystals are washed and dried, they are found to be less soluble by boiling in water, than even the sulphate of lime. The solution is of a yellow colour. The muriate of platinum has a harsh, astringent taste; it is decomposed by heat; the acid is driven off, and the oxide remains. It is also decomposed by concentrated sulphuric acid. Potash produces in this solution small reddish crystals, frequently in the form of octahedrons, constituting the triple salt already described. The same triple salt is formed by the sulphate of potash. Ammonia, or the muriate of ammonia, also forms a triple salt, by being added to the solution of muriate of platinum. Soda in sufficient quantity occasions a precipitate of the yellow oxide of platinum, and a triple salt also is formed. Mr

2135 Composition. Chenevix found that the insoluble muriate of platinum is composed of

Oxide of platinum	70
Acid and water	30
	100

8. Muriate of Platinum and Soda.

Till the experiments of Collet-Descostils, little was known of this triple salt. It may be obtained by adding to a solution of platinum a salt with base of soda. By concentration and cooling it crystallizes in the form of long prisms, and sometimes in that of triangular tables, of a yellow or red colour. It is very soluble in water, and also in alcohol. It is decomposed by muriate of ammonia, and by a solution of soda; but an excess of this salt re-dissolves the precipitate. It may be reduced by the action of the blow-pipe on charcoal. This crystallized triple salt, if it has no excess of acid, changes from a red colour to a green by exposure to the air. If in this state it be dissolved in water, and oxymuriate of lime be added to it, a deep blue precipitate is formed, which being washed and collected, is soluble in muriatic acid, and communicates to it a beautiful blue colour. The addition of alcohol deprives the solution of its colour, but the oxymuriate of lime restores it *.

* *Ann. de Chim.* xlviii. p. 165.

9. Muriate of Platinum and Potash.

This salt is formed by adding potash to a solution of muriate of platinum. Small crystals of a red colour, in the form of octahedrons, are precipitated, which are a triple salt, consisting of muriatic acid, oxide of platinum and potash.

10. Muriate of Platinum and Ammonia.

1. A similar triple salt is formed by adding ammonia to the solution of muriate of platinum. The triple salt is precipitated in the form of crystalline grains, of a reddish yellow colour, which are soluble in water. By evaporating the solution of these triple salts to dryness, and by exposing it to a strong heat, the platinum is reduced. This fact with regard to the fusibility of platinum by means of potash or ammonia, was observed by Bergman, and it is by this process that platinum is purified and wrought.

2. When this salt is precipitated by means of potash, a fulminating platinum is obtained. This, according to Fourcroy and Vauquelin, by whom it was prepared, is a compound of oxide of platinum and ammonia. When it is exposed to sudden heat, it decrepitates and is agitated with a rapid motion, but when the heat is gradually applied, it detonates violently *.

* Ann. de Chim. [illegible] p. 17[illegible].

11. Oxalate of Platinum.

Oxalic acid combines with the oxide of platinum, and affords by evaporation crystals which are of a yellow colour.

12. Benzoate of Platinum.

Benzoic acid, according to Trommsdorf, dissolves a small quantity of the oxide of platinum. When this solution is evaporated, it crystallizes. This salt undergoes no change by exposure to the air, and is not very soluble in water. The acid is driven off by heat, and the oxide of platinum remains behind.

II. Alloys.

1. Platinum combines with many of the metals, and forms with them alloys, some of which are of considerable importance in the working of this metal. 2136

Platinum forms an alloy with arsenic, which is brittle Combined with arsenic. and very fusible. It is in this state of alloy that platinum is susceptible of being formed into different utensils and instruments for which it is peculiarly fitted. It is first fused with this metal, and then cast into moulds, at first in the form of square plates. It is then exposed to a red-heat, and hammered into bars. By the heating and hammering, the arsenic is driven off, and the metal is purified and becomes infusible, but retains its ductility, so that it may be wrought like iron.

2. The alloys of tungsten, molybdena, chromium, columbium, titanium, uranium, and manganese, are unknown; nor have the alloys of cobalt and nickel with this metal been examined. 2137

3. Platinum combines with bismuth by means of fusion. Bismuth. This alloy is fusible and hard in proportion to the quantity of bismuth. It is altered by exposure to the air; it becomes yellow, purple, and black. 2138

4. Platinum readily combines with antimony, and Antimony. forms a very brittle alloy. The antimony may be separated by means of heat, but not completely. Some part remains, which diminishes the weight and ductility of the platinum. 2139

5. It has been found extremely difficult to combine Mercury. platinum and mercury. Guyton had observed that the adhesive force of platinum and mercury is greater than that

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that of metals which do not combine with it, and that it is not inferior even to those which readily form alloys; from which he conjectured that the alloy of platinum and mercury might be effected by the following process. He placed a very thin plate of pure platinum at the bottom of a matrass containing a quantity of mercury. The matrass was put upon a sand bath, and heat applied, till the mercury boiled and the matrass became red hot. When the platinum was taken out, it was found to have acquired additional weight, and to have become very brittle. But this combination is different from the other combinations of mercury with the metals, for the platinum did not lose its solid form. Mr Chenevix, in the course of experiments and researches respecting a supposed new metal called palladium, succeeded in forming an amalgam with platinum and mercury. He heated purified platinum in the form of fine powder, with ten times its weight of mercury, and rubbed them together for a long time. The result was an amalgam of platinum, which being exposed to a violent heat, lost all the mercury it contained, and the original weight of the platinum remained.

2140 Zinc. 6. Platinum readily combines with zinc, and forms with it a fusible alloy, of a bluish colour, brittle, and hard. By heating, the zinc is sublimed, and burns on the surface.

2141 Tin. 7. Platinum alloys readily with tin. This alloy is one of the most fusible. It is hard and brittle, when the two metals are in equal proportions; but tin in the proportion of 12 parts to one of platinum, affords a very ductile alloy, which becomes yellow by exposure to the air. From this it appears that platinum diminishes the ductility of tin.

2142 Lead. 8. Platinum readily combines with lead, by means of fusion. An alloy of equal parts of these metals is of a purplish colour, granulated in its fracture, brittle, and easily altered by exposure to the air. The cupellation of platinum by means of lead has been an object of considerable importance with chemists, in the view of being able to purify it in the same way as gold and silver; but on account of the infusibility and refractory nature of platinum, the attempts that have been made have rarely succeeded.

2143 Iron. 9. Dr Lewis failed in his attempt to combine platinum with iron, but he obtained an alloy by fusing together platinum and cast iron. This alloy was extremely hard, and possessed some degree of ductility. Platinum, as it is found native, is frequently alloyed with iron.

2144 Copper. 10. Platinum combines with copper by means of fusion, and gives it hardness. When the proportion of copper is three or four times greater than that of platinum, the alloy is ductile, susceptible of a fine polish, and is not altered by exposure to the air. This alloy has been employed in the fabrication of mirrors for telescopes.

2145 Silver. 11. Platinum readily combines with silver by fusion, although a very strong heat is required. The platinum greatly increases the hardness of silver, but diminishes its whiteness. When this alloy is kept in fusion for some time, the two metals are separated. During this fusion, Dr Lewis observed the silver forced towards the sides of the crucible with a kind of explosion.

2146 Gold. 12. Gold combines readily with platinum, but it requires a very powerful heat for the fusion of these two metals. Platinum diminishes the colour of gold, unless it be in very small quantity. When the proportion of platinum is above $\frac{1}{17}$, the colour of the gold begins to be altered. There is no perceptible change in the specific gravity or the ductility of gold from this alloy.

Platinum, on account of its peculiar properties, its infusibility, density, and indestructibility, could it be obtained in sufficient quantity, and at a moderate price, would undoubtedly prove one of the most useful and most important of the metals yet known. The importance and utility of platinum, on account of its scarcity, have been hitherto limited to chemical purposes; and for different chemical instruments and utensils, it has been found peculiarly appropriate, as there are few chemical agents whose effects it cannot resist. There is indeed little doubt but it might be employed with equal advantage in the construction of instruments and utensils, in various arts and manufactures.

SECT. XXV. *Of* RHODIUM, PALLADIUM, IRIDIUM *and* OSMIUM, *metals obtained from crude* PLATINUM.

Rhodium, a metal discovered by Dr Wollaston, is separated from the ore of platinum by the following process.

When a solution of this ore in nitro-muriatic acid has been precipitated as far as possible by muriate of ammonia, it retains considerable colour, and contains some metals. Let a plate of zinc or iron be immersed, and all the metals are separated in the form of a black powder. The precipitate is to be washed (without being dried) with very dilute nitric acid, assisted by a gentle heat, and the copper and lead are thus dissolved. Digest the remainder in dilute nitro-muriatic acid, and add to the solution a portion of muriate of soda equal to $\frac{1}{50}$ part of the weight of the original ore. Evaporate by a gentle heat. The dry mass contains the soda-muriates of platinum, palladium, and rhodium. The two former are separated by alcohol, and the salt of rhodium remains. From its solution the metal is precipitated by zinc in the form of a black powder, amounting to $\frac{1}{100}$ of the weight of the ore. 2147 Rhodium. Separation.

It is infusible by heat, but may be fused by means of arsenic or sulphur, which may be expelled by a continued heat. The metallic button thus obtained is not malleable. Its specific gravity is 11. It unites readily with all the metals except mercury. It is insoluble even in nitro-muriatic acid till alloyed with bismuth, copper, or lead. The muriate of rhodium, thus obtained, has a rose colour, from which the name of the metal has been derived. 2148 Properties.

From the alcoholic solution above mentioned, containing the soda-muriates of palladium and platinum, the platinum is precipitated by muriate of ammonia, and palladium may be obtained from the remaining liquid by adding precipitate of potash. The precipitate is to be ignited and purified from iron, by cupellation with borax. Or it may be precipitated from the first solution of the ore, by prussiate of mercury in the state of a prussiate, which, on being heated, yields the metal in the proportion of about 1 in 200 of the ore. 2149 Palladium. Separation.

It has been found native in small fragments, which differ from the grains of platinum, in being formed of 2150 Sometimes native.

 fibres

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fibres diverging in some degree from one extremity. A small portion of iridium is the only other ingredient in these fragments.

2151 Properties. The colour of palladium resembles that of platinum, but is a duller white. It is malleable and ductile. Specific gravity about 11. Has nearly the same conducting power with platinum, and is rather more expansible by heat. It forms a blue solution with sulphuric acid, a beautiful red with nitric, and also with muriatic acid. The precipitates from these solutions by the alkalies and earths are generally of a fine orange. Green sulphate of iron precipitates palladium in the metallic state.

2152 Alloys. It combines readily with other metals. A very small proportion of it destroys the colour of gold. An alloy of gold and platinum is used for the graduation of a magnificent astronomical circle, constructed by Mr Troughton, for Greenwich observatory. It has the appearance of platinum, and is rendered peculiarly fit for receiving the graduations by its very great hardness.

2153 Iridium. Two other metals were discovered in crude platinum by Mr Tennant, in analyzing the black powder which remains after dissolving platinum. To the first of these metals Mr Tennant has given the name of *iridium*, from the various colours it assumes in solution. It possesses the following properties. It is soluble in all the acids, but less soluble in muriatic acid, with which it forms octahedral crystals. The solution with much oxygen is deep red; with a smaller proportion, green or deep blue. It is partially precipitated by the alkalies, and by all the metals except gold and platinum. Infusion of galls and prussiate of potash deprive this solution of its colour, but without any precipitate; thus affording an easy test of its presence. The oxide, therefore, loses its oxygen by water alone. When combined with gold or silver, it cannot be separated by the usual process of refining these metals. The same substance was examined by Descostils and Vauquelin, and the properties which they ascribe to this metal are the following. 1. It reddens the precipitates of platinum made by muriate of ammonia. 2. It is soluble in muriatic acid. 3. It is precipitated by the infusion of galls and prussiate of potash.

2154 Osmium. 5. Osmium is obtained by heating the black powder with pure alkali in a silver crucible. The oxide of this metal combines with the alkali, and may be expelled by an acid, and obtained by distillation, being very volatile. It does not redden vegetable blues, but stains the skin of a deep red or black. The oxide in solution with water has no colour; but by combining with alkali or lime, becomes yellow. With the infusion of nut-galls it gives a very vivid blue colour. It is precipitated by all the metals excepting gold and platinum. An amalgam may be formed with mercury, by agitating it with the aqueous solution of this oxide. When this amalgam is heated, the mercury is driven off, and the pure metal remains behind in the state of black powder. To this metal Mr Tennant has given the name of *osmium*, on account of the strong smell of the oxide †.

† *Nichol. Jour.* viii. p. 118, and 220.

Chap. XV. Of the Atmosphere.

The atmosphere is that invisible elastic fluid which surrounds the earth. Its physical properties, such as density, elasticity, and pressure, have been long known; but its composition and constituent parts must be ranked among the discoveries of modern chemistry. In the present chapter we propose only to take a short view of the nature, constitution, and changes of the atmosphere, reserving the full discussion of the latter to meteorology, to which it properly belongs.

Sect. I. *Of the Component Parts of the Atmosphere.*

1. The air of the atmosphere was considered by the ancients as one of the four elements of which all bodies are composed. The same opinion was held by all philosophers, previous to the discoveries of modern chemistry. It was universally admitted to be a simple homogeneous substance, till by the discovery of oxygen gas by Dr Priestley, and that of azotic gas by Scheele, it was fully demonstrated that these two substances are the chief ingredients in atmospheric air. 2155 Is a compound 2156 of oxygen and azotic gases.

2. This compound possesses all the physical properties of the different kinds of air which we have hitherto examined. It is invisible, elastic, and may be indefinitely expanded and compressed. The specific gravity of atmospheric air is 0.0012, or it is 816 times lighter than water. A hundred cubic inches weigh 31 grains troy; but in consequence of the elasticity of the air, the absolute weight and the density must vary with the temperature and pressure. The estimation which we have here given, is taken at the ordinary temperature of the atmosphere, between 50° and 60°, and when the barometer, which indicates the pressure, stands at 30 inches. The density must vary by diminishing, according to the height above the surface of the earth. The experiments of naturalists, whose attention has been particularly directed to this subject, have shewn that the diminution of density is in the ratio of the compression, and therefore, that the increase of density is in geometrical progression, while the heights increase in arithmetical progression. 2157 Physical properties.

3. After the discovery of the composition of atmospheric air, it became an object with philosophers to determine the proportions of its component parts. It was observed by Priestley and Scheele, and other philosophers who were occupied in the prosecution of their discoveries, that a certain portion of a given quantity of atmospheric air only was absorbed during the processes of combustion and respiration. It was observed too, that certain substances combined with the portion of atmospheric air which disappeared during these processes, and that the same quantity of atmospheric air suffered no farther diminution, whatever length of time it was exposed to the action of these substances. The portion of the air absorbed is the oxygen gas, and on this principle is founded the construction of those instruments which have been denominated *eudiometers*, because they are employed to measure the purity of a given portion of air, by ascertaining the quantity of oxygen gas which it contains. Different eudiometers have been proposed for this purpose, but all depending on the same principle, namely, the abstraction of oxygen gas from a given quantity of air. The reader will probably recollect the effects which take place by mixing together nitrous gas and the air of the atmosphere, or oxygen gas. When these gases come 2158 Method of estimating the proportions.

Component Parts of the Atmosphere.

come into contact, red fumes are produced; the atmospheric air is partially diminished; but the oxygen gas entirely disappears. This is owing to the combination of the nitrous gas with the oxygen gas, forming nitric acid, which, if the experiment be made over water, is absorbed; thus diminishing the bulk of the air by the quantity of oxygen gas abstracted. This is the principle of the first eudiometer which was proposed by Dr Priestley; but it has been found that the results and experiments with this kind of eudiometer are far from being uniform and constant. It is subject to variation from the difference of purity of the nitrous gas employed, the water over which the experiment is made, and even the form and construction of the apparatus. The variations in the results of different experiments by different philosophers, are from 22. to 30. of oxygen gas in 100 parts of atmospheric air.

Scheele proposed a different eudiometer. A mixture of iron filings and sulphur formed into a paste with water absorbs the whole of the oxygen gas of any given portion of atmospheric air. The diminution of bulk of a portion of air, exposed to the action of this substance, therefore, indicates the proportion of oxygen gas, which it contains; but this absorption goes on slowly, and is therefore an objection to this mode of ascertaining the proportions of atmospheric air. This objection has been removed by an improvement of this eudiometer, in which hydrogenated sulphuret of potash or lime is substituted for the iron filings and sulphur. This is prepared by boiling together sulphur and lime water, or a solution of potash in water. By the use of this sulphuret, the absorption takes place in a few minutes. A given portion of air is agitated in a bottle with this sulphuret, taking care to exclude the external air with a ground stopper. The diminution of the bulk of this quantity of atmospheric air shews the proportion of oxygen gas which it contained.

Volta proposed to explode a given portion of atmospheric air with hydrogen gas, by means of the electric spark. The hydrogen and oxygen combine together and form water, and the diminution of the bulk of the airs employed is in proportion to the quantity of water formed. But to this method of ascertaining the quantity of oxygen gas in a given portion of atmospheric air, it has been objected, that the proportion of hydrogen gas requires to be accurately adjusted; for if it exceed, the superabundant quantity increases the bulk of the remaining air; and, if the proportion be too small, the oxygen and azote will form nitric acid by the action of electricity, and thus the residuary quantity of air will be too much diminished.

When phosphorus is exposed to the air, it absorbs the oxygen readily, and is converted into phosphorous acid. This, which was first proposed by Achard, has been improved by Berthollet, for the purposes of a eudiometer. A given portion of air is exposed to the action of phosphorus, in a vessel over water; when the absorption has ceased, the remaining air is measured, the diminution of which indicates the quantity of oxygen gas which it contained.

Sir H. Davy has proposed the green sulphate or muriate of iron dissolved in water, impregnated with nitrous gas. This solution is prepared by transmitting nitrous gas through green muriate or sulphate of iron dissolved to saturation in water. All the apparatus necessary is a small graduated tube, having its capacity divided into 100 parts, and greatest at the open end, and a vessel for containing the fluid. The tube is filled with the air to be examined, and then introduced into the solution. To promote the absorption, it is gently moved from a perpendicular to a horizontal position. In a few minutes the experiment is completed, and the whole of the oxygen condensed by the nitrous gas in the solution, in the form of nitric acid. But in this process it is necessary to observe the period at which the diminution stops, for after this the volume of residual gas is increased by the decomposition of the nitric acid, by means of the green oxide of iron *.

* Journ. Roy. Inst. i. p. 45.

From a number of comparative experiments made by Sir H. Davy with different eudiometers, and from other experiments on air in different places, and collected under different circumstances, it appears that the component parts of atmospheric air are always nearly the same. These proportions are from .21 to .22 of oxygen gas, and from .78 to .79 of azotic gas. The constituent parts therefore of atmospheric air by bulk may be taken at

2159 Composition.

Oxygen gas	22
Azotic	78
	100

But in estimating the proportions of given bulks of atmospheric air, it is necessary, as we have already hinted, to take into account the density and temperature, otherwise very great anomalies must happen. 2160

Water.

4. It is universally admitted, that water exists in the atmosphere; but philosophers are greatly divided with regard to the quantity of water, and the state in which it exists in the air. To ascertain the quantity of water, instruments called *hygrometers* or *measures of moisture*, have been contrived; the quantity of which is indicated by certain changes which take place by its absorption; but none of these instruments that have yet been invented are susceptible of great accuracy, and perhaps to this is owing the very different results in estimating the quantity of water in the atmosphere. There is also a very great difference of opinion whether this water exists in the atmosphere in the state of water, or whether it has been converted into vapour. According to the first opinion, the water is held in solution by the air, and the quantity increases as the temperature of the air is increased. But according to others, the water of the atmosphere is in the state of vapour. According to the experiments of naturalists, the quantity of water in the atmosphere varies in different climates, and at different seasons of the year, from $\frac{1}{80}$ to $\frac{1}{100}$ part of the weight of the atmosphere. 2161

In the state of vapour.

5. When lime-water, or an alkaline solution, is exposed to the air, it is soon covered with a crust or pellicle. This is owing to the absorption of carbonic acid, and the conversion of the alkali or lime to the state of carbonate. This shews that carbonic acid gas exists in the atmosphere. This gas has been found not only on the surface of the earth, where the density of the atmosphere is greatest, but also on the tops of some of the highest mountains. The quantity of carbonic 2162

Carbonic acid gas.

gas

Component Parts of the Atmosphere.

acid gas in the atmosphere is supposed to vary from .01 to .005 parts.

Sect. II. *Of the Constitution of the Atmosphere.*

2163 Different opinions.

1. The component parts of the atmosphere are, azotic gas, oxygen gas, water, and carbonic acid gas. Here a question has arisen among philosophers, whether these parts are chemically combined, or merely form a mechanical mixture. According to one set of philosophers, the oxygen and azotic gases of the atmosphere are in chemical union, because their proportions are always found to be uniform and constant, which it is supposed could not be the case from the inequality of the causes acting in diminishing the quantity of oxygen gas, by the different processes of combustion and respiration, which are going on in the surface of the earth, if the component parts of the air

2164 In chemical union.

were not in chemical combination. The air of the atmosphere too, it is said, possesses properties very different from the artificial mixture of its component parts. The processes of combustion and respiration continue for a greater length of time in the latter, because it parts with a greater proportion of its oxygen, and for the same reason it is more diminished by nitrous gas. According to others, the air of the atmosphere is merely a mechanical mixture. This opinion is supported by Mr Dalton, in some ingenious speculations on the constitution of mixed gas, and particularly of the atmosphere. The principle on which Mr Dalton's hypothesis is founded is, that the particles of homogene-

2165 Mechanical mixture.

ous elastic fluids only mutually act upon each other, and that the particles of an elastic fluid of one kind are neither attracted nor repelled by the particles of an elastic fluid of a different kind, when they are mixed together. According to this hypothesis, therefore, the particles of the oxygen gas of the atmosphere mutually act on each other, or are only attracted and repelled by those of their own kind *.

2. Difference of opinion also prevails, whether the vapour of water, as it exists in the atmosphere, be merely a mechanical mixture, or chemically combined. The former opinion is also supported by Mr Dalton, upon the principle that all gases mixed with vapour, expand in a proportional degree to the elasticity of the vapour in that temperature.

* See *Manch. Mem.* vol. v.

Sect. III. *Of the Changes of the Atmosphere.*

2166 Temperature.

1. The changes which are produced in the atmosphere by heat and cold, are too obvious to escape observation; but it was not till the invention of the thermometer that these changes could be observed and marked with any degree of accuracy; and even after the invention and improvement of this instrument, it was long before any scientific application was made of the changes of the temperature which it indicated. The variable temperature of the same day, the great difference between midnight and midday, and the still greater difference between the heat of summer and the cold of winter, seem to hold out a number of insulated facts, without resemblance or connection, and incapable of being arranged under any general law. But more comprehensive views, and more extended observations, have not only shewn the possibility of establishing a general principle, but have enabled philosophers to arrange and classify phenomena which were otherwise seemingly unconnected.

2. The great source of heat is the sun. This is fully demonstrated by the increase of temperature being in proportion to the duration and greater or less obliquity of the sun's rays. It has been imagined that the earth is heated by central fires: but this opinion seems to be fully disproved, by observing that the temperature depends invariably on the absence or presence of the sun; that this temperature is diminished, at least to a certain extent, by going deeper into the earth; and that the cold is greatest in places most distant from the sun's rays; so that the temperature, which is most uniform within the tropics, diminishes, other things being equal, in proportion to the distance from the equator towards the poles.

3. In considering the difference of temperature which is observed in different places, it became an object with philosophers to discover some fixed points from which the whole amount of the changes for any given period could be ascertained. This was first thought of by Mayer, who proposed the method used by astronomers, of finding the mean of certain large periods, as for years and months; and he made the discovery by which the mean annual temperature of two latitudes being known, the mean annual temperature for every other degree of latitude may be also found. The application of this rule has been greatly improved and extended by Mr Kirwan, and upon this principle he constructed tables which exhibit the mean annual temperature for all degrees of latitude from the equator to the poles. These tables were constructed by finding from observation the temperature of what he calls a standard situation, that is, a place less liable to be affected by adventitious causes, but where the cause of temperature, or the communication of heat from the source, was most uniform and constant; and having discovered this standard situation, to compare the temperature of every other situation with it. The land, Mr Kirwan thought, owing to the operation of causes which occasion variations less easily appreciable, would not afford results sufficiently uniform. This situation, he then concluded, was to be sought for on the water; and that part of the ocean which he chose, was the immense tract of water which includes that part of the Atlantic lying between the 80° of north latitude, and the 45° of south latitude, extended westward as far as the gulf stream, and to within a few leagues of the coast of America; and all that part of the Pacific ocean reaching from the 45° north latitude to the 40° south latitude, and from the 20° to the 275° of longitude east from London. This includes the greater part of the surface of the globe. But for the method of constructing these tables, and for the tables themselves, we refer our readers to the article Meteorology, where they will be inserted.

The difference of temperature, it may be observed, within 10° of the equator and within the same distance from the poles, is very small; and the variation of temperature for different years within the same space, is also found to be very little: but, as the distance increases from the equator towards the poles, the difference of temperature is greater. In latitudes under 35°, it scarcely ever freezes, excepting in very elevated situations,

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Changes of the Atmosphere. tions, and it scarcely ever hails in latitudes higher than 60°. In places near the sea, between the latitudes of 35° and 60°, it generally thaws when the sun's altitude is 40°, and seldom begins to freeze till the meridian altitude be below 40°.

2170 Monthly. 4. Mr Kirwan has also constructed tables to mark the mean monthly temperature. In every latitude the mean temperature of the month of April approaches nearly to the mean annual heat of that latitude. And from this analogy he proceeded, supposing that the temperature is always regulated by the direct action of the solar rays, unconnected with the other circumstances which occasion considerable variations. Taking all these into the account, and endeavouring to reduce them to strict calculation, he found it impracticable; and therefore he constructed his tables, partly from principle, and partly from the best observations he could procure from sea journals, and similar sources of information. The mean monthly temperature in these tables also refers to the standard ocean.

2171 Coldest season. 5. The coldest weather also prevails about the middle of January in all climates, and the warmest in July;

2172 Warmest. but if it depended immediately on the sun's heat, the greatest heat should prevail in the latter end of June, and the greatest cold in the latter end of December. But as the earth requires a considerable time to absorb heat, so also it is some time before what has been absorbed is given out. All these observations and calculations refer to the surface of the ocean, which is less subject to variation from causes, the influence of which could not be ascertained with precision.

2173 The earth heats the atmosphere. 6. But as the earth is the chief source of heat in the atmosphere that surrounds it, the temperature must decrease with the elevation above the earth, and in the highest regions of the atmosphere, where the air is perfectly free from clouds, the greatest cold must prevail. Hence, in consequence of this elevation above the level of the ocean, the highest mountains, even under the equator, are covered with perpetual snow. Mr Bouguer found the cold on the top of Pinchinca in South America, immediately under the line, to vary from 7° to 9° below the freezing point every morning before sunrise, and hence at a certain height, which varies in almost every latitude, it constantly freezes at night in every season; although in some latitudes, in the warmer climates, it thaws next day. This height he calls the lower term of congelation, and he places it at the height of 15,577 feet between the tropics. In latitude 28° he thinks it should commence in summer at the height of 13,440 feet above the level of the sea. But at still greater heights it never freezes at all, because the vapours do not ascend so high. This height M. Bouguer denominates the *upper term of congelation;* and immediately under the equator he fixes at it 28,000 feet. As the weather is not subject to great variations under the equator, the height of both these terms is nearly constant; but in other latitudes this height is variable, both in summer and winter, in proportion to the degree of heat which prevails; and as there is a mean annual temperature peculiar to each latitude, so is there a mean height for each of these terms peculiar to each latitude. By taking the differences between the mean temperatures of every latitude, and the point of congelation, it will appear that whatever proportion the difference under the equator bears to the height of either of these terms, the same proportion will the difference peculiar to every other latitude bear to their height.

Changes of the Atmosphere.

2174 Land and water different in temperature. 7. But there is not the same uniformity or capacity in air, land, and water, for receiving and returning heat. Hence arise very considerable deviations in the temperature of places, as they are more or less connected with these bodies. Air, when it is perfectly transparent, receives very little heat from the rays of the sun as they pass through it. Air which is over seas or large tracts of water, is generally many degrees warmer in winter, and colder in summer, than air which is incumbent on land, because the land receives the heat much more readily than the water; in general the air participates of the temperature of those substances with which it is in contact. Land, if dry, receives heat rapidly, but transmits or conducts it to great depths very slowly; but water receives it more slowly, and diffuses it more rapidly. From experiments made by Dr Hales, it appears that the earth is much heated during the summer, but that this heat descends very slowly, great part of it being communicated to the air; that during winter, the earth gives out to the air the heat it had received during the summer, and that wet summers must be succeeded by cold winters, because the heat is carried off by the greater proportion of evaporation during the wet season. At the depth of 80 or 90 feet below the surface of the earth, the temperature is found to vary very little, and it generally approaches to the mean annual heat. The temperature of the cave at the observatory of Paris, which is 90 feet below the pavement, is about 53.5°. The greatest variation which has been observed, does not exceed half a degree, and this only happens in very cold years. Hence, too, the temperature of springs is almost uniformly the same throughout the year, and corresponds with the mean annual temperature of the climate.

8. There is not only a considerable difference in the temperature of land and water; but this variation also holds with regard to the land itself, according as it is elevated above the surface, and according to the nature of the surface, whether it is covered with vegetables, or only exhibits bare rocks, or sterile sand. A considerable deviation also is observed to take place in proportion to the distance from the ocean. All these causes, however, are greatly modified by the relative situation of places with regard to seas and oceans, mountainous regions, and extensive tracts of level country covered with thick forests, or improved by cultivation. These causes too are modified by particular winds, which produce considerable deviations, as they proceed from the ocean, from low, flat countries, or elevated regions. 2175 Temperature varies according to the height of places.

9. Another remarkable change to which the atmosphere is subject, is the difference of its weight or pressure. The air, like all other matter, is influenced by the law of gravitation, by which it presses with a certain force on the surface of the earth. It has been found that the measure of this force is nearly equal to 15lb. on every square inch. The variations which take place in the atmosphere are measured by the barometer. The mercury in the barometrical tube is supported by a column of air of an equal base, and since this 2176 Pressure.

this column of air and the mercury in the tube mutually balance each other, it follows that they are of the same weight, and therefore the barometer may be employed as a measure of the weight or pressure of the air.

2177 The same at the level of the sea.

10. The first general fact with regard to the weight of the atmosphere is, that in all places at the level of the sea, the barometer stands nearly at the same point, and the mean height is about 30 inches. But as the elevation is increased, the barometer sinks, because then there is a shorter column of air to support it, which is therefore lighter. In no place does the weight of the air continue always the same. It is subject to daily variations, which are greater or smaller according to the latitude of the place, or the influence of particular causes. In all places within the tropics, the variations of the barometer have been observed to be smallest, and in elevated situations the variations are considerably smaller than on the level of the sea. The deviations of the mercury from its mean annual altitude are more frequent and extensive in the neighbourhood of the poles than in that of the equator, and they are greater and more frequent without the tropics in winter than in summer.

2178 Causes.

11. The causes which have been proposed to account for these variations, are changes of temperature, velocity of winds, and the agency of vapours. The air is subject to the action of heat, by which it is rarefied or condensed, according to the increase or diminutions of temperature. Dense air is heavier than that which is rarer; but if the masses of air remain the same, the weights must be the same, and consequently the heights to which they elevate the mercury will be also equal. If, therefore, a change of temperature occasion a variation of the barometer, it must be by increasing or diminishing the mass of the atmosphere. But it appears from observation, that a variation of the mass of the atmosphere is not a necessary consequence of a change of temperature, for the mercury is often at the same height at different seasons, and at different places at the same time, when the difference of temperature is very great. But even when the mercury changes with the temperature, this variation is often directly contrary to what it ought to be. The barometer has sometimes risen with an increase of temperature, instead of falling by the rarefaction of the air. The changes of temperature are very inconsiderable in the higher regions of the atmosphere, so that it would appear that the barometer can be little affected by changes of temperature. Mr Kirwan has endeavoured to show, that the influence of winds, or a greater or smaller quantity of vapours existing in the atmosphere, can have little effect in elevating or depressing the barometer. According to Mr Kirwan the variations of the barometer, or the difference of pressure of the air of the atmosphere, can only be accounted for from an accumulation of air over those places in which the mercury exceeds its mean height, and from the diminution or subtraction of the natural quantity of air, over those regions in which the mercury falls below its mean height.

2179 Winds.

12. The winds constitute another remarkable change in the atmosphere. The winds in general are subject to great irregularity; but in some parts of the world they are pretty regular and uniform. Between the 30° of N. Lat. and the 30° S. Lat. the wind, when it is not counteracted by local causes, continues to blow constantly from the same points. On the north side of the equator, that is from the equator to the 30° of N. Lat. it blows from the north-east, and from the equator to the 30° S. Lat. it blows from the south-east. This is called the *trade-wind*. Immediately under the equator the wind is observed to be pretty nearly from the east; that is, about the place where the two currents meet, the one from the north-east, and the other from the south-east; but receding from the equator, the direction of it deviates more and more from the easterly point, till it reaches the intermediate point between north and south, and then constitutes the north-east trade-wind on the north side, and the south-east trade-wind on the south side of the equator. Were the causes which produce the constancy and uniformity of the trade-winds uninfluenced by others, these winds would prevail without variation within the limits or near the boundaries of the torrid zone; but they are greatly counteracted, and subject to great variations, from the unequal influence of land and water, in rarefying or condensing the air.

2180 Trade-winds.

13. As the air of the atmosphere is a fluid body, and therefore subject to all the laws of fluids, if any part be removed, the remainder rushes in to restore the equilibrium, and hence an agitation or wind is produced, as air is capable of indefinite dilatation and compression. The denser air being heavier, must sink, and the rarefied air ascends, when air of unequal densities is mixed together. The greatest degree of mean temperature is within the torrid zone, in consequence of the sun's rays being more perpendicular, and acting with greater force on the earth's surface. The air therefore round the equator undergoes the greatest degree of rarefaction, and this extends to the north and south, in proportion to its distance from the equator, or rather its distance from the sun's place. Thus, when the sun is perpendicular to the equator, or middle part of the torrid zone, the air in that place being most rarefied, becomes lighter, ascends, and its place is filled with the colder air from the north and south. And thus, as long as the sun's influence continues to rarefy the air, would a north and south wind blow to that quarter where the rarefied air, being rendered lighter, had ascended. But as the earth has a diurnal motion on its axis from west to east; those parts of the earth's surface to the westward are first heated, and consequently the incumbent air is first rarefied. The denser air from the east must therefore rush in to restore the equilibrium. Thus, there is produced an easterly wind. But there is another current of air from the north and south: the two currents coming from the north-east trade-wind on the north side of the equator, and the south-east trade-wind on the south side. Such are the causes which are generally supposed to produce the regular trade-winds.

2181 Deviations.

14. These winds are regular and uniform in open oceans, such as the Pacific or Atlantic, but they are subject to considerable variation from the unequal rarefaction of the air over land and water. Thus, islands situated within the very course of the trade-winds have regular land and sea breezes, which are often directly contrary to the trade-wind. In consequence of the air incumbent on the land being more rarefied

Waters rarefied during the day, the wind blows from the sea, constituting the sea breeze; but the air over the sea being warmer during the night, the wind blows from the land, from which it is called the *land wind*. To a similar cause is owing another remarkable deviation from the uniformity of the trade-winds, which is observed in the great Indian ocean. Here the winds

2182 Monsoons. called *monsoons* blow from one quarter during six months of the year, and from an opposite direction during the remaining six months. While the sun is in the northern tropic, the air over the extensive Indian continent is greatly rarefied; and, in consequence of this rarefaction, the denser air from the ocean rushes in to restore the equilibrium, and hence the current of the air or wind continues during this period of the year, constituting the south-east monsoon. But when the sun passes the equator to the southward, the air over the southern hemisphere is more influenced by his rays, and therefore more rarefied. The denser air then rushes in from the north, and thus produces the north-west monsoon, which blows during our winter, when the sun is in the southern tropic.

2183 Part of the air supposed to be abstracted. 15. But even a superficial observation will shew, that the phenomena of the winds cannot be satisfactorily accounted for, merely upon the general principle of the unequal rarefaction of the air over land and water. Thus sudden changes of wind often happen in particular places, which are extremely limited, and altogether unconnected with the difference of density of the air, over land and water. The hurricane has swept the land, whose effects have not been felt on the neighbouring ocean, and the storm frequently agitates the ocean without reaching the land. These and other phenomena of the winds, equally inexplicable, have been ascribed by naturalists to the abstraction or sudden destruction of a certain quantity of the air of the atmosphere in particular places. But for the full discussion of this subject, and the other phenomena of the atmosphere, we must refer our readers to METEOROLOGY.

CHAP. XVI. OF WATERS.

1. WE have already treated of the component parts of water, of the discovery of its composition, and of its most remarkable properties, and especially those which it exhibits by a change of constitution, as in the solid state, or that of ice, in the liquid state, and in the state of vapour. In these views water was considered as perfectly pure; but this is rarely or never the case, as

2184 Water not found pure. it is found in nature. Rain water, which is the purest, is not entirely free from impregnation, even when collected before it falls to the earth. It is slightly contaminated with certain substances, which it held in solution, as it existed in the clouds, or with which it combined in its passage through the atmosphere. But waters, as they flow on the surface of the earth, or are carried through the strata under the surface, must dissolve those soluble substances with which they come in contact. It is the object of our present investigation to examine the waters as they are found in nature, and the substances with which they are impregnated.

2. The properties of pure water are almost obvious to the senses, so that few substances, at least in any quantity, can be dissolved in water, without being easily recognized. Thus, the saline, nauseous taste of sea-water, the fetid odour, or the astringent taste of mineral springs, must readily be distinguished by these striking qualities. But although it is probable that the remarkable diversity of waters, from their obvious properties, could not fail to be early observed by mankind, it is only by chemical investigation that the nature of the substances to which they owe these properties, can be ascertained; and indeed we are indebted to the discoveries and improvements of modern chemistry for the knowledge which we possess of the nature and proportion of the ingredients which enter into the composition, either of sea water or mineral springs. 2185 Can only be examined by chemical agents.

This subject has been particularly investigated by Bergman, Westrumb, Black, Fourcroy, Klaproth, and Kirwan. In the three following sections we propose to treat, 1. Of sea-water; 2. Of mineral waters; 3. Of the method of analyzing them.

SECT. I. *Sea-water*.

1. The saline taste of sea-water, we have already observed, could not fail to make it be distinguished from pure water; and this taste, it is well known, is chiefly derived from common salt which it holds in solution. Sea-water is also distinguished by a nauseous bitter taste, which is ascribed to the animal and vegetable matters which are floating in it. This taste has been considered as in some measure foreign to it; for it is only found in the water on the surface of the ocean or near the shores. Sea-water, taken up at considerable depths, contains only saline matters. The specific gravity of sea-water varies from 1.0269 to 1.0285. Its greater density is owing to the salts which are dissolved in it; and to this impregnation also it is owing, that it is not frozen till the temperature is reduced nearly to 28°. 2186 Properties.

2. The salts which are chiefly found in sea-water, are muriate of soda, or common salt, muriate of magnesia, sulphate of magnesia, sulphate of lime and soda. The quantity of saline ingredients in the waters of the ocean varies from $\frac{1}{22}$ to $\frac{1}{32}$ part. Mr Kirwan makes the average quantity about $\frac{1}{28}$ of its whole weight. The quantity of saline contents of water, taken up by Lord Mulgrave at the back of Yarmouth sands, in latitude 53°, amounted nearly to $\frac{1}{31}$; while Bergman found the water taken up in the latitude of the Canaries to contain about $\frac{1}{22}$ of its weight of saline matter. These quantities, however, vary, even in the same latitude, during rainy and dry seasons, near the land, or the mouths of great rivers. The difference of latitude does not seem to make any considerable difference in the proportion of saline matter. In latitude 80° north, 60 fathoms under ice, sea-water taken up by Lord Mulgrave, yielded about $\frac{1}{29}$; in latitude 74° nearly the same; and in latitude 60°, $\frac{1}{9}$. Pages obtained four per cent. from water taken up in latitude 81°, and the same quantity of saline matter from water taken up in latitude 45° and 39° north. In southern latitudes, the proportion was still greater; he found it to contain the following proportions: 2187 Salts. 2188 Proportion varies.

Sea-water. Lat. 49° 50′ S. 4.1666 per cent. of saline matter.

2189 In southern altitudes.

Lat. 49° 50′ S.	4.1666 per cent. of saline matter.
46° 00′	4.5
40° 30′	4
28° 54′	4
20° 00′	3.9
1° 16′	3.5

In the Mediterranean the proportion is said to be still greater; but the Euxine and Caspian seas are found to be less salt than the ocean. This also is the case with the Baltic. If the saline matters of the waters of the ocean did not consist of different kinds, the proportion of salts which it contains might be ascertained by the specific gravity. In the following table the specific gravity of sea-water taken up in different latitudes has been determined by Mr Bladh. The temperatures are reduced by Mr Kirwan to 62° of Fahrenheit; and the longitude is reckoned by Bladh from Teneriffe.

2190 Specific gravity in different latitudes.

Lat.	Long.	Sp. Gr. at 62°
N.	E.	
59° 39′	8° 48′	1,0272
57° 18′	18° 48′	1,0269
	W.	
57° 1′	1° 22′	1,0272
54° 00′	4° 45′	1,0271
44° 32′	2° 04′	1,0276
	E.	
44° 07′	1° 00′	1,0276
40° 41′	0° 30′	1,0276
34° 40′	1° 18′	1,0280
29° 50′	0° 00′	1,0281
	W.	
24° 00′	2° 32′	1,0284
18° 28′	3° 24′	1,0281
16° 36′	3° 37′	1,0277
14° 56′	3° 46′	1,0275
10° 30′	3° 49′	1,0272
5° 50′	3° 28′	1,0274
2° 20′	3° 26′	1,0271
1° 25′	3° 30′	1,0273
S.		
0° 16′	3° 40′	1,0277
5° 10′	6° 00′	1,0277
10° 00′	6° 05′	1,0285
14° 40′	7° 00′	1,0284
20° 06′	5° 30′	1,0285
25° 45′	2° 22′	1,0281
	E.	
30° 25′	7° 12′	1,0279
37° 37′	68° 13′	1,0276

From this table it appears that the proportion of saline matter is greatest near the tropics; and the smaller quantity near the equator is ascribed to the great quantity of rain that usually falls on that part of the globe.

2191 In the Baltic. 3. The experiments of Mr Wilcke show that the proportion of saline matter in the Baltic is less than that of the ocean; and that it is salter during the prevalence of a westerly wind, by which the water is driven from the ocean, than during an easterly wind. The following is the specific gravity of the waters of the Baltic, taken during the prevalence of different winds, and reduced by Mr Kirwan to the temperature of 62°. Mineral Waters.

Wind.	Specific gravity.
East,	1.0039
West,	1.0067
West, a storm,	1.0118
North-west,	1.0098

From this it appears, that the proportion of saline matters in the Baltic is increased by the influx of water from the ocean, and is considerably influenced during a storm, when the wind blows from that quarter.

4. Dr Watson has estimated the quantity of salt in water of different specific gravities. It is also reduced to the temperature of 62° by Mr Kirwan, as in the following table.

Salt.	Specific Gravity.
$\frac{1}{24}$	1.0285
$\frac{1}{25}$	1.0275
$\frac{1}{26}$	1.0270
$\frac{1}{27}$	1.0267
$\frac{1}{28}$	1.0250
$\frac{1}{36}$	1.0233
$\frac{1}{39}$	1.0185
$\frac{1}{44}$	1.0033
$\frac{1}{38}$	1.0105
$\frac{1}{102}$	1.0040
$\frac{1}{162}$	1.0023

These experiments were made with solutions of common salt, which was not perfectly pure, and therefore it is allowed that they may correspond pretty nearly with the proportions of saline matter in sea-water of the same specific gravities.

2192 Proportions. 5. The proportions of the different salts, in an analysis by Bergman, are the following:

Muriate of soda,	30.311
Muriate of magnesia,	6.222
Sulphate of lime,	1.000
	38.133

In 1000 parts of water taken up near Dieppe, Lavoisier found the following salts:

Muriate of soda,	1375
——— of lime and magnesia,	256
——— of magnesia, -	156
Lime, - - -	87
Sulphate of soda and magnesia,	84
	1958

Sect. II. *Of Mineral Waters.*

2193 Character. 1. The name of *mineral waters* has been given to those waters which are distinguished by the smell, taste, or colour, from pure water, the obvious properties of which are, transparency and insipidity. These peculiarities of taste, smell, and other properties, are owing

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Mineral Waters. owing to the impregnation of certain mineral substances which they have acquired in their passage through the soil or strata of the earth. The effects which such waters produce on the animal economy, early attracted the attention of mankind, and led to their application as remedies in the cure of diseases. It was long indeed before any other distinction of mineral waters was made,

2194 Classes. except what was indicated by their sensible qualities, and their effects on the human constitution. From these properties mineral waters have been divided into four classes: 1. Acidulous or gaseous water; 2. Saline waters; 3. Sulphureous or hepatic waters; and, 4. Chalybeate waters.

2195 Acidulous. (1.) Acidulous waters are distinguished by their penetrating acid taste, the facility with which they boil; by sparkling when they are poured into a glass; and by the emission of bubbles of air, by agitation. The acid with which they are impregnated is generally the carbonic. These waters redden the tincture of turnsole, and precipitate lime-water.

2196 Saline. (2.) The second class, or the saline waters, are sufficiently characterized by their taste, which varies according to the nature of the salt with which they are impregnated.

2197 Sulphureous. (3.) The sulphureous or hepatic waters are at once recognized by their fetid odour, and by blackening some metallic substances, as lead and silver. Some of these waters are impregnated with sulphurated hydrogen gas, while in others it is combined with lime, or

2198 Chalybeate. with an alkali.

(4.) The fourth class, or the chalybeate waters, are distinguished by an astringent taste. With the prussiate of lime they give a blue colour, or a black with the infusion of nut-galls. This property is owing to a portion of iron which is held in solution, either by carbonic or sulphuric acid. Sometimes carbonic acid is in excess, and then the water has a penetrating slightly acid taste.

2199 Substances found in mineral waters. 2. The substances which have been found in mineral waters, as they have been enumerated by Mr Kirwan, belong either to the class of gaseous bodies, acids, alkalies, earths, or salts.

2200 Gases. 3. Oxygen gas was first discovered in waters by Scheele. It is generally in small proportion, and does not exist in waters with sulphurated hydrogen gas, or iron, because it is incompatible with these substances. Azotic gas has been found in the waters of Buxton, Harrowgate, and Lemington Priors. Common air was first discovered in mineral waters by Mr Boyle; the quantity scarcely exceeds $\frac{1}{27}$ of the bulk of the water. Fixed air or carbonic acid was first discovered in Pyrmont waters by Dr Brownrig. The proportions are very variable; but there are few mineral waters which are entirely free from it. A hundred cubic inches of most waters, contain from 6 to 40 of carbonic acid gas. A hundred cubic inches of Pyrmont waters contain, according to Bergman, 95 of fixed air; according to Dr Higgins, 160, and according to Westrumb, 187 cubic inches. Sulphurated hydrogen gas is the principal ingredient in sulphureous or hepatic water. Carbonated hydrogen gas is said to have been detected in some mineral waters in Italy.

2201 Acids. 4. The next class of substances found in mineral waters, are the acids. Sulphuric acid has never been found, except in combination with other substances, forming salts in mineral waters. With some of these salts it exists in excess. Sulphurous acid has been detected in many of the hot mineral springs in Italy, in the vicinity of volcanoes. Muriatic acid has only been found in mineral waters, in combination with other substances. Nitric acid is said also to exist in mineral waters in Hungary, in a combined state. Boracic acid has been found in a separate state, in some lakes in Italy.

5. The alkalies are rarely found combined in mineral waters. In the state of carbonate they are frequent. Soda only was detected in the hot mineral springs of Iceland, by Dr Black. 2202 Alkalies.

6. Few of the earths, except in combination, have been found in mineral waters. Lime, it is said, exists uncombined in some waters; but Bergman observes that it must be in hot and not in cold mineral waters. Dr Black detected silica in the waters of Geyser and Rykum in Iceland. It has been found in those of Carlsbad by Klaproth, and it has not unfrequently been observed by others in different mineral waters. 2203 Earths.

7. The salts which have been found in mineral waters, are sulphates, nitrates, muriates, and carbonates. 2204 Salts.

Sulphates.—Sulphate of soda is frequently found in the waters of springs and lakes. Sulphate of ammonia has been found in mineral waters, in the neighbourhood of volcanoes. Sulphate of lime is one of the most common substances in most springs. Sulphate of magnesia, or Epsom salt, is not unusual in many mineral springs. Sulphate of alumina is rarely found in mineral waters; it is more commonly found in the state of triple salt or alum. Sulphate of iron is frequent in the springs and lakes of volcanic countries. It has also been found in other places. Sulphate of copper has only been detected in the waters which issue from copper mines.

Nitrates.—Nitrate of potash or nitre is rarely found in mineral waters. It has, however, been detected in several springs in Hungary; some traces of it have been observed in wells in Berlin, and in some salt springs in Germany. Nitrate of lime has been detected in springs in the sandy deserts of Arabia. Nitrate of magnesia is said also to have been found in mineral waters.

Muriates.—Muriate of potash is but rarely found in mineral waters. It has been detected in the springs of Uleaburg in Sweden. Muriate of soda or common salt exists in almost all waters, as well as in the ocean. Muriate of ammonia is not very frequent in waters; it has been detected, however, in some mineral lakes in Italy, and also in Siberia. Muriate of barytes is very rare, but according to Bergman, it has been found in some mineral waters. Muriate of lime is very generally found in mineral springs. Muriate of magnesia is very common in mineral waters. Muriate of alumina has been detected in some mineral waters by Dr Withering. Muriate of manganese was found by Bergman in some mineral waters in Sweden, and it has lately been discovered, in small proportion, in the waters of Lemington Priors, by Mr Lambe.

Carbonates.—Carbonate of potash, it is said, has been found in some mineral waters. Carbonate of soda exists very frequently in the waters of many springs and lakes. Carbonate of ammonia has been found in the

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the waters of Rathbone Place in London, by Mr Cavendish, and in some waters in France. Carbonate of lime is commonly found in almost all waters, and it is held in solution by an excess of carbonic acid. Carbonate of magnesia very frequently exists in mineral waters. When it is fully saturated with carbonic acid, it is soluble in water, without any excess of acid. Carbonate of alumina is said to have been found in the waters of Avor in Anjou, in France. Carbonate of iron is frequently found in mineral waters. It is to this that chalybeate waters owe their distinguishing properties.

8. *Borax*, or the subborate of soda, is found in some lakes in Thibet and Persia.

2205 Hydro-sulphurets. 9. *Sulphurated alkali* and *sulphurated lime*, or the hydro-sulphurets of soda and of lime, have been found in mineral waters. It is to these substances that hepatic or sulphureous waters owe their distinctive properties.

2206 Bitumen. 10. Bituminous substances have also been discovered in some mineral waters. Sometimes they have been found combined with an alkali. Waters also sometimes contain vegetable and animal matters; but these are not, properly speaking, to be considered as ingredients in these waters.

SECT. III. *Of the* ANALYSIS *of* MINERAL WATERS.

2207 Physical properties. In the analysis of mineral waters, the first thing to be attended to is to ascertain the temperature and situation of the springs from which they are obtained. The sensible properties are then to be examined, such as colour, transparency, smell, and taste. Of the physical properties of mineral waters, one of the most important, and the first to be ascertained, is the specific gravity. By this means, although not with perfect accuracy, the quantity of saline ingredients may be known; but it is only by means of chemical operations that the nature of the substances with which mineral waters are impregnated can be determined; and by obtaining these substances in a separate state, or forming new combinations, that their quantity or proportions can be accurately ascertained. In the analysis of mineral waters, therefore, after discovering their physical properties, the object of the chemist is first to detect the nature of the substances, and then the quantity or proportion of these substances which they contain. In both we shall follow the method pointed out by Mr Kirwan, in his Essay on the Analysis of Mineral Waters.

I. Of the Method of Discovering the Substances in Mineral Waters.

1. The nature of the component parts of mineral waters is discovered by the addition of certain substances which produce changes of different kinds. The substances employed for this purpose are known in chemistry by the name of *tests* or re-agents, because they act upon the substances with which the waters are impregnated, by decomposing them, and forming new combinations.

2208 Tests.

2209 Gaseous bodies. 2. Gaseous substances are easily detected, either by their escaping in the form of bubbles when the water is exposed to the air, or, if they are more permanently held in solution, by boiling a quantity of the water in a retort, and receiving the gas over water or mercury. The nature of the gas, thus collected, may then be examined by the usual tests for gases.

3. Carbonic acid is detected by the infusion of litmus, not, however, when the acid is saturated with any base, unless the acid be in excess. Saturated lime-water may also be employed as a test for carbonic acid. One cubic inch of carbonic acid gas in 7000 grains of water, may be discovered by this test. These effects are not produced by carbonic acid, after the water has been boiled. 2210 Carbonic acid.

4. The infusion of litmus, or paper tinged with it, is also employed as a test for mineral acids existing in waters. A red colour is produced, either when the acid is combined, or united with a base in excess. In this case the redness is permanent, and is not destroyed by boiling. 2211 Mineral acids.

5. Sulphurated hydrogen gas reddens the infusion of litmus, and blackens silver or lead, or the solutions of these salts. It is also easily recognized by its peculiar odour. 2212 Sulphurated hydrogen.

6. Carbonated hydrogen gas burns with common air without explosion; is not absorbed by lime-water, and has no peculiar smell. 2213 And carbonated hydrogen gas.

7. The fixed alkalies produce a reddish-brown colour with the infusion of turmeric. The same change takes place with the alkaline and earthy carbonates. The infusion of Brazil wood assumes a blue colour. Paper tinged blue with litmus, and reddened with vinegar, may be also employed as a test for alkalies; and by all the alkaline and earthy carbonates, the original blue colour is restored. The muriate of magnesia is precipitated only by the fixed alkalies. Potash forms with nitric acid a prismatic salt; with acetic acid a salt which does not deliquesce, and with sulphuric acid, a salt which effloresces. Ammonia, when in considerable quantity, is detected by the smell. If the proportion be small, it may be discovered by distilling part of the water with a gentle heat. 2214 Fixed alkalies.

8. The carbonates of the earths and the metals are precipitated by exposure to the air, or by boiling and evaporation. Carbonates of lime, of alumina, and of iron, are precipitated by boiling for a quarter of an hour. Carbonate of magnesia is only partially precipitated by the same process. 2215 Carbonates.

9. Iron, either in the state of carbonate, or combined with some other acid, is detected by tincture of galls, which produces a black or purple colour. A very minute portion of iron is detected by this test. Three grains of crystallized sulphate of iron dissolved in five pints of water, strike a purple colour in five minutes, with a single drop of this tincture. With this test the colour assumes different shades, according to the nature of the other substances which are in combination. If the water contains a carbonate of an alkali or an earthy salt, the colour is violet; it is dark purple with other alkaline salts; with sulphate of lime it is first whitish, and afterwards black; and with sulphurated hydrogen gas, the colour is purplish red. The latter, Mr Kirwan suspects, is occasioned by manganese. Iron, dissolved by carbonate of ammonia, is at first whitened, and afterwards blackened by tincture of galls. In the caustic fixed alkalies the precipitate is at first crimson red, but afterwards becomes black. Prussian alkali is a sensible test of iron; the 2216 Iron.

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the precipitate is blue: but if an alkali exists in the water, it prevents a small portion of iron from striking a blue colour with this test, until it be saturated with an acid.

2217 Sulphuric acid. 10. Sulphuric acid is detected by muriate, nitrate, or acetate of barytes, nitrate or acetate of lead, nitrate of mercury, nitrate, muriate, or acetate of strontites, and nitrate, muriate, or acetate of lime.

2218 Muriatic. 11. Muriatic acid is readily detected by nitrate of silver. It forms a white precipitate, or a cloud in the water. If there are any carbonates of alkalies or earths in the water, they must be previously saturated with nitric acid. Sulphuric acid, or the sulphates, must be precipitated by nitrate or acetate of barytes. Acetate and sulphate of silver may be also employed for the same purpose.

2219 Boracic. 12. Boracic acid, when it is uncombined, is detected by acetate of lead; but the alkaline and earthy carbonates must be previously saturated with acetic acid. The sulphates must be decomposed by means of acetate of strontites, and the muriates by acetate of silver.

2220 Lime. 13. Lime is readily detected with oxalic acid; but if the water contains any mineral acid, it must be previously saturated with an alkali. Barytes, if any exists in the water, must be precipitated by sulphuric acid. Magnesia is precipitated very slowly with oxalic acid, by which it is readily distinguished from lime.

2221 Barytes. 14. Barytes is detected by diluted sulphuric acid, with which it instantly forms an insoluble white precipitate.

2222 Magnesia and alumina. 15. Magnesia and alumina are both precipitated by means of pure ammonia and lime water; but it is necessary that carbonic acid, if any exists in the water, be previously separated by means of a fixed alkali, and by boiling. If lime-water is employed, the sulphuric acid must be first precipitated with nitrate of barytes. If the two earths are precipitated together, the alumina may be separated from the magnesia, by boiling them with pure potash, which combines with the alumina.

2223 Silica. 16. Siliceous earth may be discovered by evaporating a large quantity of water nearly to dryness, and then by re-dissolving the precipitate in nitric or sulphuric acid, and afterwards evaporating to dryness. The dry mass, re-dissolved in water and filtered, leaves the silica on the filter.

2224 Mode of estimating the proportions. The proportions in which these different acids and salifiable bases are contained in a mineral water, are known by considering what is the proportion of them contained in any precipitate which they occasion.

2225 Important views of Dr Murray. Till lately it was a great object with chemists to ascertain the mode in which these substances existed in the water. It was conceived that every acid was combined in a definite manner to form either a binary or a ternary compound with one or more of the bases present; much pains were bestowed, by frequent evaporation and cooling of the water, to find out what salts it would afford, and it was conceived that these were the salts contained in the water in question. It now appears, however, by the researches of the late Dr Murray, which commenced with an analysis of the water of Dunblane, that these operations afford no information, and that the kind of binary salts which make their appearance depends on the circumstances of the evaporation. The former view proceeded on the presumption, that the least soluble combinations of the ingredients are those existing in solution, for these are compounds which appear in the form of crystals. This author conceives it most probable, that the most soluble binary compounds are those contained in the water, and that a water from which we obtain muriate of soda and sulphate of lime consists in reality of sulphate of soda and muriate of lime. By this consideration he explains the well known medicinal activity of waters, which afford, on evaporation, none but very inert combinations. It is to muriate of lime that he ascribes the active properties of the waters of Bath and others. Perhaps it is most probable, on the whole, that in mixed chemical solutions the acids and the bases are in universal cotemporaneous combination. Whatever be in this respect the case, all the information to be derived from analysis is obtained by discovering the different acids, salifiable bases, and other simpler ingredients which they contain.

31. Alkalies combined with bitumen are sometimes found in mineral waters. These mineral soaps, or bituminated alkalies, as they are called by Mr Kirwan, form a coagulum with the acids. This coagulum is soluble in the alkalies. 2226 Bitumen.

32. Extractive matter, which is sometimes found in mineral waters, is discovered by means of nitrate of silver, with which it forms a brown precipitate; but the water containing it must be freed from sulphuric and muriatic acids with nitrate of lead. Three grains of the precipitate, according to Westrumb, indicate one grain of extractive matter. 2227 Extractive matter.

33. Animal extractive matter gives a very disagreeable taste and smell to water. It is soluble in alcohol. 2228 Animal.

Chap. XVII. Of MINERALS.

In following out the arrangement which we have laid down at the beginning of this treatise, we should now enter upon the consideration of mineral substances. To preserve the chemical investigation of the different departments of nature unbroken, we proposed to employ this chapter in a general view of the characters of mineral bodies, of their composition and methods of analysis; but as this article has been unavoidably extended to so great a length, we shall reserve the whole to the article Mineralogy, where they will be fully detailed.

Chap. XVIII. Of VEGETABLES.

1. Natural bodies may be properly divided into organized and inorganized, each of which exhibit characters sufficiently discriminative. The substances included under the 17 preceding chapters, belong to the latter class. Organized substances are vegetables and animals, which are to be treated of in this and the following chapters. The distinction between these two classes of bodies, although in some cases it is less obvious, in general is easily recognized. The most perfect forms of inorganized matter afford no marks of resemblance to the varied and complicated structure of a plant or an animal. In the mode of formation, or the growth and increase of the individuals of these two classes, there is the most striking diversity, which exhibits plain and certain characters of distinction. In the one class the growth or increase takes place by the mere aggregation of the particles of matter already prepared, and according to the laws of affinity between the 2229 Division of natural bodies.

the particles; and no new properties exist in the aggregate, which did not exist in the minutest particles of which it is composed. The other class of bodies, comprehending vegetables and animals, exhibits a very different process. The substances which enter into their composition are received into tubes or vessels, are conveyed by them to every individual part of the vegetable or animal, are subjected to peculiar changes, and assume new forms, possessing properties and qualities which could not be previously detected in the simple elements, by any chemical or mechanical operation. This is indeed the essential characteristic of vegetables and animals. The particles which compose a crystal, formed by the evaporation of water, were held in solution by the water, and invariably and uniformly arranged according to certain laws; but the almost infinite variety of substances which compose vegetables and animals, are not to be found in the materials which are necessary to promote their growth and health; neither in the water, the earth, the air, the heat, nor the light, all which contribute their share to the same end. These undergo new changes, and enter in new combinations, none of which existed in the simple elements, and none of which can be effected by any mechanical or chemical process. Indeed the laws which regulate vegetable and animal operations, seem to be totally different from the established laws of chemical action. Hence, from observing this difference of action, the existence and influence of a different principle have been inferred in animals and vegetables. This has been called the *vital principle*, or the principle of life, because by its influence the varied and complicated phenomena of animals and vegetables are exhibited, which cannot be accounted for on mechanical or chemical principles. It is by the influence of this principle that the animal or vegetable seems to possess the remarkable power of resisting or counteracting to a certain degree the effects of chemical or mechanical agents which may prove injurious to its existence; the power of regulating and selecting what is beneficial and necessary, of supplying what is deficient, and of curtailing what is redundant. Organized substances admit of a natural division into vegetables and animals. The bodies included under each of these divisions have some points of resemblance; but in general are sufficiently characterized and distinguished from each other, by their form, structure, power of motion, component parts, and peculiarities of habits. The first of these divisions, namely vegetables, forms the subject of the present chapter.

2230 Structure of plants. 2. A vegetable is composed of a root, stem, leaves, flowers, fruits, and seeds; and when all these different parts are fully developed, the vegetable is said to be *perfect*. When any are deficient, or at least less obvious, the vegetable is said to be *imperfect*.

2231 Root. The root is that part of the plant which is concealed in the earth, and which serves to convey nourishment to the whole plant. The stem which commences at the termination of the root, supports all the other parts of the plant. When the stem is large and solid, as in trees, it is denominated the *trunk*, which is divided

2232 Bark. into the wood and the bark. The bark constitutes the outermost part of the tree, and covers the whole of the plant, from the extremity of the roots to the termination of the branches. The bark is composed of three parts, namely, the epidermis, the parenchyma, and cortical layers. The epidermis, which is a thin transparent membrane, forming the external covering of the bark, is composed of fibres crossing each other. When the epidermis is removed, it is reproduced. The parenchyma, which is immediately below the epidermis, is of a dark green colour, composed of fibres crossing each other in all directions, and is succulent and tender. The cortical layers, which constitute the interior part of the bark, are composed of thin membranes, and increase in number with the age of the plant.

2233 Wood. The wood immediately under the bark is composed of concentric layers, which increase with the age of the plant, and may be separated into thinner layers, which are composed of longitudinal fibres. The wood next the bark, which is softer and whiter, is called the *alburnum*. The interior part of the trunk is browner and harder, and is denominated the *perfect wood*.

2234 Pith. In the middle of the stem is the pith, which is a soft spongy substance, composed of cells, or *utriculi*, as they are called. In old wood, this part entirely disappears, and its place is occupied by the perfect wood. The leaves are composed of fibres arranged in the form of net-work, which proceed from the stem, and footstalks by which they are attached to the branches. These fibres form two layers in each leaf, which are destined to perform different functions. The leaves are covered with the epidermis, which is common to the whole of the plant. Each surface of a leaf has a great number of pores and glands, which absorb or emit elastic fluids.

2235 Flowers and fruits. Flowers are composed of different parts. The *calyx* or cup is formed by the extension of the epidermis; the *corolla* is a continuation of the bark, and the stamina and pistilla, the internal parts of fructification, are composed of the woody fibres and pith of the plant. Fruits are usually composed of a pulpy, parenchymatous substance, containing a great number of *utriculi* or vesicles, and traversed by numerous vessels. Seeds are constituted of the same utricular texture, in the vesicles of which is deposited a pulverulent or mucous substance. These cells have a communication with the plant by means of vessels, and by these is conveyed the necessary nourishment during germination.

2236 Vessels. Plants contain different orders of vessels, which are distinguished from each other by their course, situation, and uses. Lymphatic vessels serve for the circulation of the sap. They are chiefly situated in the woody part of the plant. The peculiar vessels, which generally contain thick or coloured fluids, are placed immediately under the bark; they are smaller in number than the sap-vessels, and have their interstices filled up with utriculi or cells, with which they form a communication. Some of these proper vessels are situated between the epidermis and the bark, which are readily detected in the spring. Some are situated in the interior part of the bark, forming oval rings, and filled with the peculiar juices of the plant. Another set of proper vessels is placed in the alburnum, nearer the centre of the stock or trunk, and sometimes in the perfect wood. The utriculi or cells constitute another set of vessels, which seem to resemble a flexible tube, slightly interrupted with ligatures at nearly equal distances, but still preserving a free communication through

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Functions of Vegetables. through its whole length. They vary in form, colour, and magnitude, in different vegetables, and exist in the roots, the bark, leaves, and flowers. The tracheæ or spiral vessels, which are readily detected in succulent plants, appear in the form of fine threads, and may be drawn out to a considerable length without breaking. These vessels are very numerous in all plants, especially under the bark, where they form a kind of ring, and are disposed in distinct bundles, in trees, shrubs, and stalks of herbaceous plants.

After these preliminary observations on the characters of organized substances, and the general structure of plants, we now proceed to give a short view of the functions, decomposition, and component parts of vegetables. These shall form the subject of the three following sections.

Sect. I. *Of the Functions of Vegetables.*

I. Of Germination.

2237 Temperature. 1. When the perfect seeds of a vegetable are placed in certain circumstances, they produce plants exactly similar to those from which they originated. The requisite circumstances for the germination of seeds are, heat, air, and moisture. It is well known that no vegetation goes on when the temperature of the air is at the freezing point, and very little till it rises a considerable number of degrees above it. The seeds of different plants, it is observed, require different degrees of heat for their germination, and hence the various seasons and climates in which different plants and seeds are found to vegetate.

2238 Air. 2. But whatever the temperature may be, no seeds germinate, unless they are exposed to the action of the air. It is the oxygen of the air which is necessary for the production of this change; for when it is entirely excluded no change can take place except that of decomposition, and when it is in greater quantity, vegetation is more rapid and more vigorous.

2239 Moisture. 3. Moisture is also necessary for the vegetation of seeds. The water must be applied in moderate quantity, for, with the exception of the seeds of aquatic plants, which are possessed of peculiar habits, most seeds are deprived of their vegetative power, and entirely decomposed, when kept immersed in water. Hence it is that many seeds do not vegetate in stiff clay soils, which retain too much water, nor in sandy lands, which allow the whole of the water to filtre through them. Many seeds, although they are exposed to the favourable action of these agents, do not vegetate when they are exposed to the action of light. It is on this account, and also no doubt, for the proper application of moisture, that seeds are covered with the soil, by which means germination is found to be greatly promoted.

2240 Parts of seeds. 4. A seed is composed of three principal parts, which have been denominated the cotyledons or lobes, the radicle, and plumula. The greatest number of seeds have two cotyledons. Some, however, as many of the farinaceous seeds and seeds of grasses, have only one. Others have three, and some six. Hence plants have been distinguished into *mono-cotyledinous*, *di-cotyledinous*, and *poly-cotyledinous*.

2241 Root formed. 5. The first change which takes place on a seed placed in circumstances favourable to germination, is the increase of size by the absorption of moisture. The radicle is next formed, which stretches downwards into the earth. The plumula afterwards shoots upward, and expands into leaves and branches. The peculiar function of the root is to convey nourishment from the earth for the future growth of the plant; but from what source is the nourishment derived for the formation of the root itself?

2242 Oxygen absorbed. 6. The very first change which takes place within the seed is, that the oxygen of the air which enters along with the moisture, combines with the carbon which exists in the lobes of the seed, and carbonic acid is thus formed, which is given out in the state of gas. 2243 Carbonic acid gas emitted. The farinaceous matter of the seed being deprived of part of its carbon, is converted into a saccharine substance, which is destined for the nourishment of the embryo plant, till its parts are so far evolved, as to derive nourishment from the earth. But if oxygen gas be entirely excluded, no part of the process of germination goes on: or even if it has proceeded so far that the plumula shall have appeared above the surface in the form of seminal leaves; yet if these leaves are removed before others have been unfolded, the plant dies. The seminal leaves are the lobes which have been pushed out of the earth along with the plumula, so that if they are destroyed, the plant is cut off from the necessary source of nourishment for the evolution of its parts, and for the formation of roots and leaves, which are destined to perform the different functions of vegetation.

II. Of the Food of Plants.

2244 Supposed to be water. 1. But air, heat, and moisture, are not only necessary for the first formation of the different parts of the plant; their continued action is absolutely requisite for its future health and growth. It could not long escape observation, that plants when entirely deprived of water cease to vegetate. Hence it became the opinion of the earlier physiologists, that water constituted the chief or the only food of plants; 2245 Not pure. but it has been proved by experiments in analysing plants which have grown in pure water, that there is one of the necessary principles in their constitution, of which they receive no increase above that which previously existed in the seeds or roots from which they sprung. In a series of experiments instituted by Hassenfratz, on the roots of hyacinths, the seeds of kidney beans and other plants, he found that the quantity of *carbonaceous* matter in the full formed plant, was less than what previously existed in the bulb or seed.

2246 Is the solvent of the food. 2. But pure water is necessary as a solvent for those substances which are considered as the proper food of vegetables. When impregnated with certain saline and earthy, and still more with carbonaceous matter, it is found to be most proper for promoting the growth and increase of vegetables. We have observed plants growing in a soil which was frequently moistened with the water from a dunghill, advance with a more rapid and vigorous growth, and attain to a larger size, than similar plants in the same soil, which received only the usual supply of rain and dew from the clouds. It has been found by experiment, that this water holds in solution a considerable portion of carbon. It is not improbable that it also contains some of those saline matters which have been detected by analysis in plants in the

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the greatest health and luxuriance. The waste of the soil requires to be repaired with frequent additions of manure, which may be considered as necessary supplies of food or nourishment.

2247 Peculiar structure of the root.

3. The food of plants, whatever it may be, is taken up by the roots in a state of solution in water, and conveyed by the vessels to every part of the vegetable. For this purpose it would appear that there is a peculiar adaptation of structure in the very extremities of the roots; for, if part of the fibre of a root be cut off, the plant ceases to vegetate till new fibres are formed capable of absorbing the necessary quantity of water.

2248 Sap.

4. This fluid, found in plants, is called the *sap*. It is most abundant in the spring, as the season of vegetation advances; and during that season, when the plant is wounded, it flows out copiously, and it is then said *to bleed*. This is particularly the case with some trees, such as the birch and a species of maple; the sap of which, by certain processes, even yields wine or sugar. The sap is contained in what is called the *lymphatic* or common vessels of the plant.

2249 Is prepared in the plant.

5. The fluids taken up by vegetables, it is probable, no sooner enter the plant, than they undergo some change. Vauquelin has directed his attention to this subject, and has analyzed the sap at different periods during the season of vegetation.

2250 Sap of the elm.

The sap of the common elm (*ulmus campestris, Lin.*) extracted from the tree early in the spring, was of a brown colour, had a sweet mucilaginous taste, but scarcely reddened the tincture of turnsole. Ammonia produced in this fluid a copious yellow precipitate, soluble with effervescence in acid. Barytes and lime-water produced a similar effect. Oxalic acid and nitrate of silver gave a white precipitate. Sulphuric acid, diluted with water, occasioned a brisk effervescence, with the evolution of the odour of acetic acid from the mixture.

2251 Experiments.

Oxymuriatic acid destroyed the colour of the sap, and formed in the liquid a yellow precipitate. Hydrosulphuret of potash and sulphate of iron effected no change, but alcohol threw down a flaky precipitate. A quantity of this sap being evaporated with a moderate heat, there was found on the surface a brownish pellicle; a brown matter separated in the form of flakes, and an earthy matter deposited on the sides of the vessel, which was dry to the touch. After evaporation to a certain degree, and cooling, a yellow earth was deposited, which dissolved with effervescence in muriatic acid. When the solution was completed, the liquid was filtered, to separate the insoluble vegetable matters. The muriatic solution mixed with carbonate of potash, yielded carbonate of lime. The liquid which had deposited the vegetable matter being evaporated with a gentle heat afforded a grayish extract, which strongly attracted moisture from the air, and had a very pungent, saline taste. It effervesced with the addition of concentrated sulphuric acid, and gave out the odour of radical vinegar. Distilled with three parts of sulphuric acid, it furnished very concentrated acetic acid, and there remained in the retort sulphate of potash with excess of acid.

6. From this analysis it follows, that the extract of the sap of the elm is chiefly composed of acetate of potash. One thousand and thirty-nine parts of this sap yielded nearly the following proportions.

Acetate of potash	9.240
Vegetable matter	1.060
Carbonate of lime	.796

2252 Composition.

The deficiency was made up of water and some volatile matter.

When the season was farther advanced, the sap of the same tree was again subjected to analysis, and it was found that the quantity of acetate of potash and carbonate of lime had diminished, but that the quantity of vegetable matter was nearly double. At a still more advanced period of the season, the experiment was repeated, the result of which was, that the increase of the vegetable matter, and the diminution of the acetate of potash and carbonate of lime, were still greater. It appeared too, that carbonic acid existed in excess in the sap, and held in solution the carbonate of lime.

2253 Of the beech.

7. The same chemist analyzed the sap of the beech, and it was found to be composed of water, acetate of lime with excess of acid, acetate of potash, gallic acid, tan, mucus, extractive matter, and acetate of alumina; but the proportions of these parts are not mentioned. From this analysis it appears, that the sap of the beech differs from that of elm, in containing acetic acid uncombined, besides gallic acid and tan, having at the same time no carbonate of lime. When the sap of the same plant was examined later in the season, the proportion of gallic acid and tan had increased. Vauquelin also examined, by analysis, the sap of the carpinus sylvestris or hornbeam, and the betula alba or birch *. The component parts of the sap of the former were found to be, acetate of potash and lime, mucilage, sugar, and extract, with water; and the latter were found to be water, acetates of lime, alumina and potash, sugar, and vegetable extract. From these experiments it appears that the fluids which are taken up by plants, are immediately changed by certain processes within the plant; for some of the substances which are component parts of the sap of plants, are either not found in the liquids before they enter the plant, or exist in them in very small quantity.

2254 Of the hornbeam.

These changes, it appears too, from the same experiments, are considerably greater, at the later periods of the season of vegetation. Some of the component parts are greatly increased, while others are much diminished.

2255 Ascends through the wood.

8. The sap ascends from the root to the extremities of the branches, which has been proved by making incisions in the trunk of a tree at different heights in the spring season. The sap is observed to flow, first, from the lowest incision, and successively to the highest. It is through the vessels in the woody part of the tree, that it ascends, for none flows from an incision unless it has penetrated the wood, and in some trees it is necessary to make the incision nearly to the centre. It has been observed that coloured infusions always pass from that part of the wood called the alburnum.

2256 By the tracheæ.

9. The sap of plants is conveyed through those vessels which were described under the name of *tracheæ* or spiral vessels. These were denominated tracheæ or air-vessels by the earlier physiologists, because being found empty, when they were cut across and examined, they were supposed to convey nothing but air.

10. As the sap of vegetables moves with very considerable

* Ann. de Chim. xxxi. 2.

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Functions of Vegetables.

siderable force, it has given rise to much speculation about the nature of that power, or the cause by which this is effected. Malpighi ascribed the ascension of the sap to the alternate dilatation and contraction of the air in the air-vessels; while Grew supposed, that it was owing to the lightness of the vapour, in which state he conceived the sap entered the plant, and was conveyed through it. By many others the ascent of the sap has been ascribed to the force of capillary attraction; but the nature of this action, as it is demonstrated and explained by mechanical philosophers, seems to be incompatible with the phenomena of the circulation of the sap in vegetables, and has therefore been rejected as a hypothesis equally unsatisfactory with those which have been just mentioned. It has been ascribed with more probability to the action of the vessels themselves. This arises from what is termed the irritability of the vessels, or a certain power by which they are enabled to contract, when subjected to the action or influence of certain substances. The sap is supposed to have such an influence, and the action which takes place when it enters the roots, is owing to the irritability of the vessels. The sap is carried a certain length by the first contraction, and by successive contractions is propelled through every part of the plant, while at the same time new additions continue to enter the extremities of the root.

2257 Cause of the ascent.

III. Of the Functions of the Leaves.

1. Whatever be the nature of the process, the sap is carried to every part of the vegetable, and undergoes certain changes, which become more considerable according to the progress which it has made after its absorption. But the greatest changes which take place in the sap of plants, are effected in the leaves. The leaves are to be considered as essential organs of vegetables, for in them the sap is totally changed, and converted into the peculiar juice, the *succus proprius*, of the plant.

2258 Produce great changes on the sap.

2259 Convert it into the peculiar juice.

2. During the day, the leaves of plants transpire a very considerable quantity of moisture, the proportion of which appears from some experiments not to be much inferior to the quantity absorbed. From similar experiments, it appears that the quantity evaporated is in proportion to the extent of surface of the leaves. The quantity has been observed to be greatest during sunshine and warm weather. It is greatly interrupted during the night, and entirely checked by cold. When the quantity of moisture transpired is diminished, the moisture imbibed is found to be less in proportion. In experiments made on this transpired matter, by evaporating to dryness a quantity which had been collected, a small portion of carbonate of lime was obtained; from the residuum, a still smaller proportion of sulphate of lime, with a little gummy and resinous matter. It has been found that the transpiration of moisture takes place chiefly on the upper surface of the leaves, and this seems to be performed by a particular set of organs.

2260 During the day.

3. During the day, at least during bright sunshine, oxygen gas is given out by the leaves of plants. The quantity of oxygen gas emitted by leaves, as appears from the experiments of naturalists, depends on the quantity of carbonic acid gas absorbed by the plant; for it has been ascertained that vegetables grow rapidly and vigorously when exposed to this gas; nay, it is found essentially necessary to their health and growth. If the water with which plants are supplied be deprived of the whole of its air by boiling, no oxygen gas is emitted, and water which is impregnated with the greatest proportion of carbonic acid gas, gives out the greatest quantity of oxygen gas.

2261 Oxygen gas given out.

2262 Carbonic acid gas absorbed.

4. This process goes on only during the day, and it is more vigorous during bright sunshine; from which it is natural to conclude, that light performs some necessary part in it. It is well known that plants which grow in the dark do not acquire a green colour: and it is found that such plants contain a smaller proportion of carbon than similar plants, in the same circumstances, exposed to the light. From this it may appear what is the nature of the process when carbonic acid gas is absorbed by plants, and oxygen gas emitted. It is the decomposition of the former, which is effected; the carbon being retained in the plant, and the oxygen given out; but light being a necessary agent in this decomposition, the process must be interrupted when it is excluded.

2263 Action of light.

5. This decomposition takes place in the parenchymatous substance of the leaf; and the quantity emitted, it appears, is in proportion to the thickness of this substance. The green colour of plants, it has already been mentioned, depends on the action of light. Plants which vegetate in the dark, both have a smaller proportion of carbon, and continue of a white colour; but in a short time after they are exposed to the light, the green colour is restored.

2264 Parenchyma of the leaf gives out the oxygen gas.

6. Thus it appears, that it is one part of the functions of leaves of plants to exhale a considerable proportion of the moisture taken in by the roots; to absorb carbonic acid gas; to decompose this gas, by which its carbon is retained in the plant, and the oxygen is given out. It has also appeared from this fact, that vegetables are great sources of supply of oxygen gas, which is essentially necessary in the numerous processes of combustion, and the respiration of animals, which are constantly going on on the surface of the earth; and that thus the waste of this vital fluid is repaired, and the balance preserved between its destruction and supply.

2265 Vegetables the great source of oxygen.

7. The leaves of plants perform a very different function during the night. Instead of emitting moisture and oxygen gas, and absorbing carbonic acid gas, as they do during the day, the process is reversed. Carbonic acid gas is emitted, and moisture and oxygen gas are absorbed. The absorption of moisture seems to be chiefly performed by the under surface of the leaves, at least in many plants. It has been found by experiment, that plants, which have been made to grow in oxygen gas give out a greater quantity of carbonic acid gas, than when they grow in common air. From this circumstance it has been supposed, that the carbonic acid gas, emitted by plants during the night, is owing to the combination of the oxygen absorbed, with the carbon of the sap; for it is at the same time that oxygen is absorbed. It has also been ascribed to the decomposition of the water. By some comparatively recent experiments, indeed, it has appeared that the evolution of oxygen gas only takes place during the full and direct action of the solar rays, and that even by day, plants, when exposed only to the light reflected from

2266 Function of leaves during the night.

Functions of Vegetables. from the sky, give out carbonic acid. These experiments, however, require to be repeated on many species of plants before the doctrine here delivered can be subverted.

2267 Peculiar juice. 8. By these different processes which are carried on in the leaves of plants, the sap undergoes important changes. It is there converted into the peculiar juice of the plant, from which are derived, by other processes, the different substances produced in the different parts of plants, the nature of which is to be afterwards examined. The leaves of plants have been compared to the lungs and stomach of animals. There can be no doubt that they are essential organs in the economy of vegetables. In the very first step in the process of vegetation, during the germination of seeds, the moisture absorbed by the roots is carried to the seminal leaves, and there undergoes certain changes, before it is fit for the formation of the stem and the other leaves of the plant; for, if these leaves are removed, vegetation is entirely interrupted, and the plant dies. Even when plants have made farther progress, and are in full vigour, if they are entirely stripped of their leaves, the powers of vegetation cease, till these necessary organs are restored, and new leaves are formed. The progress of vegetation is also stopped when the surfaces of the leaves are varnished over, and the absorption and emission of the necessary fluids thus interrupted.

2268 Sap flows from the roots to the leaves. 9. The sap of plants, it has been already observed, flows from the roots towards the branches and leaves of the plant. In the leaves it undergoes peculiar changes, in consequence of part being exhaled, and in consequence of the absorption of different principles which combine with it, and no doubt contribute by this combination to the changes which take place. The sap, as we have already said, is then converted into the *succus proprius*, or peculiar juice. It is the sap of the plant, which is thus far prepared to be converted into the different parts of the plant, corresponding to its nature and properties; and, as the different parts, both of liquids and solids in plants, possess properties totally distinct from each other, and have derived these from the same nutriment, the processes by which these different substances are produced in different plants, and even in the same plant, must undoubtedly be specific.

2269 Peculiar juice from the leaves to the roots. 10. The peculiar juice of plants flows from the leaves towards the roots. If a ligature is fastened round the stem of a plant, the place immediately above the ligature, that is, between it and the leaves, swells out by the accumulation of this juice. Or if a wound be made in the bark, the peculiar juice flows in greater abundance from that side of the wound next to the leaves, than from the other side.

2270 Properties of it. 11. The peculiar juice of plants has a greater consistence than the other juices. It is readily recognized by some peculiarity of colour. In a great many plants it is milky, in some it is of a green colour, and in others it is red. The component parts of the peculiar juice of plants are little known; but from some experiments which have been made on this subject, it appears that some part of the vegetable is ready formed. In the experiments of Chaptal on the peculiar juice of plants, he detected a substance which possessed the properties of the woody fibre. In similar experiments on the seeds of plants, it was found that they contained a greater proportion of the woody fibre, from which it is inferred, that the peculiar juices of plants contain their nourishment ready prepared, and in that state in which it is found in the seed. The peculiar juices of plants contain a greater proportion of these elements which constitute the different parts of plants, than what is found to exist in the sap. These are carbon, hydrogen, and oxygen. Decomposition of Vegetables.

12. Many plants cease to vegetate as soon as they have perfected their seeds, which is accomplished by some in one season, by others in two, and hence such plants have been called *annuals* and *biennials*. Other plants, however, continue to yield seeds and fruit for many successive seasons, and to live for a great length of time. The cause of this remarkable diversity among the vegetable tribes is to us unknown. 2271 Plants have different periods of duration.

Sect. II. *Of the Decomposition of Vegetables.*

1. As soon as the plants have ceased to vegetate, they undergo a new set of changes. The whole plant is broken down; the elements of which it is composed enter into new combinations, and new substances make their appearance, which did not previously exist in the plant. This decomposition is owing, partly to the affinities between the component parts of the vegetable themselves, and partly to the affinities which exist between some of the elementary principles of the plant, and the heat, air, and moisture, without which no decomposition takes place. While the plant continued to exhibit the phenomena of vegetation, that is, while it continued to live, it possessed a power of resisting this chemical action between the elements of which it is composed, and also to a certain extent the action of external agents. During this decomposition of vegetables, air, heat, and moisture, are necessary. Gaseous bodies are generally given out, and new compounds are formed. Some plants, and some parts of the same plant, have a greater tendency to undergo this decomposition than others, because they either possess a greater proportion of the substances which promote the decomposition, or a greater proportion of the substances of which the new compounds are formed.

2. The changes or spontaneous decompositions of vegetables, as they are almost always accompanied with an intestine motion, have received the name of *fermentation*. The nature of these changes is very different, both with regard to the gaseous bodies which are absorbed or emitted, and the nature of the products which are obtained after the process is finished. Hence, fermentations have been usually distinguished into three kinds; namely, the *vinous*, the product of which is wine, when certain substances are subjected to this process, and beer, when other substances are employed; the *acetous* fermentation, during which vinegar is produced; and the *putrid* or *putrefactive* fermentation, in which the substances are still farther decomposed, and run into the state of putridity. These different kinds of fermentation might perhaps be considered merely as different stages of the same process; for unless it is checked at certain periods, it runs on through the different stages without interruption. According to some, these three species of fermentation do not include all the changes which have the characters of this process 2272 Fermentation.

to

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Decomposition of Vegetables. to which vegetables are subject. To these it has been proposed to add the saccharine fermentation, or that change which is induced on farinaceous seeds by heat and moisture, which is the germination of seeds or the process of malting; and the colouring fermentation, or that process by which the colouring matter of vegetables, as indigo, is developed. In the present section
2273 Four kinds. we propose to treat, 1. Of the vinous fermentation; 2. Of the acetous or acid fermentation; 3. The panary fermentation, or the formation of bread; and, 4. Of the putrid fermentation.

I. Of the Vinous Fermentation.

2274 History. 1. The vinous fermentation, otherwise denominated the spirituous, has been so called, because the first product is wine, which by distillation yields spirits. Boerhaave was the first who directed his attention to trace the causes, and to observe the phenomena of fermentation. The same subject was afterwards prosecuted by other chemists, and much was written on the nature and manufacture of wine; but till the discoveries of modern chemistry, and especially the important one of the composition of water, nothing was ascertained with precision concerning the nature of fermentation, or the changes which take place on the fermenting substances. To the experiments and researches of Lavoisier on the formation and decomposition of alcohol, chemistry is indebted for some of the most important facts with regard to the process of fermentation.

2275 Conditions. 2. Certain conditions are necessary to promote the vinous fermentation. The first indispensable condition is the presence of some saccharine matter. Experience has shewn that no vegetable substances are susceptible of this fermentation, which do not contain sugar. Thus, the sweet juices of fruits are usually employed in this process; and particularly, for the production of wine, the juice of the grape.

But sugar in a state of purity, or uncombined with other substances, is not susceptible of any change. A certain quantity of water, therefore, is necessary, that the saccharine matter may be in the liquid state. Water, therefore, is one of the essential conditions of the vinous fermentation; and it seems necessary that the water should neither be in too great quantity nor deficient. In the latter case the fermentation is interrupted; in the former it is promoted too rapidly, and is apt to be converted into the next stage, the acetous or acid fermentation. When the consistence is too great, water must be added, and when it is too fluid, the addition of sugar becomes necessary.

The vinous fermentation scarcely commences, if the temperature be below 60°, but at the temperature of 70° the process goes on briskly.

But sugar and water alone do not ferment, without the addition of some other substances. In the liquid expressed from grapes, which has received the name of *must*, there are, besides sugar, a portion of jelly, some glutinous matter, and tartar.

The contact of air has been considered as one of the requisites of the vinous fermentation; but this is not necessary, on account of the fermenting liquid deriving any addition from the atmosphere, for the process goes on equally well, when it is excluded, provided the gaseous bodies which are formed are permitted to escape.

A large mass is also favourable for promoting the vinous fermentation. A small quantity of saccharine matter scarcely at all undergoes this change, while it runs speedily to the acid fermentation.

3. When the substances which are susceptible of this fermentation, are placed in proper circumstances, the process commences in a few hours, or a few days, according to the temperature and the quantity of liquid employed. The liquid is then agitated with an intestine motion; it becomes thick and muddy; the temperature increases, and carbonic acid gas is disengaged. The liquid is increased in bulk, and the surface is covered with a voluminous, frothy matter, which is owing to the carbonic acid gas adhering for some time to the viscid matters in the liquid. The quantity of carbonic acid gas disengaged during this process is very considerable. It begins to be evolved at the commencement of the fermentation, and continues till its termination. At the end of a few days, or a longer or shorter time, according to the temperature and other circumstances, the fermentation ceases. The liquid becomes transparent, the matters which occasioned the muddiness having precipitated to the bottom, and from having a sweet taste, it becomes sharp and hot, and from having been viscid and glutinous, it becomes more liquid and lighter. It is now converted into wine. 2276 Phenomena of fermentation.

4. Such are the phenomena of fermentation, from which, and from the nature of the product, very considerable changes must have taken place on the component parts. One change has been observed during this process; namely, that the quantity of sugar is always diminishing, and, at the end of the process, is entirely decomposed. The liquid is now more fluid, is specifically lighter, and has obtained a vinous taste; which new properties are ascribed to the formation of alcohol which exists in all wine. It would appear, from the experiments of M. Lavoisier, that it is the sugar only which has suffered decomposition. It is divided into two portions, one of which separates, and is carried off in the form of carbonic acid gas, while the other, containing a greater proportion of hydrogen, remains in the liquid, in the form of alcohol. Part of the alcohol is carried off, and the alcohol which remains in the liquid is combined with the acids of the wine and the colouring matter, from which it must be separated by distillation. The tartaric acid, it has also been found, is partially decomposed during the process, and a portion of malic acid is formed. It appears from other experiments, that azotic gas is disengaged during this process, from which it is inferred, that some others of the constituents of the fermenting liquid have been decomposed, since sugar contains no azote. 2277 Decomposition of the sugar.

5. There is great variety in the colour, flavour, and strength of wines. These differences depend on the nature of the soil and of the grapes, and very often on the manner in which it is manufactured. But the component parts of wine are generally some acid matter, alcohol, extractive matter, oil, and colouring matter. It has been ascertained by experiment, that all wines redden the tincture of turnsole. The acid which exists in greatest abundance in wine, was found by Chaptal to be the malic acid; some portion of citric acid 2278 Component parts of wines.

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Decomposition of Vegetables.

acid also has been detected. Some wines, as champaigne, contain a considerable portion of carbonic acid.

It is to a certain portion of alcohol contained in wines that they owe their strength; and, when wines are subjected to the process of distillation, the alcohol passes over, and the spirit which is thus obtained is known by the name of *brandy*.

2279 Extractive matter.

The extractive matter found in wines has been observed to diminish in proportion to the age of the wines, as it separates gradually from the liquid, and is precipitated to the bottom.

2280 Volatile oil.

The flavour and odour of wines have been ascribed to a small quantity of volatile oil; but this quantity is so small, that no means hitherto employed have succeeded to obtain it in a separate state. Wines are distinguished by a peculiar colour, which is owing to the colouring matter originally derived from the husk of the grape.

2281 From other substances.

6. The juices of other fruits also afford materials for fermentation, as that of cyder from apples, and perry from pears. These are distinguished from wines properly so called, by containing a greater proportion of mucilaginous matter. The juice of the sugar cane also affords a fermenting liquid from which is obtained by distillation the spirit called *rum*.

2282 Beer.

7. Beer or malt liquors, as they are called in Britain, are fermented liquors obtained from farinaceous seeds. Different kinds of corn are employed for the purpose of making beer. In Britain, barley is the most common grain in the preparation of this liquid. It is first steeped in water, and afterwards thrown together in a heap for about 24 hours. During this period, in consequence of the moisture which has been absorbed by the grain, the process of germination commences, oxygen gas is absorbed, carbonic acid gas is given out, and heat is evolved, while the radicle is protruded. The process having advanced thus far, is checked by slowly drying the grain. For this purpose it is spread out on a floor, and in this state it is known by the name of malt. It is afterwards exposed to heat, fully dried, and ground to a coarse powder. An infusion is then made with water about the temperature of 160°, which is drawn off; more water is added till the whole soluble part of the malt is extracted. This infusion, which has a sweet taste, from having a portion of saccharine matter, is called *wort*. After being boiled with some bitter substances, as hops, it is allowed to ferment, and the process of fermentation is in a great measure similar to that which has been already described of the fermentation of wine. The temperature most proper for this fermentation is about 60°; the fermentation of wort is greatly promoted, and the quantity of the fermented liquor is more abundant with the addition of yeast.

2283 Fermentation goes on in close vessels.

It has been found, also, that the infusion of malt ferments in close vessels, and equally well as when exposed to the open air. During this fermentation carbonic acid gas is disengaged, which is mixed with a portion of the wort. By the distillation of the liquid obtained after the fermentation has ceased, alcohol is obtained; the nature and properties of which have been already described in treating of that liquid under inflammable substances.

II. Of the Acetous Fermentation.

1. In treating of acetic acid, which is the product of this fermentation, we have already detailed the method proposed by Boerhaave for the manufacture of vinegar, and we have also described the properties of that acid. All that is now necessary, therefore, is shortly to state the general phenomena which are exhibited during this fermentation. When wine or beer, which is the product of the vinous fermentation, is exposed to a temperature between 70° and 90°, it becomes gradually turbid; the temperature is increased; it is agitated with intestine motions, and flaky substances are seen floating through it in all directions. The intestine motions at last subside, the liquid becomes transparent by the matters which rendered it turbid precipitating to the bottom of the vessel. The liquid has now assumed different properties; it is converted into acetic acid or vinegar.

2. The conditions necessary for the acetous fermentation are, a considerable elevation of temperature, and exposure to the air of the atmosphere. During this fermentation oxygen is absorbed from the air, and unless this absorption takes place, the fermentation does not go on. It is necessary that the substances to be subjected to this fermentation contain a certain proportion of extractive matter; for if they are entirely deprived of it, the process does not go on. Weak wines or beer are more readily converted into vinegar than strong wine; but when the process of fermentation has commenced on the latter, the product is a stronger and better vinegar.

3. In examining the products of this fermentation, it has been found, that the malic acid and the alcohol which previously existed in the wine, have entirely disappeared, so that by their decomposition, they have contributed to the formation of the vinegar. Some portion of the extractive matter also has been decomposed. The acetic acid is formed also during the decomposition of many vegetable substances, either by means of heat, or other chemical agents.

III. Of the Panary Fermentation, or of Bread.

1. The fermentation which takes place in making bread is supposed to be peculiar; but the phenomena and product have not been sufficiently examined to be able exactly to ascertain its nature. The process is extremely simple. Wheat flour, which is generally employed, is formed into a paste with water, the proportions of which vary according to the age and quality of the flour. After some time it is agitated with an internal motion, similar to the other fermentations, in consequence of the action of the component parts upon each other, the formation of new compounds, and the evolution of gaseous matter. Water is essentially requisite in this fermentation. One of the changes which have taken place during the process, is that the gluten which constitutes a part of the flour has disappeared. It is entirely decomposed. This matter has acquired a sour disagreeable taste, and if it is made into bread, it is found unfit to be eaten.

A quantity of new paste is then prepared, and a small

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Decomposition of Vegetables. small quantity of the old sour paste is added to it. This produces rapid fermentation. The sour paste, thus added, to promote the fermentation, is called *leaven*, and the bread prepared by this process has received the name of *leavened bread;* a distinction which has been known to mankind from the earliest ages of the world. It is frequently mentioned in Scripture, in the Jewish history. It requires some attention to be able to determine the exact quantity of leaven necessary for the proper fermentation of the paste. When it is deficient in quantity, the process of fermentation is interrupted, and the bread thus prepared is solid and heavy, and if too much leaven be used, it communicates to the bread a disagreeable sour taste. When the fermentation succeeds, the paste swells up, and is greatly enlarged in bulk, which is owing to the formation of a quantity of gas, which is confined within the mass, by the viscidity of the glutinous part of the flour.

Other substances are employed to promote the fermentation of paste for the purpose of making bread; one of the most common is the matter which collects on the surface of fermenting liquids from farinaceous matters. This substance, which is called barm or yeast, is equally efficacious in producing fermentation, and is less apt to contaminate the bread

2289 Yeast. with any disagreeable taste. As it is collected on the surface of fermenting beer, it was examined by Westrumb, and was found to contain a great variety of ingredients. Besides the water, which was in greatest proportion, it consisted of gluten, sugar, and mucilage, with a quantity of alcohol, and a small portion

2290 Component parts. of malic, acetic, and carbonic acids. The essential parts of barm or yeast were found, by the same chemist, to be gluten mixed with a vegetable acid; and therefore yeast, which has been collected and put into bags strongly pressed and dried, by which means it is obvious many of the component parts must be separated, has been found equally fit for fermentation.

2291 Baking of bread. 2. When the paste has undergone the proper degree of fermentation, it is formed into loaves, and introduced into an oven, which has been previously heated. The same temperature is as nearly as possible employed for the baking of bread. This is regulated by throwing a little flour on the bottom of the oven. If it becomes black, without taking fire, the oven is supposed to have acquired a proper temperature. This is found to be about 448°.

2292 Changes. 3. If the fermentation has been properly conducted, the bread during the process of baking enlarges in bulk, becomes light and porous, and is full of eyes or cavities, in consequence of the extrication of the gas which was confined by the viscid, glutinous matter, and now driven off by means of heat. It is also considerably lighter, in consequence of the evaporation of moisture; and it still continues to lose weight by being kept, if it be exposed to the air. When it is first removed from the oven, bread is distinguished by a peculiar taste and odour. These are also carried off by the evaporation of the moisture, unless it be prevented by excluding the air. The component parts of bread, so far as they have been investigated, are quite different from those of the flour, so that these have undergone a chemical change.

4. Loaf bread is usually made of wheat flour, which is found most proper for this purpose, in consequence of the great proportion of gluten which it contains. Rye is also frequently employed in making bread, but being deficient in the proportion of gluten, it is less proper for the purpose. Bread made of rye has not the lightness and porousness of the wheaten loaf. Parmentier has described a process for making bread from potatoes. The potatoes are boiled and reduced to a fine paste; but before they can be converted into bread, it is necessary to add an equal weight of starch obtained from the same root. In this way a white, well-raised bread, it is said, is obtained. 2293 Bread of rye and potatoes.

To a fermentation somewhat similar is ascribed the production of the colouring matter of some vegetable substances, as for instance that of indigo; in this, however, greater changes are effected. In this process the indigo plants are put into water, which is soon agitated with an intestine motion. It is also accompanied with an increase of temperature, the production of a frothy matter on the surface, and the evolution of an elastic fluid, which is a mixture of carbonic acid and carbonated hydrogen gas. During this process, the colouring matter of the plant is separated and precipitated, from which Fourcroy proposes to denominate this the *colouring* fermentation. 2294 Colouring fermentation.

IV. Of the Putrid Fermentation of Vegetables.

1. The putrefactive process is the last stage in the decomposition of vegetable matters. In some the parts are completely separated, and resolved into their primary elements, by the escape of those substances by which they were mutually held together. In others new compounds are formed, by a new set of attractions and combinations. 2295 Nature.

2. Several conditions are necessary to promote putrefaction. The first requisite is water, without which the process does not go on. When vegetables are kept perfectly dry, they undergo no change. The contact of air is also necessary, and a moderate temperature. When the temperature is too high, the moisture is carried off by evaporation, before the changes in which this process consists can be effected; but when the moisture is not carried off, the higher the temperature, the more rapid is the putrefaction. 2296 Conditions.

3. When vegetables are placed in proper circumstances to favour this process, the colour and consistence are soon changed; the texture is destroyed, the fibres are separated; the soft and liquid parts swell up and are covered with froth; elastic fluids are disengaged, the temperature is increased, and sometimes so high as to produce actual inflammation. The gases which are disengaged, are, after the process has fairly commenced, accompanied with a fetid odour. They are composed of a mixture of carbonated hydrogen, carbonic acid, and azotic gases. After these phenomena have continued for some time, which is longer or shorter, according to the nature and consistence of the vegetable matters, great part, it appears, has been dissipated by evaporation. There remains a dark-coloured substance, containing the more fixed materials of the vegetable, as the earths combined with the acids and part of the carbon. 2297 Phenomena.

4. In observing the necessary conditions, the phenomena, and the products of the putrid fermentation of vegetables, 2298 Changes.

vegetables, the influence of the numerous attractions of the different materials which enter into their composition is manifest. Part of the hydrogen combines with the oxygen, and is carried off in the state of water, part escapes in the state of gas combined with a portion of carbon, and another portion of hydrogen unites with the azote of those plants which contain it, and forms ammonia. A fourth part remains behind, and communicates odour and colour to the residuary mass. The carbon combines partly with the disengaged hydrogen, partly with the oxygen, forming carbonic acid, and part remains behind. The oxygen is divided between the hydrogen and carbon, forming compounds of which these elements are the base.

Sect. III. *Of the Component parts of Vegetables.*

1. Having in the two former sections given a short view of the functions and spontaneous decomposition of plants, we are now to consider the nature and
2299 Obtained by different processes. properties of those substances which enter into their composition. Some of these substances are obtained from plants, while they continue to exhibit the phenomena of vegetation; such are saccharine matters obtained from the sap, which is extracted by wounding the bark and wood, without much seeming injury to the health and growth of the plant; and such too are gummy and resinous matters, which many plants throw off by spontaneous exudation; and which, so far from being injurious, is perhaps necessary in some degree to vegetation; but, in general, the substances formed during the process of vegetation, or which are constituent parts of vegetable matters, can only be obtained by the destruction of the vegetable itself. These are procured by different processes, which we shall shortly describe, in treating of the nature and properties of each individual substance.

2300 Enumeration of substances. 2. The component parts of vegetables, so far as they have been examined, and sufficiently characterized by distinct properties, may be enumerated under the following heads:

1. Gum,
2. Sugar,
3. Jelly,
4. Acids,
5. Starch,
6. Albumen,
7. Gluten,
8. Extractive matter,
9. Colouring ditto,
10. Bitter ditto,
11. Narcotic ditto,
12. Oils,
13. Wax,
14. Camphor,
15. Caoutchouc,
16. Resins,
17. Gum-resins,
18. Wood,
19. Tan,
20. Suber,
21. Alkalies,
22. Earths,
23. Metals.

I. Of Gum.

1. Gum exudes from many trees during the process of vegetation, in the form of a viscid, transparent, insipid fluid. The finer kind of gum is obtained chiefly from the *mimosa nilotica*, a plant which is very common in many parts of Africa. This gum is usually distinguished by the name of *gum arabic*. After it separates from the tree, the watery part evaporates, and the gum remains behind. It has then some degree of hardness, and is so brittle that it may be reduced to fine powder. It retains its transparency, is generally of a yellow colour; but, when pure, it is entirely colourless. It has neither taste nor smell. The specific gravity is from 1.316 to 1.481. 2301 Extract and properties.

2. Gum is not changed by exposure to the air, but it is deprived of its colour by the action of the sun's light. When it is exposed to heat, it becomes soft, swells up, gives out air-bubbles, blackens, and is reduced to charcoal. During the change it gives out very little flame, and is greatly enlarged in volume. It readily dissolves in water. The solution is thick and adhesive, and well known as a paste, under the name of *mucilage*. This solution is little disposed to decomposition. By evaporation the whole of the gum may be obtained unchanged. 2302 Action of air and heat.

3. Gum is soluble in the vegetable acids without decomposition. Sulphuric acid decomposes it, and converts it into water, acetic acid, and charcoal. With the assistance of heat, muriatic acid produces a similar effect. Oxymuriatic acid converts it into citric acid. 2303 Of acids.

Gum is soluble in nitric acid with the assistance of heat. Nitrous gas is emitted during the solution, and, when it cools, saclactic acid is deposited. Malic acid appears at the same time; and, by continuing the heat, the gum is at last converted into oxalic acid. Four hundred and eighty grains of gum, digested with six ounces of nitric acid, afforded Mr Cruickshank 210 grains of oxalic acid, and six grains of oxalate of lime.

4. By puring alcohol into a mucilagineus solution, the gum is precipitated, so that it is insoluble in this liquid. It is also insoluble in ether. 2304 Alcohol.

5. Mr Cruickshank distilled 480 grains of gum arabic by exposing it to a red heat in a glass retort, and obtained the following products: 2305 Distillation.

Acetic acid mixed with some oil	210 grs.
Carbonated hydrogen and carbonic acid gases	164
Charcoal - - -	96
Lime and a little phosphate of lime -	20
	480

Thus the constituent parts of gum are, oxygen, hydrogen, carbon, azote, and lime. 2306 Constituents.

6. Besides gum arabic, the properties of which we have now described, there are different species of gum obtained from different plants, which, however, in their general properties resemble gum arabic. In some indeed they seem to be different, but these differences have not been distinctly ascertained. Gum tragacanth, the produce of the *astragalus tragacantha*, which is in the form of vermicular masses, is less transparent than gum arabic, less soluble in water, and more adhesive; but yields 2307 Obtained from other plants.

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Component Parts of Vegetables. yields by distillation similar products. Gum obtained from the cherry and plum tree, is of a brownish colour, softer and more soluble in water, but seems otherwise to possess nearly the same properties as gum arabic.

2308 Mucilage exists in many plants. 7. Gum in the state of mucilage exists in a great number of plants, and especially in the roots and leaves. It seems to be most abundant in bulbous roots, as those of the hyacinth, which contain such a quantity that they may be advantageously employed in place of gum arabic. It is obtained also in considerable quantity from many of the lichens, and most of the fuci. Mucilage is found in greatest proportion in young plants, but this proportion diminishes with the age of the plant. It is a principal constituent in the leaves and roots of esculent vegetables.

2309 Uses. 8. In the state of mucilage, gum constitutes a nutritious aliment. On account of its adhesive properties it is employed as a paste, and by the calico-printers to mix with their colours to give them consistency. It is well known as a component part of ink, to prevent the precipitation of its more insoluble ingredients, and it forms a very valuable article in the Materia Medica.

II. Of Sugar.

2310 In all parts of plants. 1. Sugar exists in every part of plants. It is found in the roots, as those of the carrot and beet root; in the stems, as in the birch, the maple, some palms, and especially the sugar-cane; in the leaves, as those of the ash; in the flowers, the fruits, and seeds.

2311 Sugar-cane. 2. But the sugar which now forms a very extensive article of commerce, and may be considered as a necessary of life, is entirely obtained from the juice of the sugar-cane, which is chiefly cultivated in the East and West Indies, for the purpose of extracting the sugar. When the plants have arrived at their full growth, which in the West Indies is in the course

2312 Manufacture. of 12 or 14 months, they are cut down and bruised by means of machinery; the juice which is collected is conveyed to iron boilers, where it is boiled, with the addition of a small quantity of quicklime, and the impurities which rise to the surface are scummed off. The boiling is continued till it acquires the consistence of syrup, after which it is put into shallow vessels, where it is allowed to cool and granulate. In general, it is afterwards put into hogsheads, in which it is imported to Europe, the bottoms of which are perforated, that the molasses with which the sugar is mixed may be allowed to drain off. Sometimes it is put into conical earthen vessels, open at both ends, the base of which is covered with moist clay, so that the water filtres through the sugar, and carries with it a greater quantity of the molasses and other impurities. The sugar thus treated, is called clayed sugar. It is not different from the former, but in being somewhat purer. The addition of quicklime in the boiling is supposed to take up some vegetable acids which prevent the granulation of the sugar.

2313 Raw. 3. In this state the sugar is known in commerce by the name of *raw Muscovado sugar*. It is still farther purified by dissolving it in water, and boiling, when the impurities which rise to the surface are again removed; a quantity of lime is also added, and it is clarified with blood. When boiled down to a proper consistency, it is put into unglazed earthen vessels of a conical shape, and inverted to allow the water from the moist clay with which the base of the cone is covered, to pass through the sugar, and carry off its impurities. It is still farther purified by again dissolving it in water, and subjecting it to a similar process. According to the number of processes to which it has been subjected, it is called single or double refined sugar. 2314

4. Sugar in this state is of a white colour; it is well known for its sweet taste; it has no smell. It has some degree of transparency when it is crystallized. It is considerably hard; but it is brittle, and may be easily reduced to powder. It is phosphorescent in the dark. When the solution of sugar in water is concentrated, it crystallizes in the form of six-sided prisms, terminated by two-sided summits. The specific gravity of sugar is 1.4045. Properties. 2315

5. When sugar is exposed to heat, it melts, swells up, becomes of a dark brown or black colour, emits air bubbles with a peculiar smell, which has been called *caromel*. If a red heat be applied, it suddenly bursts into flames, with a kind of explosion. Action of heat.

6. Neither oxygen nor azote have any action on sugar. It is not altered by exposure to the air. If the air be moist, it absorbs a little water. There is no action between hydrogen and sugar. It is very soluble in water; at so low a temperature as 48° water dissolves its own weight of sugar. This power increases with the temperature of the water. When water is saturated with sugar, it is called syrup, which by concentration and rest affords crystals. 2316 Water.

7. Sugar is soluble in many of the acids. It is decomposed by sulphuric acid; when heat is applied, the acid itself is decomposed, and converted into sulphurous acid; and a great quantity of charcoal is deposited. 2317 Acids.

Nitric acid acts on sugar with considerable violence; an effervescence is produced, nitrous gas is emitted; and the sugar is converted into oxalic and malic acids.

Muriatic acid gas is slowly absorbed by sugar, which becomes of a brown colour, and acquires a very strong smell. Sugar is instantly dissolved when it is thrown in the state of powder into liquid oxymuriatic acid; it is converted into malic acid, while the oxymuriatic acid is deprived of its oxygen, and reduced to the state of muriatic acid. Alcohol readily dissolves sugar. One part of sugar is soluble in four of boiling alcohol. Sugar also combines with the oils, and by this means they may be mixed with water.

8. The fixed alkalies combine with sugar, and deprive it of its sweet taste; but by adding sulphuric acid, and precipitating the sulphate which is formed by means of alcohol, the taste is restored. Some of the earths as lime, combine with sugar, and form similar compounds. 2318 Alkalies.

9. The sulphurets, hydro-sulphurets, and phosphurets of the alkalies and some of the earths, decompose sugar, and reduce it to a state somewhat similar to gum. Mr Cruickshank dissolved a quantity of sugar in alcohol, and added to it phosphuret of lime. After exposing the mixture to the open air for some days, it was evaporated, and water was added. There was no evolution of gas, and the phosphuret was found converted into a phosphate. By filtering the liquid, and by evaporation, 2319 Sulphurets, &c.

poration, a tenacious substance, resembling gum, remained behind.

10. By distilling sugar in a retort, the first part of the product is water, nearly in a state of purity. Acetic acid with a little oil next comes over, and afterward empyreumatic oil. A bulky carbonaceous matter, which sometimes contains a little lime, remains behind. Mr Cruickshank obtained by the distillation of 480 grains of pure sugar, by means of a red-heat,

Acetic acid and oil	270 grs.
Charcoal	120
Carbonated hydrogen and carbonic acid gases	90
	480

2320 Constituent parts.

Sugar, therefore, is composed of oxygen, carbon, and hydrogen. The proportions of its constituent parts, according to Lavoisier, are the following:

Oxygen	64
Carbon	28
Hydrogen	8
	100

2321 Maple sugar.

11. Sugar is also obtained from the juice of the maple tree in North America. The juice is extracted from the tree during the ascent of the sap in the spring season. A single tree, it is said, yields from 20 to 30 gallons of sap, from which are obtained five or six libs. of sugar. It is manufactured in the same way as the juice of the sugar cane.

2322 Beet root.

It has lately been proposed to extract sugar from the root of the beet; and the attempt has been made, even in the large way, by Achard of Berlin. The process which he followed is to boil the roots, cut them into slices, and extract the juice by pressure. The roots are again put into water for 12 hours, and again subjected to the press. The liquids thus obtained are filtered through flannel, boiled down to 3, and filtered a second time. The remaining liquid is reduced by boiling to 1 of the original quantity, and again filtered. It is then evaporated to the consistence of syrup. The crust which forms on the surface must be broken from time to time, and the spontaneous evaporation allowed to continue till the surface is covered with a viscid pellicle, instead of the crystals which first form on it. The whole mass is then introduced into woollen bags, and the mucilage is separated by pressure. This sugar, which in many respects possesses the properties of common sugar, is contaminated with some matter, which communicates a bitter nauseous taste. Many other plants also contain sugar, either in the roots, the sap, or the seeds. It exists in wheat, barley, beans, pease, and other leguminous seeds, especially when they are young, in considerable quantity.

2323 Uses.

12. The uses of sugar are so familiar, that it is scarcely necessary to enumerate them. In most countries where it can be obtained, it may be considered in some measure as a necessary of life. It contains a great proportion of nutritious matter. It is not changed by the action of the air, so that it may be preserved for any length of time. It is employed to preserve other vegetable matters from putrefaction, and sometimes it is also advantageously applied to a similar purpose in the preservation of animal substances.

III. Of Jelly.

2324 Preparation.

1. Jelly is a soft tremulous substance which is obtained from the juice of different fruits, especially from currants and bramble berries. The juice is extracted by expression, and when it is allowed to remain at rest, it coagulates. It is still mixed with a portion of aqueous liquid; but this being poured off, and the coagulated part washed with water, the jelly remains nearly pure.

2325 Properties.

2. It is sometimes perfectly colourless, but frequently tinged with the colouring matter of the fruit. It is of a soft, tremulous consistence, and has an agreeable slightly acid taste. It dissolves readily in hot water, and again coagulates on cooling. In cold water it is nearly insoluble. It is deprived of the property of coagulating by boiling, and then it is similar to mucilaginous matter.

2326 Resembles gum.

3. By coagulating the juices of the fruits which yield jelly, separating the liquid parts by filtration, afterwards washing the coagulum with cold water, and by allowing the mass to dry, it is found diminished in bulk, and is transparent and brittle, having many of the properties of gum; so that it has been supposed that jelly is this latter substance in combination with some vegetable acid.

2327 Action of nitric acid.

4. Jelly is converted into oxalic acid by means of nitric acid. It combines readily with the alkalies; and when it is distilled, it yields a considerable portion of acetic acid mixed with oil, but no perceptible quantity of ammonia. Jelly is found in all the acid fruits, as in gooseberries, oranges, and lemons.

IV. Of Acids.

2328 Easily known.

1. The acids which exist in many vegetables are at once recognized by their taste. These acids were formerly denominated *essential salts of vegetables*, and it was supposed, that all essential salts were the same, and were composed of tartar, or vinegar. But Scheele's discovery of the citric, malic, and gallic acids, which possessing distinct properties from those of tartaric and acetic acids, proved the contrary. Some vegetables contain only one acid, as oranges and lemons, which contain citric acid only. In other vegetables two acids are found, as in gooseberries and currants, the malic and citric acids; and sometimes three, as the tartaric, citric, and malic acids, which exist together in the pulp of the tamarind. As the acids which exist in vegetables have been already described, with the method of preparing them, it is now only necessary to enumerate the vegetable acids, specifying at the same time some of the plants from which they are obtained.

2329 Acetic.

2. Acetic acid has been discovered in the sap of some trees, and in the acid juice of *cicer arietinum*. In the latter it is mixed with oxalic and malic acids. Acetic acid was detected by Scheele in the *sambucus nigra* or elder.

2330 Oxalic.

3. Oxalic acid exists in combination with potash, in the leaves of the *oxalis acetosella* or wood-sorrel. In other

Component Parts of Vegetables. other species belonging to the same genus, and in some species of rumex, it is in the state of acidulous oxalate of potash. Oxalate of lime has been found in the root of rhubarb.

2331 Tartaric. 4. The following vegetable substances contain tartaric acid; in which, however, it is combined with potash, in the state of acidulous tartrate of potash. In this state it is found in the pulp of the tamarind, the juice of grapes, of mulberries, of *rumex acetosa* or sorrel, of *rheum raponticum* or rhubarb, and of *agave americana*. It is found also in the roots of *triticum repens* or couch-grass, and in *leontodon taraxacum*, or dandelion.

2332 Citric. 5. Citric acid is found in the juice of oranges and lemons, in the berries of two species of *vaccinium*, the *oxycoccos* or cranberry, and the *vitis idæa* or red whortleberry, the *prunus padus* or bird-cherry, *solanum dulcamara*, bitter-sweet or nightshade, *rosa canina*, or wild rose.

2333 Malic. 6. Malic acid exists unmixed with other acids, in the apple, the barberry, plum, sloe, elder, rowan, or fruit of the mountain ash.

In the gooseberry, in the cherry, strawberry, currants, and some other fruits, malic and citric acids are found nearly in equal proportions.

Malic acid has been found mixed with tartaric acid in the *agave americana*, and in the pulp of tamarinds, along with citric acid. Vauquelin found it combined with lime, forming a malate of lime, in the *sempervivum tectorum* or house-leek; in three species of *sedum* or stone-crop, namely the *album*, *acre*, and *telephium*; in different species of *crassula* and *mesembryanthemum*, and in *arum maculatum*.

2334 Gallic. 7. Gallic acid is found in a great number of plants, and in them it exists chiefly in the bark. The following are the relative proportions of the quantity of gallic acid in different plants, as they have been ascertained by Mr Biggin.

Elm	7	Sallow	8
Oak cut in winter	8	Mountain ash	8
Horse-chesnut	6	Poplar	8
Beech	7	Hazel	9
Willow boughs	8	Ash	10
Elder	4	Spanish chesnut	10
Plum-tree	8	Smooth oak	10
Willow trunk	9	Oak cut in spring	10
Sycamore	6	Huntingdon or Leicester willow	10
Birch	8		
Cherry-tree	4	Sumac	14*

* Nichol. Jour. iii. p. 394. 4to.

2335 Benzoic. 8. Benzoic acid is found in benzoin, balsam of Tolu and Peru, liquid styrax, cinnamon, and vanilla. Fourcroy and Vauquelin suspect that it exists in the *anthoxanthum odoratum*, or sweet-scented grass, which communicates the aromatic flavour to hay.

2336 Prussic and phosphoric. 9. Prussic acid has been found in the leaves of the laurocerasus and peach, in bitter almonds, in the kernels of apricots; and it is supposed that it exists also in the kernels of peaches, of plums, and cherries. It is obtained from the kernels of apricots by distilling water off them with a moderate heat; and if lime be added to the concentrated infusion of bitter almonds, a prussiate of lime is formed.

10. Phosphoric acid has been found in different parts of plants; but it is generally combined with lime, forming a phosphate of lime. This salt exists in the leaves of many trees, in the *aconitum napellus* or monks-hood, and in all kinds of grain.

Some acids belonging to the vegetable kingdom, in addition to those enumerated in our chapter on acids, are now taken into the list. 2337 New acids. Such are the *kinic* acid, obtained from cinchona; the *meconic* acid, obtained from opium, in which it exists combined with a newly discovered alkali, *morphine* or *morphium*; *moric* acid, which exists in combination with lime in the bark of the *morus alba*; the *sorbic* acid, obtained from the *pyrus* (formerly called *sorbus*) *aucuparia*.

V. Of Starch.

1. If a paste be formed of wheat flour and water, 2338 Preparation. and this be washed with additional quantities of water, till it is no longer turbid, but comes off pure and colourless, the mass which remains becomes tenacious and ductile. This is called *gluten*, which will be afterwards described. If the water with which the paste was washed be allowed to remain at rest, it deposits a white powder, which is distinguished by the name of *fecula* or *starch*.

2. Starch is of a fine white colour, and is usually in 2339 Properties. the state of concrete columnar masses. It has no perceptible smell, and scarcely any taste. It is little altered by exposure to the air; when it is exposed to 2340 Action of heat. heat on a hot iron, it melts, swells up, becomes black, and burns with a bright flame. The charcoal which remains, contains a little potash. When it is distilled, it gives out water mixed with acetic acid, which is contaminated with oil. It gives out also carbonic acid and carbonated hydrogen gas.

3. Starch is not soluble in cold, but forms a thick paste with boiling water, and when this paste is allowed to cool, it becomes semitransparent and gelatinous; it is brittle when dry, somewhat resembling gum. If this paste be exposed to moist air, it is decomposed, for it acquires an acrid taste.

4. Sulphuric acid dissolves starch slowly; sulphurous 2341 Of acids. acid is disengaged, and a great quantity of charcoal is formed.

Muriatic acid also dissolves starch, and the solution resembles mucilage of gum arabic. When left at rest, a thick, oily, mucilaginous liquid appears above, and a transparent straw-coloured fluid below. The odour of muriatic acid remains; but when water is added, it is destroyed, and a strong peculiar smell is emitted.

Starch is also soluble in nitric acid, with the evolution of nitrous gas. The solution assumes a green colour, and when heat is applied, the starch is converted into oxalic and malic acids. Some part of the starch, however, is insoluble in nitric acid, and when this is separated by filtration, and washed with water, it has a thick oily appearance like tallow, is soluble in alcohol, and when distilled, yields acetic acid, and an oily matter similar to tallow in colour and consistence.

5. Starch is insoluble in alcohol, but is soluble in 2342 Composition. the alkalies; in pure potash it swells up, becomes transparent and gelatinous, and is then susceptible of solution in alcohol. The component parts of starch, as appears by distilling it, and by the action of re-agents, are oxygen, hydrogen, and carbon.

6. Starch exists in a great number of vegetable substances,

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Component Parts of Vegetables.

stances, but chiefly in the roots and seeds, and particularly those which are employed as food.

2343 Found in roots and seeds.

Starch, it is well known, may be obtained from the potato. If the potato be grated down and washed with water till it comes off pure and colourless, this water being left at rest, deposits a fine white powder, which assumes something of a crystallized appearance, and is heavier than wheat starch.

2344 Potato.

2345 Sago.

Sago, which is well known on account of its nutritious qualities, is obtained from the pith of different species of palms which grow within the tropics. The stem is cut into pieces, which are split into two; the pith is washed out with cold water, which being left at rest deposits the starch. The water is poured off, and before the remaining mass is fully dried, it is forced through a perforated vessed, and granulated, in which state it is brought to Europe.

2346 Saloup.

Saloup, which is chiefly composed of starch, is prepared from the roots of different species of orchis. It is mostly imported from Persia.

2347 Cassava.

Cassava, or cassada, is a kind of bread chiefly composed of starch, which is much used as an article of food in the West Indies. It is prepared from the roots of the *jatropha manihot*. The roots are well washed, grated down, and put into bags, which are subjected to strong pressure. By this process the whole of the juice is separated. This juice, or something at least which it holds in solution, when taken internally, is a deadly poison to most animals. The matter remaining in a bag is dried and sifted, and without any other addition, when it is spread thin on a hot stone, it forms a cake, which is the cassada bread, found to be of a very nutritious quality, in consequence of the great proportion of starch which it contains.

2348 Lichen.

Some species of the tribe of lichen contain a considerable proportion of starch, as the lichen rangiferinus, or rein-deer lichen, which affords food to the rein-deer, and the lichen islandicus, which is formed into bread by the Icelanders, and is found to be extremely nutritious. The latter has lately been recommended as a remedy in consumption; but it probably possesses no other virtue in the cure of that fatal disease, than affording a great proportion of nutritious matter in small bulk.

VI. Of Albumen.

1. The existence of albumen in vegetable substances had begun to be doubted by chemists, till it was lately discovered, by Vauquelin, in the juice of the *carica papaya*, or *papaw-tree*, which grows in different countries within the torrid zone. The juice which exudes from this tree was brought home in the liquid state, mixed with an equal quantity of rum, and another portion of the juice was in the state of extract. The first was of a reddish brown colour, was semitransparent, and had the odour and taste of boiled beef. The second was of a yellowish white colour, semitransparent, and of a sweetish taste; had no perceptible smell, but was of a firm consistence, and in the form of small irregular masses. When the dried portion was macerated in cold water, it was almost entirely dissolved. When nitric acid was added, a copious white precipitate was formed. This was the albumen in the state of white flakes. When the extract of this juice was subjected to distillation, it yielded carbonate of ammonia, a thick, fetid, reddish coloured oil, carbonic acid, and carbonated hydrogen gases, and there remained behind a light carbonaceous matter; which, being burnt, left a quantity of white ashes, consisting almost entirely of phosphate of lime.

2. From other experiments to which this matter was subjected by the same chemist, from its solution in water, its coagulation by means of heat, its action with the acids, the alkalies, metallic solutions, the infusion of nut-galls, and alcohol; he concludes, that it is precisely of the same nature with animal albumen *. 2349 Resem[bles] animal [al]bumen.

* Ann. de Chim. … p. 27… and xlix. p. 30…

VII. Of Gluten.

1. When a paste is formed with flour and water, and washed with more water till it passes off pure and colourless, a tenacious, ductile, soft, elastic mass, remains behind, which is gluten. 2350 Preparation.

2. This substance is a gray colour, extremely ductile and tenacious, and possesses considerable elasticity. It has a peculiar smell, but no perceptible taste. When it is suddenly dried, it increases much in volume, and, when it is exposed to heat, it cracks, swells, blackens, and burns like horn, exhaling a fetid odour. When it is distilled, it yields water impregnated with ammonia, and an empyreumatic oil: charcoal remains behind. When moist gluten is exposed to the air, it gradually dries, becomes hard, brittle, slightly transparent, and of a brownish colour, having some resemblance to glue. When it is broken, it resembles the fracture of glass. It is insoluble in water, but retains a portion of it, which it absorbs, and to which the elasticity and tenacity are owing. It is deprived of these properties by boiling. 2351 Properties.

3. When it is kept moist, it ferments with the evolution of hydrogen and carbonic acid gases. An offensive putrid odour is given out at the same time. The gluten afterwards, if the process be allowed to go on, exhales the smell, and acquires the taste of cheese. In this state it is found to contain ammonia and acetic acid. 2352 Ferments.

4. Gluten is soluble in all the acids. It is precipitated from this solution by all the alkalies, and is then nearly in the state of extractive matter, being deprived of its elasticity. It is decomposed by concentrated sulphuric acid; hydrogen gas is emitted, and water, charcoal, and ammonia are formed. It is also decomposed by nitric acid; azotic gas is emitted, and if the heat be continued, a portion of oxalic acid is formed. Yellow coloured oily flakes are precipitated. After gluten is fermented, it is soluble in acetic acid, and this solution may be employed as a varnish. 2353 Action of acids.

5. Gluten is insoluble in alcohol and in ether; but if fermented gluten be triturated with a little alcohol, and afterwards mixed with a quantity of the same liquid, part of it is dissolved and forms a varnish, which may be employed either for paper or wood, for cementing china, or for mixing with vegetable colours that are used as paints. Pieces of linen dipped in this varnish, adhere strongly to other bodies, and if lime be added to the solution, it constitutes a good lute. 2354 Of alcohol on fermented gluten.

6. With the assistance of heat gluten is soluble in the alkalies; and when they are much concentrated it is decomposed, and formed into a kind of soap, consisting of oil and ammonia. 2355 Of alkalies.

7. It appears from the distillation of gluten, and from

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from its spontaneous decomposition, that it consists of oxygen, hydrogen, carbon, and azote. The vapour which is evolved during the fermentation of gluten blackens silver, from which it is inferred that sulphur
2356 Composition. is one of its constituent parts. From the properties and composition of gluten, the resemblance between this substance and animal matter is sufficiently obvious.

2357 In wheat. 8. Gluten exists in greatest abundance in wheat flour, but it is found in a great number of plants, and
2358 Leaves. in different parts of vegetables. It exists in considerable proportion in the juice of the leaves of many plants, as those of the cabbage, cresses, &c. When this juice is procured by expression, filtered through a cloth, and allowed to remain at rest, it deposits in the course of some days a greenish powder, which has been called the green fecula of plants. This fecula is chiefly composed of gluten mixed with a resinous matter, which gives it its colour, and a portion of woody fibre. If this juice be exposed to the temperature of about 130°, the fecula coagulates in the form of large flakes. It dries when separated from the water, and assumes the appearance of horn. When it is treated like gluten, it also acquires the smell and taste of cheese.

2359 In seeds and fruits. Gluten has been found in acorns, chesnuts, and horse-chesnuts, in barley, rye, pease, and beans; in apples and quinces; in the leaves of *sedum* of different species, hemlock, borrage, saffron; in the petals of the rose, in the berries of the elder, and in the grape. None was detected in the potato by Proust, although he found it in several other roots.

A substance which resembles the fibrina of the blood, was found by Vauquelin in the juice of the papaw-tree. When this juice is mixed with water, part is dissolved, and part remains insoluble. The latter has a greasy appearance, becomes soft in the air, viscid, brown, and semitransparent. It melted when thrown on burning coals, while drops of grease exuded. It was entirely consumed, without leaving any residuum. But according to some, this substance is exactly similar to gluten, and therefore, is not to be considered as one of the constituents of vegetable matter.

2360 Uses. 9. Gluten is one of the most important of the component parts of vegetable substances. It is one of the chief ingredients in wheat, and to this it is owing that wheat flour is fit for being formed into bread.

VIII. Of Extractive Matter.

2361 Preparation. 1. The word *extract* was formerly employed to signify the inspissated juices of vegetables, but of late it has been limited to a peculiar principle possessed of distinct properties. If saffron be infused in water for some time, and if the infusion be filtered and evaporated to dryness, the residuum is that substance to which the name of extractive principle is given.

2362 Properties. 2. The following properties of extract were ascertained by Vauquelin. 1. All extracts have an acid taste. 2. If a few drops of ammonia be added to a solution of extract, a brown precipitate is formed, which consists of lime, and part of the extract becomes insoluble. 3. Sulphuric acid disengages a penetrating acid vapour, which is found to be acetic acid. 4. When quicklime is added to a solution of extractive matter, ammonia is disengaged. A solution of sulphate of alumina without excess of acid, being poured into a solution of extractive matter, and boiled, there is formed in the liquid a flaky precipitate which is composed of alumina and vegetable matter, and rendered insoluble in water. 6. Almost all metallic solutions produce a similar effect. With muriate of tin an insoluble brown precipitate is formed, which is composed of the oxide of tin and vegetable matter. 7. Oxymuriatic acid poured into a solution of extractive matter, forms a copious, dark yellow precipitate. Muriatic acid remains in the solution. 8. If wool, cotton, or thread, be impregnated with alum, and boiled with a solution of extractive matter, these substances become charged with a great quantity of the extractive substance, they assume a fawn-brown tint, and the solution loses a great deal of its colour. The same effect is produced by immersing the substances to be dyed in a solution of muriate of tin. The effect is still better, if oxymuriatic acid be employed instead of alum, or the solution of muriate of tin. 9. When extractive matter is distilled in an open fire, it yields an acid liquid, which contains a greater portion of ammonia than when it is distilled in the humid way with lime or alkali. 10. When extractive matter is dissolved in water, and is left exposed to the open air, it is completely decomposed. The carbonates of potash, of ammonia, and of lime, and some other mineral salts which previously existed in the extractive matter, and are indestructible by putrid fermentation, remain behind.

3. It appears that extractive matter is found in greater proportion in old plants. It is found in different parts of the plant. It frequently forms one of the constituents of the sap. It is this extractive matter which precipitates during the evaporation of the sap, or when oxymuriatic acid is added to it. 2363 Exists in old plants.

Extractive matter has been found in the bark of many trees, and it is supposed that it exists in all barks which possess an astringent property. It has been found in the bark of the common willow, the Leicester willow, the oak, and the elm. 2364 In the bark.

Extractive matter has been obtained from the infusion of catechu, in which it is united with tan. If the powder of catechu be repeatedly washed with water, the liquid which passes off no longer precipitates gelatine. The residuum is extractive matter, of a reddish-brown colour, has no smell, but a slightly astringent taste. The solution in water is at first yellowish-brown, but acquires a red colour by exposure to the air. Many of the metallic salts form a precipitate with the solution of this matter. Linen boiled in it almost extracts the whole, and becomes of a light red brown colour. Extractive matter softens when exposed to heat; the colour becomes darker, but it does not melt. When it is distilled, it yields carbonic and carbonated hydrogen gases, acetic acid, and a small portion of extractive matter unchanged. A light porous charcoal remains behind. 2365 Catechu.

The infusion of the leaves of senna is of a brown colour, has a peculiar aromatic odour, and a bitter taste. When the air of the atmosphere or oxygen gas is made to pass through this infusion, a yellow coloured precipitate is formed. It is produced also by adding to the solution muriatic or oxymuriatic acid. In this state the extractive matter has combined with oxygen, and has assumed a yellow colour, and being no longer 2366 Senna.

soluble

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soluble in water, it is precipitated. The taste is slightly bitter. It is soluble in alcohol, but when water is added, it is thrown down. It is soluble also in alkalies, and forms with them a deep brown solution. When placed on burning coals, it gives out a dense smoke, exhales an aromatic odour, and leaves behind a spongy mass of charcoal.

2367 Peruvian bark.

Extractive matter is obtained from the infusion of Peruvian bark, which being united with oxygen, becomes of a fine red colour. It is obtained by boiling water on it, and by slow evaporation, and then dissolving what remains in alcohol. By evaporating the alcohol, the peculiar extractive matter is deposited. The matter thus obtained was of a brown colour, of a bitter taste, soluble in hot water and alcohol, but insoluble in cold water. It is of a black colour when dry and brittle. It breaks with a polished fracture. With the addition of lime-water it was precipitated in the form of a fine red powder, which combined with alkalies, but is insoluble in water and alcohol.

IX. Of Colouring Matter.

2368 Exists in many plants.

1. Colouring matter is extracted from a number of plants for the purposes of dyeing, as from madder, carthamus, Brazil wood, logwood, yellow weed or reseda luteola, fustic or yellow wood, anatto, and indigo.

2369 Madder.

2. The colouring matter of madder or *rubia tinctorum*, is soluble in alcohol. By evaporation it leaves a residuum of a dark red colour. A violet precipitate is formed in this solution by a fixed alkali. Sulphuric acid produces a fawn-coloured precipitate, and sulphate of potash, a beautiful red. Precipitates of different shades of colour are obtained with alum, nitre, chalk, acetate of lead, and muriate of tin.

2370 Carthamus.

3. Carthamus (tinctorius) contains two colouring matters, the one yellow and the other red. The first only is soluble in water, but the solution is turbid. It becomes transparent with the addition of acids; with alkalies it inclines to an orange colour; a fawn-coloured precipitate is formed, and then the solution becomes clear. Alum produces a dark yellow precipitate, but not very copious. A slight tincture is extracted from the flowers of this plant by means of alcohol, after the whole of the yellow matter has been dissolved by water.

2371 Brazil wood.

4. Brazil wood, or *fernambouc*, is much employed in dyeing. A recent decoction of this wood gives a red precipitate inclining to fawn colour with sulphuric acid. The liquid in which the solution was made remains transparent and of a yellow colour. With the first addition of nitric acid the tincture first passes to a yellow colour; but with a greater quantity, becomes of a dark orange yellow and transparent, after having deposited a matter similar in colour to the former, but more copious. The same changes take place with the muriatic acid as with the sulphuric.

2372 Logwood.

5. Logwood or *Campeachy wood* yields its colouring matter to water and to alcohol, but more copiously to the latter. The tincture of logwood, or the solution in alcohol, is of a beautiful red colour, inclining to violet or purple. These different shades are more obvious in the decoction in water. When the aqueous solution is left to itself, it first becomes yellow, and then changes to black. The addition of acids produces a yellow colour; alkalies deepen the colour and restore the purple or violet. Sulphuric, nitric, and muriatic acids throw down a light precipitate which separates slowly. Sulphate of iron communicates a bluish colour somewhat resembling ink. A copious precipitate of a similar colour is formed at the same time.

2373 Yellow weed.

6. Yellow weed, or dyers weed (*reseda luteola*, Lin.) in solution in water yields a yellow colour inclining to brown. When it is diluted with a greater quantity of water, the yellow colour which was more or less bright changes a little to green. The colour becomes paler with the addition of acids. It becomes deeper by the action of alkalies.

2374 Fustic.

7. Fustic, or yellow wood, (*morus tinctoria*, Lin.) contains a great proportion of colouring matter. A strong decoction in water is of a dark reddish yellow colour. When water is added to this solution the colour becomes orange-yellow. The liquid grows turbid with the addition of acids. Alkalies render it much deeper and nearly red.

2375 Anatto.

8. Anatto is in the form of a dry hard paste, externally brown, and internally of a beautiful red colour. It is prepared from the seeds of the *bixa orellana*, by reducing them to powder, mixing them with water, and allowing them to ferment. Anatto is more soluble in alcohol than in water. With the addition of an alkali the solution is promoted, and the colour inclines less to red.

Beside these, a great variety of other vegetable substances give out their colouring matter to water or alcohol, and are employed in dyeing. To what has now been said, however, we shall only add a short account of one of the most important, namely, indigo.

2376 Indigo.

9. Indigo is a colouring matter which is obtained from several plants, and has some resemblance to fecula or starch. The indigo of commerce is chiefly obtained from the *indigofera tinctoria*, a shrubby plant which is cultivated in the East and West Indies, for the purpose of extracting the colouring matter.

2377 Preparation.

10. When the indigo plant has arrived at maturity, it is cut down, and conveyed to large wooden vessels, where it is covered with water, and soon commences a fermentation. When the plant is cut down at the period of its maturity, it produces a more beautiful colour, but in smaller quantity. If it be too late, the quantity is still diminished, and the indigo is of a bad quality. The putrefactive process soon commences, and succeeds best about the temperature of 80°. The water becomes turbid and of a green colour. The smell of ammonia, and carbonic acid gas are evolved. The fermenting process is finished in the period of from 6 to 24 hours, according to the temperature and state of the plant. The liquid is then poured off into flat vessels, in which it is constantly agitated till blue flakes appear. With the addition of a quantity of lime-water these flakes precipitate to the bottom. A yellowish liquid is poured off, and the blue precipitate is collected in linen bags, from which the water drains off. When the matter in the bag has acquired sufficient consistence, it is formed into small cakes, which are slowly dried in the shade. This is the indigo of commerce.

2378 From other plants.

11. Indigo may be also extracted from the *nerium tinctorium*, or rosebay, a plant which grows in abundance in the East Indies, from the leaves of which Dr Roxborough

Component Parts of Vegetables.

Roxborough extracted it, by the following process. He digested the leaves in a copper vessel with water, kept at the temperature of 160° till they assumed a yellowish colour. The liquid becomes of a deep green; it is then poured off, and with the addition of lime-water is agitated till the indigo is precipitated. To produce one pound of indigo, two or three hundred pounds weight of green leaves were found necessary; but this quantity varies according to the season and state of weather in which they are collected.

2379 From woad.

12. The *isatis tinctoria*, or woad, which is a British plant, also yields indigo, by treating it in the same way as the indigo plant.

2380 History of indigo.

13. The history of indigo is curious. It was early known in India, but its value as a dye-stuff was not understood in Europe before the middle of the 16th century. But what is most singular, the use of this substance was either restricted or entirely prohibited in different countries from some prejudice that its effects in dyeing were injurious. The use of it was prohibited in England from the time of Queen Elizabeth till the reign of Charles II. It was also prohibited in Saxony. It is described in the edict as a corrosive substance, and denominated *food for the devil!* In France during the administration of Colbert, the dyers were restricted to the use of a certain quantity. For some time after, indigo was generally employed as a dye stuff in Europe, and was chiefly cultivated in the West Indies, and some parts of the American continent. This indigo was generally preferred in the market. What is now cultivated in the East Indies is found to be equal in quality.

2381 Properties.

14. Indigo is a light, friable substance, of a compact texture, and a deep blue colour. The shade varies from copper, violet, and blue tints. The lightest indigo is the best. It is always contaminated with extraneous matters. Bergman found in the purest indigo which he could procure, the following component parts:

2382 Composition.

Pure indigo	47
Gum	12
Resin	6
Barytes	10.2
Lime	10.0
Silica	1.8
Oxide of iron	13.0
	100.0

Other earths have been found in indigo. In some specimens Proust detected magnesia.

2383 Action of heat.

15. Pure indigo is a soft powder of a deep blue colour, which has neither taste nor smell. When exposed to heat, it emits a bluish red smoke, and then burns away with a faint white flame. The earthy part remains behind in the state of ashes. It undergoes no change by exposure to the air. It is insoluble in water, but if kept some time under it, a fetid odour is exhaled, owing to some change.

2384 Of acids.

16. Diluted sulphuric acid poured upon indigo dissolves only the earthy and mucilaginous matters; but if concentrated sulphuric acid be added, in the proportion of eight parts of acid to one of indigo, the latter is dissolved with the evolution of heat, in about 24 hours. The mixture is black and opaque; but if water be added, it becomes clear, and of a fine blue colour, producing various shades, according to the quantity of water. This solution of indigo in sulphuric acid is called *liquid blue*, or according to Bancroft, sulphate of indigo.

2385 Effects of different substances on liquid blue.

Bergman made a great number of experiments on the effect of different substances on this solution, some of which we shall now mention, in which the colour was either changed, or entirely destroyed. When it was dropped into sulphurous acid, the colour, which was at first blue, became green, and was at last destroyed. In diluted tartaric acid the colour became gradually green, and was at last converted into a pale yellow. In acetic acid it became green, and was at last destroyed. In potash, carbonate of potash, soda, ammonia and its carbonate, the colour became green, and at last disappeared. In sulphate of soda, the solution being diluted, after some time became green. It also became green in sulphate of iron, and at last disappeared. In the sulphurets the colour was very soon destroyed. Black oxide of manganese produced the same effect. These experiments have been mentioned, to shew that indigo is deprived either partially or totally of its colouring matter, by those substances which have a strong affinity for oxygen. From this it is inferred that indigo owes its colour to oxygen; and that it becomes green when it is deprived of it.

2386 Nitric acid.

Concentrated nitric acid attacks indigo with such violence that it sometimes inflames it. By diluting the acid, the action is greatly moderated. The solution becomes of a brown colour; crystals appear, which are supposed to be oxalic acid, and a brown viscid substance remains behind.

Muriatic acid dissolves indigo precipitated from sulphuric acid, and forms a liquid of a dark-blue colour. The other acids, as the phosphoric, acetic, and tartaric, exhibit similar phenomena. They readily dissolve indigo, which has been precipitated.

Oxymuriatic acid has little action on indigo in substance, but it destroys the colour of it in the state of solution.

2387 Of alcohol.

17. Neither alcohol, ether, nor oils, have any action on indigo. Common indigo, when digested with alcohol and ether, communicates a yellow colour; but this, it is supposed, is owing to the solution of the resinous substance.

2388 Alkalies.

18. The solution of the fixed alkalies readily dissolves indigo, when it is precipitated from its solution. The colour of the solution is at first green, and is at last destroyed. Liquid ammonia and its carbonate produce a similar effect, from which it appears, that indigo is decomposed by the alkalies.

19. Lime water also dissolves indigo precipitated from its solution. The colour is at first green, becomes gradually yellow; when exposed to the air, the green returns, and at last disappears.

20. Bergman subjected indigo to the process of distillation; from 576 grains he obtained the following products:

2389 Composition.

Carbonic acid gas	19
Yellow acid liquid containing ammonia	173
Oil	53
Charcoal	331
	576

The

Component Parts of Vegetables.

The component parts of indigo, therefore, appear to be oxygen, carbon, hydrogen, and azote.

X. Of Bitter Matter.

2390 In different substances.

1. A great number of vegetable substances are distinguished by a very bitter taste, such as quassia, a substance used in medicine, gentian, hops, chamomile. This taste is ascribed to a peculiar matter, called from this property *bitter matter*. It may be obtained by infusing quassia for some time in water. This solution, which is of a yellow colour, has an extremely bitter taste, but no smell. If the water be evaporated with a moderate heat to dryness, a brownish yellow substance, which has some degree of transparency and ductility, remains behind. After some time it becomes brittle.

2391 Properties.

2. When this substance, which has a very bitter taste, and a brown yellowish colour, is heated, it softens, swells, and blackens, then burns away without much flame, and leaves a small quantity of ashes. It is very soluble in water and alcohol. Nitrate of silver renders it turbid, and afterwards produces a yellow precipitate in the form of flakes. Acetate of lead produces a copious white precipitate.

XI. Of Narcotic Matter.

2392 Found in different plants.

1. A peculiar substance has been detected in opium, to which it is supposed the properties it possesses of producing sleep are owing. On account of this property this substance has received the name of *narcotic matter*. It is obtained from the milky juices of some plants, as those of the poppy, lettuce, and some others. Opium, which is extracted from the poppy, is prepared by the following process.

2393 Extraction of opium.

The heads of the *papaver album* or white poppy, which is cultivated in India and different countries of the east for this purpose, are wounded with a sharp instrument; a milky juice flows out, which concretes, and is collected and formed into cakes.

2394 Properties.

2. In this state opium is a tenacious substance, of a brownish colour, has a peculiar smell, and a disagreeable bitter taste. It becomes soft with a moderate heat. It readily takes fire, and burns rapidly. By the analysis of opium, it appears to be composed of the sulphates of lime and of potash, extractive matter, gluten, mucilage, resinous matter, and an oil, besides the narcotic matter to which its peculiar properties are owing.

2395 Separation of the narcotic matter.

3. By digesting opium in water part of it is dissolved, and by evaporating the solution to the consistence of syrup, a gritty precipitate appears, which becomes more copious with the addition of water. This precipitate is composed of resinous and extractive matter, besides the peculiar narcotic matter which is crystallized. When alcohol is digested on this precipitate, the resinous and narcotic matters are dissolved, and the extractive matter remains behind. As the solution cools, the narcotic matter crystallizes, but the crystals are coloured with a portion of resin. By repeated solutions and crystallizations it may be obtained tolerably pure *.

* *Ann. de Chim.* xlv. 253.

2396 Of alcohol.

If alcohol be digested on the residuum, it acquires a deep red colour; the same crystals are deposited on cooling, and may be purified in the same way from the resinous matter with which they are contaminated.

2397 Properties.

4. The narcotic matter, or, as it is called by Derosne, *the essential salt of opium*, when properly purified, is of a white colour, crystallizes in right-angled prisms, with a rhomboidal base, and has neither taste nor smell. It is insoluble in cold water, and requires 400 parts of boiling water for its solution, from which it is precipitated by cooling. The solution does not redden the tincture of turnsole. It is soluble in 24 parts of boiling alcohol, and requires about 100 parts when it is cold. When water is added to the solution in alcohol, it is precipitated in the form of a white opaque matter.

2398 Action of ether, &c.

Ether and the volatile oils dissolve this salt with the assistance of heat; but on cooling it is deposited in the form of an oily liquid, and some time after crystals appear at the bottom of the vessel.

2399 Of acids.

5. One of the most decided characters of this substance is its easy solubility in all the acids, and without the aid of heat. It is precipitated from these solutions by means of an alkali, in the form of white powder. Pure alkalies increase the power of its solubility in water; and the acids, when not added in excess, occasion a precipitate. When nitric acid is poured on the crystals reduced to a coarse powder, it communicates to them a red colour, and readily dissolves them. When the solution is heated and evaporated, it yields crystals of oxalic acid in considerable quantity. The residuum has a very bitter taste.

2400 Of heat.

6. When it is thrown on burning coals, it gives out a copious flame. When heated in a spoon, it gradually melts like wax. Distilled in a retort with a moderate heat, it melts, and afterwards swells up, with the evolution of white vapours, which condense on the sides of the vessel, in the form of a yellow oily matter. There passes over, at the same time, a little water impregnated with carbonate of ammonia. Towards the end of the process, carbonic acid and carbonated hydrogen gas, with some ammonia, are disengaged. There remains in the retort a light, spongy, voluminous mass of charcoal, which, by burning, gives some traces of potash. The oily matter deposited in the neck of the retort is very viscid, and has a strong aromatic odour, with a pungent, acrid taste.

2401 Effect on animals.

7. Derosne tried the effects of this substance on animals, and in very small quantity. The symptoms which appeared, when it was given to dogs, were exactly similar to those which are produced when a large quantity of crude opium is swallowed. They were recovered from its effects by means of vinegar, which he accounts for on the principle of the easy solubility of this substance in acids.

2402 Composition.

8. From the effects of heat and of nitric acid on this substance, it appears to be composed of oxygen, hydrogen, carbon, and azote.

2403 Opium found in other plants.

9. This narcotic substance is also found in the milky juice, and in the extracts which are obtained from several other plants, as from different species of *lactuca* or lettuce, *hyoscyamus niger* or henbane. The leaves of some plants also produce similar effects, as those of the *deadly nightshade*, *foxglove*, and *conium maculatum* or hemlock.

XII.

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Component Parts of Vegetables.

XII. Of Oils.

2404 Fixed. 1. The nature, properties, and component parts of oils, have already been detailed, when treating of inflammable substances. Oils are of two kinds, fixed and volatile. Fixed oil exists chiefly in the seeds of plants, as linseed oil, almond oil, and rape-seed oil. Fixed oil is also found in the pulp of some fruits, as in that of the olive. Fixed oils are found in those seeds which have double lobes, or two cotyledons, and in these they are mixed with a quantity of mucilage. These oils are extracted from seeds by expression and boiling.

2405 Volatile. 2. Volatile oils are found in all parts of plants excepting the seeds. In some plants they exist in the root, or the stem, and in others in the leaves, the flower, the pulp and rind of the fruit. The peculiar odour by which almost all plants are distinguished, is supposed to be owing to a volatile oil. These oils are also extracted by expression, and sometimes by distillation.

XIII. Of Wax.

2406 Preparation. 1. Wax, of which bees form their combs for containing honey, is collected from vegetables; and a similar substance being found in different parts of plants, it is to be considered as vegetable matter. The varnish with which the upper surface of the leaves of some trees is covered, possesses the properties of bees wax. If the bruised leaves are digested in water, and afterwards in alcohol, till the soluble part is extracted, and the residuum be mixed with six times its weight of a solution of ammonia, and after maceration, the solution being poured off and filtered, diluted sulphuric acid be added in excess to saturate the alkali, constantly stirring it, the varnish precipitates in the form of a yellow powder. It is then to be washed with water, and melted with a moderate heat. This substance is wax.

2407 Properties. 2. Pure wax is of a white colour, has no taste, and scarcely any smell. The aromatic smell of bees wax is owing to some substance with which it is mixed, for it is entirely removed by exposure to the air, when the colour at the same time disappears. Pure wax undergoes no change by exposure to the air. The specific gravity is 0.96. It is insoluble in water.

2408 Action of heat. 3. Wax becomes soft by the application of heat. Unbleached wax melts at the temperature of 142°. When it is pure it requires the temperature of 155°, and then melts into a colourless transparent fluid. By increasing the heat, the wax boils and evaporates; with a red heat the vapour takes fire, and burns with a bright flame.

2409 Acids. 4. The acids have scarcely any action on wax. It is bleached by means of oxymuriatic acid, but no other effect is produced.

2410 Alcohol, &c. 5. Wax is soluble in boiling alcohol. It requires 20 parts of alcohol to dissolve one of wax, and as the solution cools, the greater part is precipitated. With the addition of water the whole is thrown down. With the assistance of heat ether dissolves wax nearly in the same proportion, but on cooling it is also precipitated.

Wax is soluble in the fixed oils with the aid of heat. This compound is known by the name of *cerate*, which is much employed to form plasters for dressing wounds. It is soluble also in some of the volatile oils, as those of turpentine, with the assistance of heat. As the solution cools, part of the wax is precipitated.

6. Wax combines with the fixed alkalies, and forms with them substances similar to soap. 2411 Alkalies.

7. According to the analysis of Lavoisier, wax is composed of 2412 Composition.

Carbon	82.28
Hydrogen	17.72
	100.00

8. When wax is distilled with a temperature above 212°, water comes over, some acid, and a little fluid and odorous oil. The oil in the course of the process becomes thicker, and at last assumes the consistency of butter; and hence it has been called *butter* of wax. This substance by repeated distillation is converted into a volatile oil. A coaly matter remains in the retort. 2413 Butter of wax.

9. Wax is extracted from a number of plants, possessing different degrees of consistency, as that from the cacao, called the *butter of cacao;* from the *croton sebifera*, called the *tallow of croton;* and the myrtle wax extracted from the *myrica cerifera*, or *candle-berry myrtle* of America. The myrtle wax is obtained from the berries of this plant. They are collected and put into a kettle, and covered with water to the depth of half a foot. Heat is applied, and the berries are pressed against the sides of the vessel. The wax melts, and swims on the top. It is collected, passed through a cloth, dried and melted again, and then cast into cakes. The wax, it appears, exists chiefly in the outer covering of the berries. Myrtle wax is of a pale-green colour; the specific gravity is 1.015. When heated to the temperature of 109°, it melts; with a stronger heat it burns, giving out a white flame with little smoke; an agreeable aromatic odour is at the same time emitted. In its other properties it resembles bees wax. 2414 Obtained from many plants.

Proust has detected wax in the rind of plums, oranges, and similar fruits, and in the green fecula of many plants.

XIV. Of Camphor.

1. Camphor is obtained from the *laurus camphorata*, a species of laurel which grows in China and Japan. It is extracted by sublimation in an iron pot. The Dutch afterwards purify it by a second sublimation. 2415 Extraction.

2. It is a white, brittle substance, possessing a hot acrid taste. The specific gravity is 0.9887. It is not altered by exposure to the air, but it is so extremely volatile, that it disappears entirely if left in an open vessel. It crystallizes by sublimation in close vessels in the form of hexagonal plates or pyramids. It is insoluble in water, although at the same time it communicates some of its odour. 2416 Properties.

3. When a heat about the temperature of 300° is suddenly applied, it melts, and then is volatilized. It readily catches fire, and burns with a bright flame, without leaving any residuum. It even burns on the surface of water. When a small quantity of camphor in 2417 Action of heat.

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a state of inflammation is introduced into a large glass vessel filled with oxygen gas, it bursts out into a vivid flame; the inside of the vessel is covered with a black powder, and a great deal of carbonic acid gas is disengaged. If a little water has been previously put into the vessel, it is impregnated with carbonic and camphoric acid.

2418 Acids.

4. Camphor is soluble in the acids, but with the addition of water or an alkali, it is precipitated unchanged. Camphor in sulphuric acid forms a red solution; in nitric acid, a yellow solution, which was formerly called *oil of camphor*. By the repeated distillation of nitric acid off camphor, it is converted into camphoric acid.

Sulphurous acid, muriatic acid, and fluoric acid, in the state of gas, dissolve camphor. If oxymuriatic acid gas be made to pass into a solution of camphor in nitric acid, it is immediately changed to a rose colour, and instantly afterwards it becomes yellow, which is permanent during the process. When water is added to the solutions of camphor in acids, it is separated. Camphor is also soluble in water impregnated with carbonic acid gas, and in acetic acid. The latter compound constitutes Henry's aromatic vinegar.

5. Alcohol readily dissolves camphor, but it is precipitated with the addition of water. By diluting alcohol which holds camphor in solution with water just so much as not to precipitate the camphor, the latter crystallizes in the form of feathers. The fixed and volatile oils dissolve camphor with the assistance of heat, but on cooling the camphor is precipitated, and crystallized, as in the solution with alcohol.

2419 Alkalies.

6. Camphor communicates to the alkalies a little of its colour, but is not otherwise soluble in these bodies.

2420 Composition.

7. According to the analysis of Bouillon Lagrange, by distilling one part of camphor with two of alumina, formed into a paste with water in a glass retort, the component parts of camphor are carbon and hydrogen; the proportion of carbon being much greater than in oils.

2421 Oil of camphor.

In the course of the distillation, he obtained a volatile oil, of a golden yellow colour, which floated on the surface of the water in the receiver. It had an acrid burning taste, and aromatic odour, similar to that of thyme or rosemary.

2422 Found in many plants.

8. Camphor has been detected in many other plants. It has been extracted from the roots of thyme and sage, and in these plants it seems to be combined with volatile oil. If the oil be exposed to a temperature below 54° in the open air, it evaporates, and the camphor crystallizes. It may be also obtained by distilling the oil in a water bath, under the temperature of 212°, till a third part of the oil passes over. Part of the camphor is found crystallized in the vessel, and by repeating the process, the whole may be extracted from the oil. By mixing the camphor with a little dry lime, and subliming it, it may be purified.

XV. Of Caoutchouc.

2423 History.

1. Caoutchouc is a soft elastic substance, chiefly obtained from the inspissated juice of two trees, the *hævea caoutchouc* and *jatropha elastica*, which are natives of South America. This substance was first brought from America about the beginning of the 18th century. It is called by the inhabitants of *Esmeraldas*, a province of Quito, *heve*, and by the natives of the province of Mainas, *caoutchouc*.

2424 Preparation.

2. It is extracted by making incisions in the bark of the tree. A milky juice flows from it, which is collected in proper vessels. The juice is then applied, one stratum above another, on earthen moulds, and suffered to dry in the sun, or before a fire. Various figures are formed on the surfaces of the different pieces by means of a pointed instrument. They are then exposed to smoke, and, when perfectly dry, the moulds are broken. In this state it is brought to Europe. It is generally in the shape of bottles, but sometimes in other forms.

2425 Properties.

3. When caoutchouc is pure, it is of a whitish colour; it is soft and pliable like leather, extremely elastic, and possesses great tenacity. The specific gravity is 0.9335.

2426 Action of heat.

4. When caoutchouc is exposed to heat, it readily melts into a matter of the consistence of tar. It burns with a bright white flame, and diffuses a fetid odour.

5. Sulphuric acid decomposes caoutchouc; charcoal is precipitated, and the acid is partially converted into sulphurous acid. It is also decomposed by nitric acid; carbonic acid gas, azotic gas, and prussic acid gas, are disengaged, and oxalic acid is formed. Muriatic acid has no action upon it; but if oxymuriatic acid is poured upon the milky juice, the caoutchouc is immediately precipitated, and the acid is converted into muriatic acid. If a given quantity of air be confined in a vessel over a quantity of this milky juice, the oxygen of the air is absorbed, and a pellicle of caoutchouc is formed on the surface, from which it appears that the formation of caoutchouc is owing to the combination of its base with oxygen.

2427 Alcohol.

6. Caoutchouc is insoluble in alcohol. It is soluble in ether, but it is necessary that the ether be previously washed with water. By this treatment it is formed into syringes, catheters, and other instruments. It is soluble in the volatile oils, but it remains somewhat glutinous after the evaporation. A mixture of volatile oil and alcohol forms a good solvent for caoutchouc, and in this state it may be employed as a varnish for paper or stuffs. A varnish may also be formed with it by dissolving it in boiling wax. It is also soluble in rectified petroleum, and when the solution is evaporated, the caoutchouc remains unchanged.

2428 Alkalies.

7. According to some, caoutchouc is insoluble in the alkalies; but, according to others, all of these bodies are capable of dissolving it.

2429 Composition.

8. By distillation caoutchouc yields ammonia; and from this, and its decomposition by means of sulphuric and nitric acids, its constituent parts must be carbon, hydrogen, azote, and oxygen.

2430 Found in different vegetables.

9. Caoutchouc has been detected in different parts of many other plants, but it is mixed with resinous, gummy, and extractive matters. It has been found in different species of the misletoe, in opium and mastic. It has also been extracted from the *artocarpus integrifolia* or bread-fruit tree, the *urceola elastica*, and *ficus indica*.

XVI. Of Resins.

2431 Nature of.

1. Resinous bodies form a very numerous class of vegetable

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Component Parts of Vegetables.

vegetable substances. When volatile oils are exposed to the air, they become thick after a shorter or longer time, and are then found to be converted into a *resin*. The oil absorbs oxygen from the air, and is deprived of part of its carbon, which combining with the oxygen of the atmosphere, forms carbonic acid. Resinous substances, therefore, are generally considered as volatile oils saturated with oxygen. The general properties of resinous substances are the following.

2432 Properties. 2. They are solid, brittle, and commonly of a yellowish colour, with some degree of transparency. The taste, resembling volatile oils, is hot and acrid. They have no smell. The specific gravity is from 1.0180 to 1.2289. All resinous bodies are electrics, and when excited by friction, the electricity is negative; hence it is called *resinous electricity*.

2433 Action of heat. 3. They melt by being exposed to heat, and burn with a yellow flame, giving out a great quantity of smoke. Resins are insoluble in water.

2434 Acids, &c. 4. Resinous substances are soluble in nitric acid; part is precipitated by the addition of water, and the whole by means of the alkalies. With the assistance of heat they are all soluble in alcohol, and in sulphuric ether. Resins are soluble in some of the fixed oils, and also in volatile oils.

2435 Alkalies. 5. Resinous substances have been found to be soluble in the fixed alkalies.

6. We shall now enumerate some of the resins which are best known.

2436 Rosin. *Rosin.*—This substance is extracted from different species of the fir, and the resinous matter obtained from it has received different names. That procured from the *pinus slyvestris* is the common turpentine; from the *pinus larix*, Venice turpentine; and from the *pinus balsamea*, balsam of Canada. The turpentine is obtained by stripping the bark off the trees; a liquid juice flows out, which gradually hardens. This juice consists of oil of turpentine and rosin. By distilling the turpentine the oil passes over, and the rosin remains behind. By distilling to dryness common rosin is obtained. When water is added, while it is yet fluid, and incorporated by agitation, what is called yellow rosin is formed.

2437 Pitch. *Pitch.*—Is a resinous juice obtained from the *pinus picea*, or pitch pine. It is purified by melting and squeezing it through linen bags, and it is then known by the name of *white* or *Burgundy pitch*. White pitch mixed with lamp black forms black pitch.

2438 Mastic. *Mastic.*—This is a resinous substance obtained from the *pistacia lentiscus*, a tree which grows in the Levant. The fluid which exudes from the tree, concretes into yellowish semitransparent brittle grains. It has little taste, melts and exhales a fragrant odour when heated, and readily dissolves in alcohol and fixed oils. It contains a little volatile oil.

2439 Sandarac. *Sandarac.*—This resinous substance is extracted from the juniper. It is a spontaneous exudation from this plant in the form of brown tears, which are semitransparent and brittle.

2440 Labdanum. *Labdanum*, or *Ladanum*.—This is the produce of the *cistus creticus*, a shrub which grows in Candia. It is the exudation of a viscid juice, which concretes by exposure to the air. It has a fragrant odour and a bitter taste.

2441 Dragons-blood. *Dragons-blood.*—This resinous substance is a production of the *dracæna draco* and some other plants. It is of a dark-red colour, opaque and brittle. The powder is of a crimson colour. It melts when it is heated, and readily burns. It has no taste, is insoluble in water, but soluble in alcohol, to which it communicates a crimson colour. It is also soluble in the fixed oils, and gives them a red colour.

2442 Anime. *Resina animæ.*—This resin is the produce of a species of *hymenæa*, or locust tree, a native of North America. It is soluble in alcohol, and is employed as a varnish.

2443 Copal. *Copal.*—This resinous substance is obtained from the *rhus copallinum*, a tree native in North America. The copal most preferred is brought from Spanish America. It is a light brown transparent substance. It melts when heated, but is not directly soluble in alcohol, or in oil of turpentine, and it is with difficulty soluble in fixed oils. Copal forms an excellent varnish. Indeed it is one of the best that is known for beauty and durability.

2444 Varnish. If copal be treated with oil of turpentine in a close vessel, from which the vapours are not allowed to escape, they exert a great pressure, which prevents the the boiling, and thus the mixture acquires a higher temperature. A considerable portion of the copal is thus dissolved, and with the addition of a little poppy oil, it forms an excellent elastic varnish.

If copal be kept melted till a sour-smelling aromatic odour ceases to proceed from it, and if it be then mixed with an equal quantity of linseed oil previously rendered colourless by exposure to the sun, it combines with the oil, and thus forms a varnish. The substances varnished with this preparation must be dried in the sun.

Copal may be dissolved in alcohol, by previously dissolving half an ounce of camphor in 16 ounces of alcohol. This solution is poured on 4 ounces of copal in a matrass, which is stopped with a cork, and perforated with a pin. When the copal is nearly dissolved, the process is stopped, and the matrass allowed to cool, before the cork is removed. This solution forms a colourless varnish.

Copal, it is said, may be dissolved in alcohol, by exposing it to the action of the vapour. This process is conducted by boiling a quantity of alcohol in the bottom of a vessel, at the top of which a piece of copal is suspended. During the process the copal softens, and falls down like oil into the alcohol.

2445 Elemi. *Elemi.*—This resinous substance is the produce of the *amyris elemifera*, a tree which grows in the East and West Indies. It is semitransparent, of a pale yellow colour, softish, and hardens by keeping. It has a strong fragrant smell, and when distilled it yields a fragrant oil.

2446 Balm of Gilead. *Opobalsamum*, or *balm of Gilead.*—This resin is procured from another species of amyris, the *Gileadensis*, a native of Arabia. The best kind, which is highly valued by the Turks, is never seen in Europe.

2447 Copaiva. *Copaiva*, or *balsam of Copaiva.*—This resinous substance is obtained from the *copaiva officinalis*, a tree which is a native of South America. It exudes by wounding the trunk of the tree. It is transparent, of a yellowish colour, has a pungent taste, and an agreeable smell. It is at first of the consistence of oil, but afterwards becomes as thick as honey. By distillation the

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the volatile oil, with which it is mixed, may be separated, and the resinous matter remains behind.

2448 Guaiac. *Guaiac.*—This resin is the produce of the *guaiacum officinale*, a tree which is a native of the West Indies. The resin exudes spontaneously in tears, but it is chiefly obtained by cutting the wood into billets, and boring them longitudinally. When one of these is heated on the fire, the resinous matter is melted, and runs through the hole as the wood burns. This resin is of a brownish-yellow colour, and has some degree of transparency. It is soluble in alcohol, and has neither smell nor taste. It melts when heated, and when it is thrown on hot coals, it diffuses an agreeable odour. When swallowed in the state of powder, it produces a strong sensation of heat in the throat.

2449 Lac. *Lac.*—This resinous substance is obtained from the *croton lacciferum*. It is of a deep red colour, with some degree of transparency. It is the basis of the finer kinds of sealing wax, and is employed as a varnish.

2450 Amber. *Amber.*—This substance possesses many of the properties of the resins, and it has been considered by some of vegetable origin. It is a brittle hard substance, transparent, sometimes colourless, but often yellow or deep brown. The specific gravity is 1.065. It has neither taste nor smell, except when it is heated, and then it becomes soft, and gives out a fragrant odour. It burns with a strong heat, leaving only a small residuum. It is insoluble in water, but alcohol dissolves a small quantity of it. When the solution is concentrated, it becomes milky with the addition of water. The precipitate which is formed is a resinous substance. It is soluble in the fixed alkalies at a boiling temperature.

2451 Effect of acids. Sulphuric acid converts amber into a black resinous mass. It is also soluble in nitric acid.

2452 Distillation. By the distillation of amber, carbonic acid gas and carburated hydrogen gas, an acid liquor, and an oil, which is at first thin and transparent, but afterwards larger and thicker, is obtained. Succinic acid sublimes towards the end of the process.

2453 Varnish. When amber is roasted, it becomes soluble in the oils, and forms a varnish. This varnish may be formed by spreading the amber on a flat-bottomed iron pan, and exposing it to heat till it melts. It is then covered up, and set by to cool. One part of this roasted amber, which has lost half of its weight, if the process be properly managed, is then to be mixed with three parts of linseed oil. The mixture is to be exposed to a gentle heat till the amber is dissolved. It is then to be removed from the fire, and four parts of the oil of turpentine are to be added when it is nearly cold. The clear part, after it has settled, is strained through a linen cloth.

2454 Benzoin. *Benzoin.*—This substance contains a resinous matter combined with an acid, and is commonly ranked among balsams. Benzoin is obtained from the *styrax benzoin*, a tree which is a native of Sumatra. It is a brittle substance, has a fragrant odour when rubbed, and when it is heated, the acid escapes. It may be dissolved in alcohol, but it is insoluble in water.

2455 Styrax. *Styrax.*—This substance, which is in a half-fluid state, exudes from a tree in Arabia. It is of a greenish colour, has an aromatic taste, and an agreeable odour. The benzoic acid, which is one of its component parts, dissolves in water. The whole of it is soluble in alcohol. It absorbs oxygen, and becomes harder by exposure to the air.

Storax.—This substance is procured from the *styrax officinale*, a native of the Levant. It is of a brown colour and brittle, has an aromatic taste, fragrant odour, and is soluble in alcohol. It gives out benzoic acid by heat. 2456 Storax.

Balsam of Tolu.—This substance is obtained from the *toluifera balsamum*, a native of South America. It is of a reddish brown colour, becomes solid and brittle when exposed to the air, and has a very fragrant smell. 2457 Balsam of Tolu.

Balsam of Peru.—This is obtained from the *myroxylon peruiferum*, a plant which is a native of South America. The resin is extracted by boiling the twigs in water. It is of the consistence of honey, has a brown colour, an agreeable smell, and an acrid taste. It is soluble in alcohol. The acid part is soluble in water. Benzoic acid is driven off by heat. 2458 Of Peru.

XVII. Of Gum-Resins.

1. This class of substances seems to be composed of a mixture of resinous matter with a portion of gummy and extractive matter. They are never obtained from plants by means of spontaneous exudation, but are procured by wounding the plants which contain them. The general properties of gum-resins are the following. 2459 Constituents.

2. They are always in the solid state, and commonly brittle and opaque. They are softened by heat, but do not melt, and are less combustible than the resins. They burn with flame. They have an acrid taste, with a strong smell, somewhat resembling garlic. They are partially soluble in water, and in alcohol. The solution in water is opaque and milky, and the solution in alcohol is transparent. They are partially soluble in vinegar and wine. They are soluble in nitric acid, and also in the alkalies, with the assistance of heat. 2460 Properties.

3. The gum-resins by distillation yield a portion of ammonia, which shews that azote forms one of their constituent parts.

4. Many of the gum-resins have been long known in medicine, and some of them are of considerable importance. We shall specify the peculiar properties of the following.

Olibanum.—This gum-resin is chiefly collected in Arabia, from the *juniperus lycia*. It is brought from Mecca to Cairo, and from thence to Europe, in the form of transparent brittle grains, not larger than a chesnut, of a yellow colour, a peculiar aromatic smell, but with little taste. With water it forms a milky fluid, but it is entirely soluble in alcohol. When heated it does not melt, but inflames and burns with an agreeable smell. It is the frankincense of the ancients, and is still employed to diffuse an agreeable fragrance in the Greek and Romish churches. 2461 Olibanum.

Scammony.—This substance is extracted from the *convulvulus scammonia*, a climbing perennial plant which grows in Syria. By cutting the roots, a milky juice flows out, which is collected and dried in the sun. It is of a dark-gray colour, a bitter acrid taste, and a nauseous smell. It forms a greenish milky fluid with 2462 Scammony.

water

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Component Parts of Vegetables. water. It is soluble in alcohol. It is employed in medicine as a cathartic.

2463 Euphorbium. *Euphorbium.*—This substance is obtained from the *euphorbia officinalis*, which is a native of Ethiopia. The milky juice which flows from incisions made in the plant, is dried in the sun. It is in the form of small yellow tears. It has no smell, and at first no perceptible taste, but it communicates afterwards a burning sensation to the mouth. It is soluble in alcohol. It has been considered as poisonous.

2464 Asafœtida. *Asafœtida.*—This gum-resin is obtained from the *ferula asafœtida*, a perennial plant, which is a native of Persia. It is extracted from the roots by cutting off the extremity. The milky juice flows out, which is dried in the sun. It is brought to Europe in large irregular masses, which are of a whitish, reddish, or violet hue. It has a strong, fetid, alliaceous smell, and a bitter acrid taste. It is but partially soluble, both in alcohol and in water. It is much employed in medicine as a stimulant and antispasmodic.

2465 Ammonia. *Ammoniac.*—This gum-resin is supposed to be obtained from another species of the ferula, a plant which grows in Abyssinia and in the interior parts of Egypt. It is brought from the East Indies, usually in large masses, which are composed of little lumps or tears, of a milky colour. When exposed to the air, it is changed to a yellow colour. It has a nauseous, sweet taste, which is succeeded by a bitter. It has a peculiar smell. It is not fusible; but when placed on hot coals, it burns away in flame. It forms a milky solution with water and vinegar, and it is partially soluble in alcohol.

2466 Myrrh. *Myrrh.*—It is not yet known from what plant this substance is obtained. It is brought from the East Indies in the form of tears; is light and brittle, of a reddish-yellow colour, and an unctuous feel. It has a bitter aromatic taste, and a strong but somewhat grateful odour. It does not melt, and burns with difficulty. It is more soluble in water than in alcohol. With the former the solution is yellow and opaque; with the latter it is transparent.

2467 Sarcocol. *Sarcocol.*—This substance is supposed to be the product of the *penæa sarcocolla*. It is brought from Persia and Arabia, in the form of small whitish-yellow grains. It has a bitter and somewhat sweetish taste. It is almost entirely soluble in water.

2468 Galbanum. *Galbanum.*—This substance is obtained from the *bubon galbanum*, a perennial plant which grows in Africa. The milky juice sometimes exudes from the joints of the old plant, but is most commonly procured by cutting them across. This juice becomes hard, and is the galbanum brought to Europe. It is in the form of whitish-yellow tears, has a bitterish acrid taste, and a peculiar smell. It forms a milky solution with water, wine, and vinegar. It is scarcely soluble in alcohol. It does not melt, but yields a considerable proportion of oil by distillation.

2469 Sagapenum. *Sagapenum.*—It is only conjectured that this gum-resin is obtained from the *ferula persica*. It is brought in large masses or distinct tears from Alexandria. It is of a yellow colour, becomes hot in the hand, but is not fusible. It has a hot, nauseous, bitterish taste, and a disagreeable garlic smell. It is sparingly soluble in alcohol, but dissolves almost entirely in water. It yields by distillation a fetid volatile oil.

Opoponax.—This gum-resin is obtained from the *pastinaca opoponax*, a perennial plant which grows wild in the south of Europe. It is obtained by wounding the stock or root, and is in the form of round drops or tears, or in irregular masses of reddish-yellow colour. 2470 Opoponax. It has a bitter, acrid, and somewhat nauseous taste, with a strong peculiar smell. It forms a milky solution with water, and yields an essential oil by distillation.

Gamboge.—This gum-resin is obtained from the *stalagmitis gambogioides*, a tree which grows wild in Siam and Ceylon. 2471 Gamboge. In Siam it is procured in drops by breaking the leaves and young shoots, from which it is supposed to derive the name of *gum guttæ*. In Ceylon it is obtained by wounding the bark and collecting the juice, which is afterwards dried in the sun. It is brought from the East Indies in cakes or rolls. It is of a orange-yellow colour, opaque and brittle, has no smell, and little taste, leaving only a slight sense of acrimony when it has been kept in the mouth. It forms a turbid yellow solution with water, and is almost entirely soluble in alcohol. It is employed in medicine, and is a violent cathartic.

Bdellium.—Little is known of this substance, or of the tree from which it is obtained. 2472 Bdellium. It is in the form of small pieces or tears of different sizes, of a golden-yellow colour, with a reddish tint. This substance, or a substance with the same name, was long celebrated among the ancient physicians.

XVIII. Of Wood.

1. If a piece of wood be boiled in a great quantity of water till it no longer gives out taste or smell, and if it be afterwards digested in alcohol, the substance which remains is the woody fibre. 2473 Preparation.

2. It is either in a fibrous, lamellated, or pulverulent form. 2474 Properties. This substance, which is more or less coloured, has neither taste nor smell, is not altered by exposure to the air, and is insoluble in water and alcohol.

3. When it is heated in contact with air, it blackens, exhales dense, acrid, pungent fumes, and leaves behind a coaly matter, which does not change its form. 2475 Action of heat. By reducing it to ashes, it is found to contain a little potash, sulphate of potash and lime, phosphate of lime. When it is distilled in a retort it yields water, acetic acid contaminated with oil, a thick oily matter, carbonated hydrogen and carbonic acid gases, and a portion of ammonia, combined with acetic acid.

4. By the action of nitric acid on quinquina, which resembles the woody fibre, Fourcroy obtained from 100 parts the following products: 2476 Compositions.

Oxalic acid	56.250
Citric acid	3.905
Malic acid	0.388
Acetic acid	0.486
Azotic acid	0.867
Carbonate of lime	8.330
	70.226
Residuum,	32.031

A quantity of carbonic acid gas was also disengaged, which

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which was not estimated. The increase of weight is ascribed to the oxygen which combined with the bases of the acids which were formed during the decomposition of the woody fibre by the nitric acid. The residuum, by distillation, yielded a yellowish fluid mixed with alcohol and some acetic acid, a concrete oil solubl in alcohol, charcoal, and carbonate of lime, besides carbonic acid and carbureted hydrogen gases. The component parts of wood, therefore, appear to be, oxygen, carbon, hydrogen, azote, and lime.

2477 Proportions of charcoal. The relative proportion of wood in plants has been estimated by the proportion of charcoal which they afford. From different woods, Proust obtained charcoal in the following proportions.

Black ash	25
Guaiac	24
Pine	20
Green oak	20
Heart of oak	19
Wild ash	17
White ash	17

XIX. Of Tan.

2478 Preparation. 1. Tan is obtained from a great number of vegetable substances. It exists in considerable proportion in oak bark and nut-galls; and it is obtained from the latter by the following process.

Reduce a quantity of nut-galls to a coarse powder, infuse them in water till it is saturated, pour off the liquid, and boil it to dryness. A black matter remains, which is *tan*, nearly in a state of purity. It is proposed also to extract tan from nut-galls by other processes. If a solution of muriate of tin be added to the infusion of nut-galls, a copious precipitate of a yellow colour is produced. When this is separated by filtration, and dried, it is in the form of a buff-coloured powder. It is a compound of oxide of tin and tan. It is then mixed with water, and a stream of sulphurated hydrogen gas is passed through it. An insoluble sulphuret of tin is formed, and the tan is dissolved in water. By filtration and evaporation of this water to dryness, a brown substance remains, which is tan; but by this process it is not perfectly pure, being mixed with a portion of extractive matter. It has also been proposed to separate tan from the infusion of nut-galls by means of concentrated sulphuric or muriatic acid, carbonate of potash, or lime water.

2479 Properties. 2. Tan is a brittle substance, of a brown colour, has a very astringent taste, is soluble in water and alcohol, to both of which it communicates a brown colour and very astringent taste.

2480 Action of heat. 3. When it is heated, it becomes black, gives out carbonic acid gas, and burns in the open air, leaving behind a small quantity of lime.

2481 Acids. 4. Tan is precipitated from the infusion of galls, by means of sulphuric, nitric, and muriatic acids, and forms with them compounds which are soluble in water.

2482 Alkalies. 5. The alkalies combine with tan, and form compounds which are soluble in water. A reddish brown colour is produced in the liquid by the addition of potash or soda, and it loses the property of precipitating gelatine. Ammonia forms a similar compound with the infusion of galls.

6. Most of the earths combine with tan, and form with it compounds which are chiefly insoluble in water. Lime water, added to the infusion of galls, produces an olive-coloured precipitate. A similar precipitate is obtained by means of barytes, strontites, and magnesia. 2483 Earths.

7. The metallic oxides combine with tan, and form compounds which are nearly insoluble in water. Similar precipitates are obtained by means of many of the metallic salts. The green sulphate of iron produces no precipitate; but the red sulphate gives a deep-blue precipitate, which becomes black by exposure to the air, or when it is dried. This is the base of writing ink, as was formerly described in treating of the sulphate of iron. 2484 Metallic oxides and salts.

8. Tan forms an insoluble compound which gelatine, which is the principle of the important process of tanning leather, and is nothing more than the combination of tan with the animal matter called *gelatine* or *glue*. 2485 Gelatine.

9. Tan is chiefly found in the bark of trees; it is also found in the leaves, the wood, the sap, and sometimes it is obtained by spontaneous exudation, as is the case with the substance called *kino*. Several varieties of tan have been found in different vegetable substances, as in catechu, dragon's blood, sumach, and fustic. 2486 Exists in the bark chiefly.

10. The quantity of tan varies with the age and size of the tree, and at different seasons. The greatest proportion has been found in the inner bark. Sir H. Davy ascertained the quantity of tan obtained from the solid matter extracted by water, from an ounce of different vegetable substances. 2487 Proportion varies.

	Solid Matter.	Tan.
White inner bark of old oak	108 grs.	72 grs.
young oak	111	77
Spanish chesnut	89	63
Leicester willow	117	79
Coloured or middle bark of oak	43	19
Spanish chesnut	41	14
Leicester willow	34	16
Entire bark of oak	61	29
Spanish chesnut	53	21
Leicester willow	71	33
elm	—	13
common willow	—	11
Sicilian sumach - - - -	165	78
Malaga sumach - - - -	156	79
Souchong tea - - - -	—	48
Green tea - - - - -	—	41
Bombay catechu - - - -	—	261
Bengal catechu - - - -	—	231
Nut-galls - - - - -	180	127 *.

* Phil. Trans. 1803.

The following proportions of tan were found by adding a solution of glue to the infusion of the plant in water. 2488 Proportions in different plants.

	Proportion of Tan.		Proportion of Tan.
Elm	2.1	Horse chesnut	2.2
Oak cut in winter	2.1	Beech	2.4
		Willow	

Component Parts of Vegetables.

	Proportion of Tan.		Proportion of Tan.
Willow boughs	2.4	Poplar	6.0
Elder	3.0	Hazel	6.3
Plum tree	4.0	Ash	6.6
Willow trunk	4.0	Spanish chesnut	9.0
Sycamore	4.1	Smooth oak	9.2
Birch	4.1	Oak cut in spring	9.6
Cherry tree	4.2	Leicester willow	10.1
Sallow	4.6	Sumach	16.2 *.
Mountain ash	4.7		

* *Phil. Trans.* 1799.

XX. Of Suber.

2489 Constitutes the epidermis. 1. The vegetable substance denoted by the name of *suber*, is, according to Fourcroy, the epidermis or outer covering of trees. This substance is analogous to common cork, which is the epidermis of the *quercus suber*, from which the name of this peculiar vegetable substance is derived.

2490 Properties. 2. It is a light, soft, elastic substance, is insoluble in water, but readily absorbs this liquid. Common cork is the same substance, having greater density, and accumulated in greater quantity.

2491 Action of heat. 3. This matter is very combustible, and burns with a white vivid flame, leaving behind a very black, light, voluminous coaly matter. When distilled, it yields ammonia.

2492 Of nitric acid. 4. When cork is treated with nitric acid, carbonic acid gas and nitrous gas are evolved. The cork is decomposed, and converted, partly into a yellow, soft, unctuous matter, which swims on the surface, and partly into suberic acid; the nature and properties of which have been already described.

XXI. Of Alkalies.

2493 Fixed alkalies only found. 1. The fixed alkalies only have been detected in plants, and there are few plants which do not yield a smaller or greater proportion of one of these alkalies. It is supposed that they exist in plants, in combination with acetic and carbonic acids.

2494 Potash. 2. Potash, formerly called *vegetable alkali*, because it was supposed to exist only in vegetables, is found in all plants except those which grow near the sea. The process for extracting it has been already described. The vegetables are reduced to ashes by burning; the ashes washed with water, which is filtered and evaporated to dryness. The potash remains behind.

3. Shrubby and herbaceous plants yield a greater proportion of ashes than trees. The branches of trees afford more ashes than the trunks, and the leaves more than the branches. Other salts are found mixed with the potash, such as the sulphates of potash and of lime, muriate of potash, phosphate of lime, and phosphate of potash; the last of which has been detected in maize and wheat. In the following table the proportion of ashes obtained from 100 parts of different plants, and the quantity of potash which these ashes yield, are exhibited.

	Ashes.	Potash.
Sallow	2.8	0.285
Elm	2.36727	39.——
Oak	1.351185	0.15343
Poplar	1.23476	0.07481
Hornbeam	1.1283	0.1254
Beech	0.58432	0.14572
Fir	0.34133	0.00000
Vine branches	3.397	0.55
Common nettle	10.67186	2.5033
Common thistle	4.04265	0.53734
Fern	5.00781	0.6259
Cow thistle	10.5	1.96603
Great river rush	3.85395	0.72234
Feathered rush	4.33593	0.50811
Stems of Turkey wheat	8.86	1.75
Wormwood	9.744	7.3
Fumitory	21.9	7.9
Red clover		0.078
Vetches		2.75
Beans with their stalks		2.

4. Soda is generally found in all marine plants, and in many others which grow near the shore. The proportion of soda which many plants containing it yield, is very considerable. A hundred parts of the *salsola soda* afford 19.921 of ashes, from which may be extracted 1.992 part of soda. It is from different species of *fuci* that the soda or kelp of Britain is obtained. The soda of commerce is extracted from two species of salsola, the *sativa* and the *vermiculata*, which grow abundantly on the shores of Spain and the Mediterranean. 2495 Soda.

5. Of late several compounds of vegetable origin possessing alkaline qualities have been discovered by chemists, and ranked among the alkalies. The first of these is *morphine*, found in opium, in which it exists in combination with the *meconic acid*. The process for obtaining it consists of the following steps. 1. To boil a strong solution of opium along with a little magnesia. This earth combines with the meconic acid, and leaves the morphine free, but precipitated along with the meconate of magnesia. 2. The mixed precipitate, after being gathered on a filter and washed with cold water, is treated with weak alcohol at 150°, which separates the colouring matter. 3. It is then boiled in pure alcohol, which dissolves the morphine, and, while it cools, deposits it in white crystals. Morphine turns syrup of violets green, and turmeric brown. It is found to be the active matter from which opium derives its power over the animal economy. Another alkali has been obtained from the Angustura bark, and has been named *brucine*, from the name of the genus by which this bark is yielded, the *brucea anti-dysenterica*. A third, from the seeds of *delphinium staphisagria*, is called *delphine*; and a fourth, *strychnine*, is obtained from the *strychnos nux vomica*. Here a most extensive field has been opened for chemical research; and we may expect a rapidly increasing list of similar vegetable compounds, by manipulations performed on the different species of plants, particularly those known to possess active qualities, or the products of which present any remarkable character. 2496 New alkalies.

XXII. Of Earths.

1. Four of the earths have been detected in vegetables, namely lime, silica, magnesia, and alumina. 2497 Lime.

Few

Component Parts of Vegetables.

Few plants have been found which do not contain some portion of lime. It is the most abundant of all the earths in plants.

2498 Silica. 2. Silica has been found in several plants, and chiefly in the epidermis, some of which are almost entirely composed of this earth. A hundred parts of the epidermis of the following plants yielded the annexed proportions of this earth.

Bonnet cane	90
Bamboo	71.4
Common reed	48.1
Stalk of corn	6.5

2499 Magnesia and alumina. 3. Magnesia is more rarely found in vegetables. It has been detected in considerable proportion in the fuci and other sea plants. The greatest proportion yet discovered is found in the *salsola soda*. A hundred parts of this plant have yielded 17.929 of magnesia.

4. Alumina is found in plants in very small quantity.

2500 Proportion of earths. 5. In the following table is exhibited the quantity of earths in general, found in 100 parts of different plants.

Oak	1.03
Beech	1.453
Fir	0.003
Turkey wheat	7.10
Sun-flower	3.72
Vine branches	2.85
Box	2.674
Willow	2.515
Elm	1.96
Aspen	1.146
Fern	3.221
Wormwood	2.444
Fumitory	14.000

Herbaceous plants, it appears, contain a greater proportion of earths than trees. In all the kinds of grain which Bergman examined, he found all the four earths. From 100 parts of oat grain, Vauquelin obtained a residuum of 3.1591, which by analysis he found to be composed of

Silica	60.7
Phosphate of lime	39.3
	100.0

By burning the stem and seeds of the same grain, the residuum by analysis afforded the following substances:

Silica	55
Phosphate of lime	15
Potash	20
Carbonate of lime	5
	95

Some traces of oxide of iron were also detected.

XXIII. Of Metals.

2501 Iron and manganese. The only metallic substances which have certainly been found in plants are iron and manganese. Iron has been detected in the ashes of salsola; and manganese has been found in the ashes of the pine, green oak, calendula, vine, and fig-tree. Gold, it is said, has been found in some plants, but in very minute proportion.

Functions of Animals.

Chap. XIX. Of ANIMALS.

Animals constitute the second division of organized matter. They are distinguished from vegetables by texture, form, and component parts. The more characteristic differences between animals and vegetables are, the locomotive power of animals, irritability, and sensibility. Animal matters pass to the putrid fermentation, and they are all soluble in the alkalies. Sulphuric acid reduces them to a carbonaceous matter. Charcoal is precipitated, and ammonia is disengaged. Nitric acid acts violently on animal substances, with the evolution of azotic gas. 2502 Character.

In treating of animal matters, we shall first consider the functions of living animals; 2. The decomposition of animal matters; and, 3. Their component parts. These subjects shall occupy the three following sections.

Sect. I. *Of the Functions of Animals.*

In taking a view of animal substances, it is necessary to consider the functions of the living animal, so far at least as these functions admit of explanation on chemical principles. It is beyond the reach of human sagacity fully to understand the simplest processes in the animal economy. These cannot be explained on chemical or mechanical principles; but to comprehend clearly and fully, even what is known of the functions of living animals, it would be necessary to enter into a description of the structure and nature of the organs by which they are performed. This is not the province of chemistry; it belongs to Anatomy and Physiology. We must here content ourselves with giving a short account of the chemical changes which take place by the action of living animals. The functions of animals which have occupied the attention of chemical physiologists, and which we propose to treat of in this section, are respiration, digestion, secretion, and assimilation. 2503 Cannot be explained on chemical principles.

I. Of Respiration.

1. Respiration is to be considered as one of the vital functions of animals. No animal can exist when it is interrupted, nor indeed can it be suspended, even for a short time, without hazard. The mechanical part of this function, consists in alternately drawing air into the lungs, and expelling it. 2504 A vital function.

2. That all gases are not fit for respiration is well known. Some indeed, as carbonic acid gas, the moment they are inhaled, are destructive to life. Others, although not productive of such sudden effects, prove ultimately fatal to the animal which is forced to respire them. Animals are very differently constituted, both with regard to the structure of their respiratory organs, and with regard to the quantity of air which must be respired in order to support life. In these respects, the hot and cold-blooded animals differ much from each other; and even among the cold-blooded, there are some tribes which require a very small quantity of air, and can bear with much less apparent 2505 All gases not fit for respiration.

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Functions of Animals.

apparent inconvenience a temporary interruption of this function; but for all animals, whatever be their nature, whatever be their structure, or whatever be the modifications of their respiratory system, the air of the atmosphere is best adapted for the support of life. It is the oxygen of the air which is necessary for the breathing of animals; but although animals live longer in a given quantity of oxygen gas
2506 Not even pure oxygen. than in atmospheric air, as appears from the experiments of Count Morozzo, related in the chapter on oxygen gas, yet it is too powerful, or too stimulating for their organs; for to such as have been confined to breathe it, it has been found highly injurious.

2507 Some fatal to life. 3. Some of the gases prove immediately fatal to life; such for instance is carbonic acid gas. It seems to be certain that no animal ever made a full inspiration of this gas unmixed, without being destroyed. It is so noxious to animal life, that the organs themselves, by an involuntary action, obstruct it in its passage to the lungs. Other gases are equally fatal after a few inspirations, such as hydrogen and azotic gases; and indeed it is probable, that if the lungs were completely emptied of air, before the inspiration of any gas whatever, excepting oxygen gas or atmospheric air, a single inspiration would prove fatal. This, however, is never the case; for after the fullest expiration, a considerable quantity of air remains in the lungs. We may conclude, therefore, that the air of the atmosphere is the only gaseous substance proper for the respiration of animals, and the support of life.

2508 The same air can only be once respired. 4. The same quantity of atmospheric air or oxygen gas, after having been once respired by animals, becomes totally unfit for farther respiration, either by the same animals or any other. It is then deprived of a great part of the oxygen, and contaminated with noxious gases. This even happens to fishes and insects, which require a very small quantity of air. If the water in which the former live be deprived of its air, it is equally fatal to them, as immersion under water is to those animals which live in the air of the atmosphere.

2509 The quantity. 5. Attempts have been made by physiologists to ascertain the quantity of air respired by animals. This must be extremely different in the different classes. Even in the same class of animals, it is probable that it varies much. The difference of the results of experiments on man to ascertain this point is enormous. No conclusion whatever can be drawn from the number of respirations made in a given time, even if this could be determined with any degree of accuracy, which is scarcely to be expected. For no function of the body is sooner influenced by mental affections than the breathing. The very attention implied in reckoning the number of respirations has some effect in occasioning deviations from the natural number. Some have reckoned the number of respirations 14 in a minute, while others make it amount to 27, which shews that little dependence can be placed on any precise statement of the number. But even if this could be accurately ascertained, still it would not enable us to ascertain the quantity of air respired. For it is extremely probable that this quantity varies greatly in different men and in different animals, and in the same animal at different times, arising from causes, the operation of which either entirely eludes observation, or is altogether inappretiable. Accordingly we find that the differences of the results of observations made on the quantity of air taken in at a single inspiration, or of the quantity calculated in the lungs after expiration, 2510
are not less than those of the number of respirations. Changes on the air.

6. The nature of the changes which the air inspired undergoes has been ascertained with more accuracy. Part of the air which is respired disappears; and this part consists of oxygen. Dr Menzies estimates the quantity of oxygen gas consumed by a man in 24 hours at rather more than 41 oz. troy. Lavoisier fixes it at $32\frac{1}{2}$ oz. nearly; and Sir H. Davy gives as the result of his experiments and calculations about $32\frac{1}{2}$ oz.

7. The air thrown out of the lungs by expiration contains at the same time a quantity of carbonic acid gas exactly equal in volume to the oxygen which disappears. 2511 Gases expired.

8. Water in the state of vapour is also thrown out of the lungs during respiration. 2512 Water.

9. The blood, as it flows from the left side of the heart, is of a bright red colour. It is conveyed from this organ by the arteries to every part of the body. It is then taken up by the veins, and carried back to the heart, by the venous system. The blood having thus circulated through the body, enters the right side of the heart, its colour being totally changed. It is now of a dark purplish red colour, instead of the bright red which it possessed when it passed out of the heart, to be distributed through the body. But before the blood can go to the left side of the heart to enter the general circulation again, it must pass through the lungs, where it re-acquires the bright red colour. From the lungs it proceeds to the left side of the heart, from which it flows as before through the arterial system to all parts of the body. The blood thus acquires this florid red colour in the lungs. 2513 Circulation of the blood.

10. This change was ascribed by some of the earlier chemical physiologists to the absorption of air. Dr Priestley observed that venous blood, which was of a dark colour, became of a bright red when exposed to oxygen gas, and that hydrogen gas produced a contrary effect. The same thing has been since observed by other chemists. According to Dr Priestley, the blood was deprived of its phlogiston as it passed through the lungs; according to the theory of Lavoisier and others, no part of the air inspired is absorbed; the blood gives out hydrogen and carbon, which, combining with the oxygen of the air, form water and carbonic acid. He supposed that the quantity of oxygen in the water and carbonic acid expired was equal to that which had disappeared during respiration. According to another theory, the oxygen gas combines with the blood, and while this combination takes place, the carbonic acid gas and water which are expelled from the lungs along with the azotic gas, are given out. According to later experiments, it appears that there is no reason for believing, that any part of the air inspired passes into the blood. The oxygen, when it has entered the lungs, seems to unite there with the carbon, which is conveyed from the blood-vessels to the air-cells, by a species of secretion. Nor is there any reason for believing, that the formation of water by the combination of oxygen with hydrogen, 2514 Changes on the blood.

gen, is one of the effects of the function of respiration.

2515 Purposes of respiration. 12. What are the purposes accomplished by these changes? What are the definite uses of respiration in the animal economy?—As the blood is the source from which are derived the materials for repairing the constant waste of the body, it is necessary that means should be provided to supply this waste, to which the blood is constantly subjected. This is accomplished, as we shall find afterwards, by the process of digestion, the product of which is conveyed to the blood. But before it can be converted into blood, it must undergo certain changes, which take place in the lungs. The separation of the superfluous carbon is an essential
2516 To form fibrina. change, and the only one perfectly ascertained. There is one essential part of the blood, and an essential part also of solid animal organs, namely the fibrine, which does not exist in the chyle and lymph, which are the substances conveyed to the blood, to repair its waste, before they have passed through the lungs along with the blood. Hence it is supposed that one purpose of respiration is to form the fibrine of the blood.

2517 To preserve temperature. 13. Another great purpose of respiration in the animal economy is to preserve the proper degree of temperature necessary for the health and life of the animal. It is well known that the temperature of animals is not regulated, like that of inorganized matter, by the surrounding medium. In whatever temperature animals are placed, except in those extreme degrees of heat or cold which destroy life, the temperature of the body continues almost uniformly the same, and this temperature, it appears, corresponds to the quantity of air inspired. Hence it is that the temperature of the lower orders of animals which require but a small proportion of air, as insects, fishes, and amphibious animals, is not much higher than that of the medium in which they live, and on this account they constitute a division of animals which have been distinguished by physiologists by the name of *cold-blooded animals*. The temperature of warm-blooded animals, whatever be that of the medium in which they live, is from 96° to 140°. The temperature of man is about 98°, while that of birds, which require a greater proportional quantity of air, is usually 5° or 6° higher.

2518 Theories of animal heat. 14. The manner in which the temperature of the body is kept up by means of respiration, has been thus accounted for, on the principles of Dr Black's theory of latent heat. Part of the latent heat of the air, which was inspired and combined with the blood, is given out, and thus raises the temperature of the blood, and that of the whole body through which it circulates. But if this change took place in the lungs, and all the latent heat of the air inspired was extricated in these organs, it was urged as an objection to this theory, that the temperature in them would be much higher than in other parts of the body. According to the theory of Crawford, the capacity of arterial blood for caloric, or the specific caloric of arterial blood, that is, the quantity of caloric which is necessary to raise it to a given temperature, is greater than that of venous blood; and the caloric disengaged in the lungs by the combination of oxygen with carbon, which is strictly analogous to the combustion of charcoal, immediately disappears again, being requisite to keep up the existing temperature of the blood, now enlarged in its capacity for caloric by passing from the venous to the arterial state. And the specific caloric of arterial blood, as it circulates through the body, is more and more diminished, in proportion as it is converted into venous blood; caloric, therefore, is evolved. In this way it has been proposed to obviate the objection of the temperature of the lungs being highest, if, as it has been supposed, the whole of the caloric is here evolved; and to account for its gradual evolution, and the consequent uniformity of temperature which exists in every part of the body. Such are two of the important purposes which seem to be accomplished by means of the function of respiration; namely, the complete formation of the blood, and the preservation of animal temperature.

II. Of Digestion.

1. The animal body is subject to continual waste, and the quantity of this waste varies according to the nature and age of the animal. This waste is repaired by the blood, which must consequently receive some supplies, to make up for its continual consumption. On this account, all animals require food or nourishment, to compensate for the waste of the body, and directly for the consumption of the blood from which this waste is supplied. 2519 Waste of the body.

2. Different animals, according to their nature, constitution, and the circumstances in which they are placed, require different kinds of food. Some animals live entirely on vegetables, others feed exclusively on animals, while a third class feed indiscriminately on vegetables and animals. But whatever be the kind of food, or whatever the nature of the animal, it is all converted, by the process of digestion, into the same uniform substance. In most animals the food, as it is taken into the mouth, is broken down, mixed with the saliva, and conveyed to the stomach, and after it has remained there for a short time, it is totally changed, and is converted into the uniform substance above alluded to, called *chyme*. 2520 Food of different animals different.

3. In attempting to account for the functions of the animal body, chemists and physiologists have been always too much disposed to consider the changes which take place within the body, as analogous to those which take place on inorganized or dead matter, in supposed similar circumstances. Accordingly we find among the speculations of philosophers, that digestion has been ascribed to fermentation. By one set it was ascribed to the vinous or acetous; and by another set to the putrefactive fermentation. But now, that the nature and circumstances of the processes both of fermentation and digestion have been more accurately observed, this opinion is exploded. The experiments of physiologists, also, have led to more rational views of the function. 2521 False analogies of physiologists.

4. It is now found, that the conversion of the food into chyme is effected by the action of a peculiar fluid secreted in the stomach, from which it has been denominated *gastric juice*. This liquid possesses different properties in different animals, for those animals which live entirely on vegetables cannot digest animal food, and the gastric juice of those which have been accustomed to live entirely on animals, has no effect on vegetables. It is true, indeed, that the nature of animals in this respect, as well as in most of their habits, may 2522 Gastric juice.

 be

be completely reversed, when their habits are changed by slow degrees. All substances taken into the stomach are not equally acted upon by the gastric juice. Some of the hardest are readily dissolved, while others, seemingly less compact and durable, remain unaltered. The husks of grain in the stomachs of many animals resist its action, while the hardest bone is consumed.

2523 *Its nature unknown.* 5. No accurate knowledge has yet been obtained concerning the constitution of the gastric juice. According to some, it is of an alkaline nature; according to others, it possesses acid properties. But this difference of opinion is by no means to be wondered at, if we consider the difficulty, perhaps the impossibility, of obtaining the gastric juice in a state of purity, to subject it to chemical examination. Even if it were possible to collect it perfectly pure, its effects could not be the same as within the body, since all animal matters, the moment they are separated from the living body, begin to undergo new changes, and to exhibit new properties. All experiments, therefore, which have been made, to ascertain the nature of the gastric juice, and the process of digestion out of the body, must be regarded as inconclusive. They shew us the effects of this liquid in the state of dead matter, but can lead to no knowledge of its nature and properties while it exists in the living body (B).

2524 *Food converted into chyme.* 6. Whatever be the nature of this liquid, or the process of digestion, the food, as we have already observed, is broken down in the mouth and mixed with the saliva, which, in the first instance, probably contributes much to favour its commencement; for the process of digestion is considerably deranged when the secretion of saliva is interrupted, or its usual quantity diminished. All, then, that is certainly known concerning this change is, that the food conveyed to the stomach is in a very short time converted into chyme.

2525 *Which is changed into chyle.* 7. The chyme, which is a soft, pulpy matter, after being formed in the stomach, is carried to the intestines, where it is mixed with other substances, and undergoes new changes. As soon as it has passed into the intestines, it is converted partly into a milky fluid called chyle, and partly into excrementitious matter. Thus it is decomposed by some process, and separated into two parts, one of which is destined for the nourishment and reparation of the body, while the other is ejected.

2526 *Chyle separated into two parts.* 8. The chyle, when formed from the chyme, mixes with the bile which flows from the liver into the intestines. In consequence of this combination, it is supposed the excrementitious matter is separated from the chyle, and is thrown out of the body; while the chyle itself is taken up by a set of vessels called *lacteals*, which open on the inner surface of the intestines, and receiving this fluid, convey it to a large trunk in which they all terminate, denominated, from its situation in the thorax, the *thoracic duct*. The use of the bile is supposed to be, to separate the excrementitious matter which might prove injurious to the system, if it were absorbed along with the chyle; for this purpose the bile, it is supposed, is decomposed; its saline and alkaline constituents combine with the chyle, by which it becomes more liquid, while the resinous and albuminous matter, combine with the excrement, and in this state act as a stimulant to the intestines, so that the contents, which might prove injurious, if long retained, are the more speedily ejected.

2527 *Is totally changed.* 9. As a proof that the food which has been taken into the body has been totally changed, substances have been detected in the excrement of different animals which did not previously exist in the food. According to Vauquelin, excrementitious matter is always distinguished by an acid property. Benzoic acid has been detected in that of horses and cows. An acid of a peculiar nature has been found in the dung of pigeons; in general this matter is much disposed to ferment, and at last gives out ammonia.

In the analysis of the excrement of a hen by Vauquelin, compared with the nourishment, he found that while the oats which were taken in were composed of phosphate of lime and silica, that the shells of the eggs, and the excrements which were examined, consisted of phosphate of lime, carbonate of lime, and silica. The proportion of silica which was found in the excrement was less than the quantity taken in; but the quantity of phosphate of lime was increased, and a quantity of carbonate of lime, which did not previously exist in the food, was formed *.

* *Ann. de Chim.* xxix.

2528 *Properties of chyle.* 10. Little is known of the properties of the chyle, excepting that it possesses some in common with milk. Like milk, it coagulates, and divides into a serous and oily matter. In the thoracic duct the chyle is mixed with another fluid called the lymph, which is conveyed from all parts of the body by a set of vessels denominated the *lymphatics*. This fluid is in considerable quantity, is viscid and colourless; but from the difficulty of collecting it, little is known of its properties. The lymph and the chyle, thus mixed together, are conveyed by the thoracic duct to the blood-vessels. It is mixed with the blood in the veins, and conveyed by them to the right side of the heart, from which it is carried to the lungs, where it undergoes the changes already described in the account of respiration, and the whole is converted into arterial blood, which returns to the left side of the heart, from whence it is distributed to all parts of the body.

2529 *Of lymph.*

III. Of Secretion.

2530 *Matter separated from the blood.* 1. In the course of the circulation of the blood, different substances are separated from it, some of which are destined for the growth and nourishment of the body, as in young animals, or for the repair and supply of parts that are destroyed; while other substances, which seem either to be superfluous, or if retained, would

(B) The stomachs of young animals contain a substance which has the property of coagulating milk. Acids also have this property, from which it has been concluded that the substance in the stomach of young animals, which produces this effect on milk, is of an acid nature; but it ought to be recollected, that when used by us it is out of the body, and has undoubtedly undergone new changes; and besides, it is not known exactly what different substances may have the property of inducing this change on milk.

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would be injurious, are thrown out of the body. These secretions are performed by peculiar organs, the description and operation of which belong to ANATOMY and PHYSIOLOGY. At present we will give a short account of two of the most important of these secretions, namely, the secretion of urine, and that of perspirable matter.

2531 By the kidneys. *Secretion of urine.*—The urine, which is an excrementitious matter, is separated from the blood by the action of the kidneys. According to the observations of anatomists and physiologists on the structure and office of these organs, a great proportion, or even, as some suppose, the whole of the blood, passes through them. As the urine secreted by these organs seems to serve no purpose in the animal economy, since the whole of it is thrown out, it is probable that the substances of which it is composed, or at least their constituents, would have proved injurious if they had been retained.

2532 Is an important change. 2. Whatever the change be which takes place on the blood by the action of the kidneys, it is of the utmost importance to the health and even to the life of the animal; for if these organs are destroyed by disease or accident, death is the certain consequence.

3. By the action of the kidneys on the blood, new substances make their appearance. Such are urea and uric acid, which exist in the urine, but cannot be detected in the blood; but the bases or constituents of these substances must have formed part of some of the matters of the blood, which are therefore decomposed for their evolution; and this decomposition must take place in these organs. The urine, or secreted matter, has been accurately analysed, and its component parts, after it is thrown out of the body, pretty well ascertained; but it is yet unknown what are the peculiar changes which the blood undergoes by the action of the kidneys.

2533 Secretion from the skin. *Perspiration.*—1. A considerable quantity of matter is separated from the blood by means of a set of vessels on the skin of animals. This action is called *perspiration*, and the substance emitted, *perspirable matter*. The attention of physiologists and chemists has been long directed to ascertain the quantity and nature of the matter thus thrown off. To ascertain the first point, many experiments have been made. Sanctorius, an Italian physician, was the first who made this attempt, by weighing himself at stated times for many years, and estimating the quantity of food which was taken in, and the quantity of excrementitious matter thrown off. The difference, he supposed, indicated the quantity of matter perspired; but neither in his experiments, nor in those of many others, who endeavoured to ascertain the same thing, was any estimate made of the quantity of matter given out by the lungs.

2534 Quantity. 2. With this distinction in view, a set of experiments was instituted by Lavoisier and Seguin. The latter was inclosed in a varnished bag, which prevented the escape of every thing thrown off from the body, excepting what was lost by respiration. Having previously weighed himself, and continued the experiment for some time, the quantity of matter thrown off by respiration was ascertained, by weighing a second time. By weighing himself afterwards without the covering, and repeating the operation at the end of a similar interval, he was enabled to ascertain the quantity lost by cutaneous transpiration alone, by subtracting what had been previously ascertained to have passed off from the lungs, from the whole diminution of weight indicated in the preceding experiment. From the experiments thus conducted, the following conclusions were drawn.

a. In a state of health, and when there is no disposition to corpulence, the body returns to the same weight once every 24 hours.

b. Indigestion retards transpiration. The weight is increased for four days, and on the fifth the body returns to its original weight.

c. Drink only, and not solid food, increases the perspiration. It is least at the moment of taking food, and immediately after.

d. The perspiration is greatest during digestion.

e. The greatest quantity of matter perspired amounted in a minute to 26.25 grains troy; the least to nine grains.

f. The pulmonary transpiration is proportionally greater than that of the skin. It is greater in winter, on account of the necessity of preserving the temperature of the body.

3. The quantity of matter perspired is greatest during hot weather, and in hot climates. The quantity too bears a relation to the quantity of urine. The following are the results of the experiments of Rye, made in Ireland, on the relative proportion of urine and perspirable matter, which were excreted in the course of one day at different seasons of the year.

	Matter perspired.	*Urine.*
	Ounces.	Ounces.
Winter,	53	42
Spring,	60	40
Summer,	63	37
Autumn,	50	37

4. When the temperature to which the body is exposed is much elevated, the quantity of perspired matter is greatly increased, and it then appears in a visible liquid form called *sweat*. This answers a very important purpose in the animal economy, for by this means the equilibrium of temperature is preserved. The heat which is absorbed is carried off along with the matter which evaporates from the surface of the body, and thus the increase of temperature, which would otherwise prove fatal, is prevented. 2535 Sweat.

5. The next object of chemical physiologists was to ascertain the nature of the substance which is perspired. This has been found extremely difficult, on account of the small quantity which it has been possible to collect. But it has been ascertained to consist chiefly of water and carbon, with an oily matter. Phosphoric acid also, and phosphate of lime, have been detected in the perspirable matter. In the air which has been confined in contact with the skin, carbonic acid gas has been detected; from which it is concluded, that either the carbon must have been evolved, and combined with the oxygen of the air, or the oxygen gas must have been absorbed, and combining with the carbon, is given out in the state of carbonic acid. The former is the conclusion drawn. The oily matter which is emitted by the skin, is supposed to occasion the 2536 Component parts.

Functions of Animals. the peculiar smell by which animals are distinguished. The remarkable circumstance of a dog being able to trace another animal to a great distance by the smell, or to discover his master by the same means to a much greater distance, is ascribed to the emission of this matter. The matter perspired, according to Berthollet, possesses acid properties, and the acid he supposes is the phosphoric. Phosphate of lime has been detected in the skins of horses by Fourcroy and Vauquelin.

2537 Other secretions. Besides these there are other secretions which are destined for peculiar purposes in the animal economy, or immediately connected with the functions of particular organs, or parts of the system. Such is the secretion of saliva in the mouth, of tears in the eyes, of mucus in the nose, and wax in the ears. The secretion of milk in the female is destined for the nourishment of the offspring; but we shall not enter into the description of the organs employed in these secretions. The nature and properties of the matters secreted will come under our consideration in treating of the different parts of animals.

IV. Of Assimilation.

2538 Waste of the body must be repaired. 1. The continual waste and decay of the body require to be repaired. This, as we have already seen, is the purpose of taking nourishment into the body; part of which being subject to the processes of digestion and respiration, is converted into blood, from which source are derived those supplies of new matter which are wanted in the formation of new parts, or to make up the general decay of the system. New supplies of matter are peculiarly necessary, in young animals, in which the parts already formed increase in size and consistency, and in which, in the progress of the growth of the body, entirely new parts are evolved. But if there be any truth in the speculations of physiologists, of the whole matter in the body being periodically changed, even after it has arrived at its full growth, a constant supply of new matter becomes absolutely necessary. All these supplies are furnished by the blood, and for this purpose it is distributed to every part of the body. The materials for repairing the general waste, for increasing those parts which are already formed, or for the formation of new parts, are all derived from it. From this source are derived the most fluid, as well as the most solid parts of the body; the saliva of the mouth, and the gastric juice of the stomach, so necessary in the function of digestion, by which the health and life of the animal are preserved, as well as the bones and muscles, which give it strength, firmness and motion. The process by which the different substances furnished by the blood for the repair of some parts and the formation of others, has been distinguished by the name of *assimilation*, because, in consequence of new actions and combinations, matter exactly similar to the parts repaired or renewed, is deposited, which did not previously exist in the blood.

2539 By particular organs. 2. These changes are effected by the action of peculiar organs or vessels. Whatever be the nature of the food taken into the stomach, it is converted into chyme by the process of digestion. This again, by a farther change, as it passes into the intestines, forms the chyle, which is conveyed to the blood, and after this fluid has undergone the changes which are induced on it by respiration, it has acquired those properties which render it fit for the important purposes to which it is destined. Decomposition of Animal Substances.

3. By the action of the different secretory organs, the same matter is always separated in each from the blood, while the animal continues in the healthy state. 2540 Which always secrete the same matter. The perspirable matter is separated by the glands or vessels on the skin, and the saliva is prepared by the glands of the mouth. The matter of bones, of muscles, or of nerves, is separated and deposited in those places where it is required, and no other. While the body continues healthy, muscular matter is not deposited among the bones, nor is osseous matter mixed with the muscles.

4. The most astonishing part of the animal system is that power which it possesses of accommodating itself to particular circumstances. 2541 Functions vary with circumstances. It would be less surprising that the same actions and the same functions, after they have commenced, should continue to be performed with uniformity and regularity. But, in the animal system, new actions take place, or at least those which were comparatively feeble and limited, become more powerful and more extensive. Thus, a part of the body which has been destroyed or removed is, by this new or extended action, completely renovated. A large piece of muscle in the healthy state of the body is soon renewed; and, what is more surprising, the constituent parts of bone are prepared, when necessary, and deposited in those places where large pieces of this substance have been removed.

5. But although some, or perhaps all these changes which take place in the different processes going on in the animal system, are of a chemical nature, yet they are subject to the controul of some power, the characteristics of which are totally different from those of a chemical or mechanical agent. 2542 Are regulated by the living principle. This is the living principle, which counteracts, regulates, and directs the effects of chemical agents. It is by means of this power that the materials of which the different parts of the body are composed, are deposited in their proper places. It is by means of the same power that a greater quantity of matter necessary for the renovation of any particular part which has been destroyed, is prepared and deposited exactly in that place where it is wanted. But the power of this agent is limited. Certain substances taken into the stomach, which are unfit for digestion or nourishment, are immediately rejected; others are too powerful, and destroy the organ itself. As the strongest proof of the existence and controul of this power, the constituent parts of animal bodies begin immediately to decompose each other as soon as its action has ceased. The gastric juice of the stomach, which acts only on the substances introduced into it in the living state, has been sometimes found to corrode and destroy the stomach itself, after death. But the investigation of the nature of this agent, and of its influence on the animal body, belong to PHYSIOLOGY.

SECT. II. *Of the* DECOMPOSITION *of* ANIMAL SUBSTANCES.

1. As soon as an animal has ceased to live, its frame and texture are destroyed, the constituent parts are separated,

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parated, they enter into new combinations, new substances are formed, and the component parts are totally changed. The rapid spontaneous decomposition of animal matters, which has been called *putrefaction*, is
2543 Decomposition of vegetables and animals different.
one of the most striking characters by which they are distinguished. Vegetable matters, we have seen, when vegetation ceases, are also subject to decomposition; but in them the process is slow and gradual, and many of the products are totally different.

2544 Owing to the difference of composition.
2. The remarkable difference between the spontaneous decomposition of vegetables and animals, depends on the difference of the constituent parts of these two classes of organized substances. Animal matters are composed of a greater variety of constituent principles, and hence arises a greater variety of action, when the different component parts begin to act on each other. By the numerous and complicated attractions which exist among these constituent principles, decomposition is more readily effected, and a greater variety of new products make their appearance.

2545 Conditions of putrefaction.
3. But notwithstanding the varied and complicated structure of animal substances, total decomposition or putrefaction does not take place, except in certain circumstances, by which the mutual action of the constituent principles is promoted. The chief circumstances necessary for the putrefaction of animal matter are, moisture and moderate heat. Dry animal matters hardly undergo any change. Bones, when moistened with water, the soft parts of animals, and still more the liquid parts, run rapidly on to putrefaction. Heat is also necessary to promote this change. No putrefaction takes place at or below the freezing temperature. Before it commences, the temperature must be elevated some degrees above this point, and as the temperature rises, the rapidity of the process is proportional. This condition, however, has its limits; for when the heat reaches a certain point, so far from promoting the process of putrefaction, it totally retards or interrupts it, by carrying off the moisture. The contact of air was once thought necessary to favour this process; but although it appears that this is not an essential condition, putrefaction goes on more rapidly in the open air, perhaps by receiving and carrying off the elastic fluids as they are formed, as well as by the action of its oxygen. Matters which have already undergone this change, brought in contact with recent animal substances, promote and accelerate their putrefaction.

2546 Phenomena.
4. When animal matters are placed in favourable circumstances, the solid parts become soft, and the liquid parts more fluid. The colour changes, and is converted into a reddish brown, or deep green. The odour, which is at first disagreeable, becomes fetid and insupportable. An ammoniacal smell is diffused; but this is only temporary, while the putrid odour continues during the whole process. The liquids become turbid, the soft parts are melted into a kind of jelly, accompanied with an intestine motion, and an enlargement of the bulk of the whole mass, owing to the escape of elastic fluids, which are slowly disengaged. The whole matter is then reduced to one mass, the swelling ceases, the bulk is diminished, and the colour deepens. Towards the end of the process, a peculiar odour, somewhat aromatic, is emitted. When it ceases entirely, an unctuous, viscid, and fetid earthy mass remains behind.

5. The duration of this process is extremely various, according to the nature of the substances and the circumstances in which they are placed; but it has been divided by some into different stages. In the first there is merely a tendency to putrefaction, accompanied with 2547
a very slight change of texture and colour. The second change, or incipient actual putrefaction, exhibits The process different.
some traces of acidity; the parts are more softened, a serous matter begins to flow from the relaxed fibres; the colour is more altered, and the putrid fetid odour exhaled. In the third or more advanced stage of putrefaction, the fetid odour is more or less mixed with the smell of ammonia; the dissolved putrid matter acquires a deeper colour, and is diminished in weight by the escape of a great quantity of volatile matter. In the last stage, or when the process is completed, the ammoniacal odour vanishes, the fetid smell becomes less powerful, and is often succeeded by something of an aromatic smell. The animal matter has diminished greatly in bulk, and has lost all appearance of organized structure. There remains only a dark brown, earthy substance, unctuous to the feel, which has been called *animal earth*. But these changes are regulated by the particular circumstances in which the process takes place. 2548

6. In the course of the putrefactive process of animal substances, different gases are successively emitted. Elastic fluids.
These are chiefly carbureted, sulphureted, and phosphureted hydrogen gases, water in the state of vapour, ammonia, and carbonic acid gas. These bodies are evolved and volatilized, carrying with them some of the principal constituents. Other products, formed at different periods of the process, and of a more fixed nature, make their appearance; such, for instance, are an unctuous matter, and a kind of soap, formed of this matter and ammonia; such too is nitric acid, which is frequently formed during this decomposition, and is combined with an earthy or alkaline base; and such finally is the unctuous earth which remains after the evolution and separation of the former products. 2549

7. The process of putrefaction, then, consists in a change produced by the action of affinities, more Nature of the process.
powerful than those which hold together the constituent principles of the animal matter. These constituents are, hydrogen, azote, carbon, and oxygen, with a small proportion of sulphur, phosphorus, and different species of phosphates. During the decomposition, a portion of the hydrogen combines with azote to form ammonia, while another portion probably combines with part of the oxygen to form water; part of the carbon is united with a portion of oxygen, to form carbonic acid; the union of azote with a third portion of oxygen constitutes nitric acid; a combination of hydrogen, carbon, and azote, yields a volatile or fixed oil, according to the proportion of the constituents; and finally, the saline, earthy, and metallic substances, which are little susceptible of change, during this process, remain unaltered, and constitute the residuum. Thus, in taking a general view of the affinities which come into action during this process, the amount of those which tend to combine the hydrogen with the azote, to form ammonia; the oxygen with the carbon, to form carbonic acid; the carbonic acid with the ammonia, to form carbonate of ammonia; the hydrogen, carbon, and oxygen, to form oil, and this last with ammonia

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Component Parts of Animal Substances. ammonia to constitute soap, besides the hydrogen and oxygen to form water, is greater than the sum of the forces which retain in combination, the hydrogen, the azote, the carbon and oxygen, which are the principal constituents of animal compounds.

2550 In the open air. 8. Such are the results when the process is conducted in close vessels. When it takes place in the open air, similar results are obtained, but in a manner somewhat different, according to the nature of the compounds which are formed. In this case part of the animal substance is dissolved, and carried off by the air and the water. The ammonia and carbonic acid are dissipated as they are formed; part of the carbureted hydrogen is also volatilized by the increase of temperature, and no unctuous matter or ammoniacal soap is formed.

2551 Cause of the fetid odour. 9. It is well known that the odour which proceeds from putrid animal matters is extremely offensive. This is owing, in a great measure, to the sulphureted and phosphureted hydrogen gases disengaged. This is not merely offensive, but noxious to the health, and sometimes destructive to the life of animals. These effects are no doubt owing to the putrid effluvia which are exhaled, and which are taken into the lungs during respiration. To counteract the effects of those putrid exhalations, attention should be paid to agitate the air of inhabited places by proper ventilation, which may be done by burning wood in the vicinity of infectious air, so that the smoke may be mixed with it, or by directing currents of water into similar places. To destroy the noxious effects of putrid *miasmata*, which are produced in confined places, frequented by numbers of people, muriatic acid gas, disengaged from common salt by means of sulphuric acid, has been successfully employed. Oxymuriatic acid gas has also been proposed for the same purpose.

2552 Method of preserving animal matters. 10. It is an object of considerable importance in domestic economy, to prevent the process of putrefaction in those animal substances which are to be preserved and employed as food. It is also an object of some importance for many other purposes. Different methods have been proposed to accomplish this. It is effected by depriving the animal matters entirely of their moisture, without which the process is interrupted. Animal matters are also preserved by keeping them at the freezing temperature, or below it. The same object is attained by covering up matters to be preserved with such substances as readily enter into combination with water, and thus prevent its effects upon the animal matters. The acids, sugar, alcohol, and some salts, it is supposed, act in this way, by preventing putrefaction. With the same view aromatic and resinous substances, volatile oils, camphor, the powder of dried astringent and fragrant plants, charcoal and bitumen, are employed.

Sect. III. *Of the Component Parts of Animal Substances.*

Having given a short account of the functions of living animals, and of the spontaneous decomposition which takes place after death, we now proceed to take a view of their component parts, as they have been investigated by chemical analysis. This shall be the subject of the present section, which, for the sake of perspicuity of arrangement, will be subdivided under the four following heads: I. Of the constituent parts of animal substances in general. II. Of the liquid parts of animals. III. Of the solid parts; and IV. Of substances peculiar to different classes of animals.

I. Of the Constituent Parts of Animal Substances in General.

The simple substances which enter into the composition of the different parts of animals, are chiefly azote, carbon, hydrogen, and oxygen, of which, arranged in different proportions, the soft parts are composed; phosphorus and calcium, which constitute the basis of the hard parts; sulphur, the fixed alkalies, muriatic acid, iron, and manganese. But by the constituent parts of animals, are here to be understood those substances into which they are resolved by analysis. Some of these are compound, and some are simple, as will appear from the following enumeration. 2553 Elements.

2554 Component parts.

1. Gelatine,
2. Albumen,
3. Fibrina,
4. Urea,
5. Sugar,
6. Oils,
7. Resins,
8. Phosphorus,
9. Sulphur,
10. Acids,
11. Alkalies, earths, and metals.

I. Of Gelatine.

1. Glue, a well known substance in the arts, is gelatine in a state of impurity. This may be obtained pure by repeatedly washing the fresh skin of an animal in cold water, afterwards boiling it, reducing it to a small quantity by a slow evaporation, and allowing it to cool. It then assumes the form of a solid tremulous substance called jelly. When this substance is dried in the air, it becomes hard and semitransparent. 2555 Preparation.

2. Gelatine has different degrees of hardness, and when pure, it is colourless and semitransparent. It is brittle, breaks with a vitreous fracture, and has neither taste nor smell. 2556 Properties.

3. When it is exposed to heat, in the dry state, it becomes white, then blackens, and is converted into a coaly matter. Tremulous gelatine melts before it undergoes these changes. When it is distilled, it affords a watery fluid, impregnated with ammonia and a fetid oil. A voluminous mass of charcoal remains behind. 2557 Action of heat.

4. Gelatine remains unaltered in the dry state by exposure to the air; but the solution in water is soon decomposed, giving out an acid, the nature of which is unknown, a fetid odour, and some ammonia. It is not very soluble in water; it increases in bulk, and becomes soft and tremulous. In this state it soon dissolves in warm water; but as the solution cools, it returns to its former state. 2558 Of air and water.

5. With the assistance of heat gelatine is readily dissolved 2559 Acids.

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solved by the acids. Sulphuric acid acts slowly on this substance, and forms a brown solution, which becomes gradually darker with the evolution of sulphurous acid. Nitric acid, by digestion on gelatine, is decomposed; azotic gas is evolved, and afterwards a great quantity of nitrous gas. The gelatine is dissolved, and converted partly into oxalic and malic acids, and an oily matter which remains on the surface. Muriatic acid readily dissolves gelatine, and forms a brown-coloured solution, from which a white powder is gradually precipitated. When this solution is added to the solution of tan in water, a copious precipitate is formed.

2560 Alkalies. 6. Gelatine is readily dissolved by the alkalies, with the aid of heat. There is no action between any of the earths and this substance.

2561 Metallic oxides. 7. Some of the metallic oxides form precipitates with gelatine in its solution in water. The compound thus formed is insoluble. Similar precipitates are occasioned by some of the metallic salts.

2562 Tan. 8. Gelatine forms a copious white precipitate with tan. A brittle compound is thus produced, which is insoluble in water, and is not changed by exposure to the air.

2563 Composition. 9. The component parts of gelatine are carbon, hydrogen, azote, and oxygen, with some traces of phosphate of lime and of soda, but the proportions of these substances have not been determined.

2564 Different kinds. 10. There are various kinds of gelatine, probably arising from slight variations of the proportions of its constituents, or from the addition of other substances, the nature of which has not been distinctly ascertained. Glue is extracted from different animal substances, as bones, muscles, membranes, but especially from skins, by first steeping them in lime-water, to purify them from all extraneous substances, and afterwards boiling them with pure water. The strongest glue is obtained from the skins of old animals. What is called *size*, is a weaker kind of glue, which is colourless and transparent, and is extracted from the skins of eels, horses, cats, rabbits, and from some kinds of white leather. It is this which is employed in the manufacture of paper, and in gilding and painting. Isinglass, another kind of glue, is extracted from different parts of the sturgeon, and some other fish.

2565 Found in different parts of animals. 11. Gelatine forms a principal part both of the solid and fluid parts of animals. It is found in blood and in milk, in the bones, ligaments, skin, and other solid parts.

2566 Uses. 12. Animal jelly, which is gelatine, is well known as a very nutritious food, and is much employed in the state of glue, size, and isinglass, in numerous arts.

II. Of Albumen.

2567 Obtained from eggs. 1. The white of an egg consists chiefly of albumen. It is combined with a portion of soda and sulphur. From these substances it cannot be separated without decomposition, so that its properties are probably modified by them.

2568 Action of heat. 2. When albumen is exposed to a heat of about 165° it coagulates into a solid white mass, of different degrees of consistency, according to the duration of the heat applied. This is the characteristic property of albumen. In this state it has totally changed its properties. Formerly soluble in water, it cannot now be dissolved in that liquid, either hot or cold.

Coagulation. Different opinions have been formed concerning the nature of this change, or the cause of the coagulation of albumen. It has been ascribed by some to the absorption of caloric, and by others to that of oxygen. The former opinion was that of Scheele, and the latter is supported by Fourcroy; but this coagulation is found to take place when air is entirely excluded, or without any change being produced in the surrounding air. It has been supposed by others, that the coagulation is produced by the extrication of caloric, as in other cases when fluid bodies are converted into solids. According to an experiment of Fourcroy, this extrication of caloric actually takes place; but it is ascribed by others to a different arrangement of the particles of the albumen, which is induced by the action of the heat applied.

3. The properties of albumen, it has been observed, are very different after coagulation. Before coagulation it is a glairy liquid which has scarcely any taste, and no smell. When dried in a moderate heat, it becomes brittle and transparent, and by being spread thin, forms a varnish. When thus dried, it is not changed by exposure to the air, but otherwise it soon becomes putrid. Properties of uncoagulated albumen.

4. Albumen is coagulated by means of the acids. With the aid of heat, sulphuric acid dissolves it, and forms a solution of a green colour. By the action of nitric acid, azotic gas is disengaged: the albumen is then dissolved; nitrous gas is given out, and oxalic and malic acids are formed, besides a thick oily substance which appears on the surface. The coagulation of albumen does not take place when it is dissolved in a great proportion of water. Albumen is also coagulated by means of alcohol and ether, but if the quantity of water in which it is dissolved be considerable, the coagulation is not effected. Action of heat. Acids.

5. By trituration with a concentrated solution of pure potash, albumen, left at rest for some time, coagulates, and is converted into a substance resembling jelly, which is brittle and transparent when it is dried. No change takes place on albumen by the action of the earths. Alkalies.

6. Albumen is precipitated, from its solution in water, by many metallic salts. The precipitate is white, yellow, or brown, according to the metal employed. Metallic salts.

7. Tan precipitates albumen from its solution in water, in the form of a copious yellow substance, which is insoluble in water. It becomes brittle when dry, and is not changed by exposure to the air. Tan.

Coagulated albumen.—1. Albumen, when it is coagulated, acquires new properties. It is then a tough, opaque substance, of a pearly white colour, and of a sweetish taste. It is insoluble in water, and is less subject to change. When it is dried in the temperature of 212°, it is converted into a hard, brittle, yellowish substance, of the transparency of horn. When it is some time digested in water, it becomes soft, white, and opaque, like albumen newly coagulated. By long action a small part seems to be dissolved, but no precipitation is formed in this solution by the infusion of tan. Properties. Action of heat.

2. The mineral acids, largely diluted with water, dissolve a portion of coagulated albumen; but by the addition Acids.

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Component Parts of Animal Substances. addition of the same acids in their concentrated state, it is again precipitated. If coagulated albumen be kept in diluted nitric acid for several weeks, the acid acquires a yellow colour, which gradually deepens; the albumen becomes more opaque, but is not dissolved. By saturating the yellow-coloured acid with ammonia, no precipitate is formed, but it assumes a deep orange colour. If the albumen be then introduced into liquid ammonia, the latter assumes a deep orange colour, inclining to red. The albumen dissolves slowly, and after the solution is completed, it is of a yellowish-brown colour. By washing and boiling in water, the albumen thus treated with nitric acid is dissolved, the liquid becomes of a pale yellow, and assumes the form and appearance of jelly, when it is concentrated. If this mass be dissolved in boiling water, the solution is precipitated by tan; so that nitric acid has the property of converting coagulated albumen into gelatine.

2579 Alkalies. 3. Coagulated albumen is readily dissolved in a solution of potash by boiling. Ammonia is disengaged, and a soap is formed. If this soap be dissolved in water, and muriatic or acetic acid be added, a precipitate is formed which also has the properties of soap. When it is moderately heated, a portion of oil flows out, and a viscid brownish substance remains behind.

2580 Composition. 4. Albumen is composed of carbon, hydrogen, azote, and oxygen, but the proportions have not been determined. It is supposed by some that it contains a greater proportion of azote than gelatine.

2581 Exists in different parts of animals. 5. Albumen constitutes an essential part in the composition of bones and muscles. Cartilage, horns, and hair, consist almost entirely of this substance, as well as the membranous portion of shells and sponge.

2582 Uses. 6. Albumen is advantageously employed for clarifying liquids. The liquid to be purified is mixed with the white of eggs, the serous part of the blood, or other substances containing albumen, and then heated. By the action of heat the albumen is coagulated, and falls to the bottom, carrying with it those substances which were mixed with the liquid, and occasioned the opacity, and which, on account of the minuteness of the particles, could not be otherwise separated.

III. Of Fibrina.

2583 Obtained from blood. 1. Fibrina is readily obtained by allowing blood to remain at rest for some time after it has been drawn from an animal. The clot, which has formed and falls to the bottom, is to be separated, put into a linen cloth, and repeatedly washed with water, till the liquid come off insipid and colourless. The fibrous part of the blood, as it has been called, or the fibrina, remains behind.

2584 From muscle. Mr Hatchet obtained it by cutting lean beef into small pieces, macerating in water for fifteen days, changing the water daily, and squeezing it out at the same time by pressure. The muscular substance was boiled every day five hours for three weeks in a fresh portion of six quarts of water. The fibrous substance was then pressed, and dried with the heat of a water bath. What remained is considered as fibrina nearly pure.

2585 Properties. 2. Fibrina is of a white colour, soft and elastic, when it is recently extracted from blood; and as it dries the colour becomes deeper. When it is extracted by boiling and maceration from muscular matter, it is brittle, has some degree of transparency, and does not become so deep in the colour. It has neither taste nor smell. It is insoluble in water and alcohol, and is not changed by exposure to the air.

2586 Action of heat. 3. When it is exposed to heat, it contracts suddenly, and emits the smell of burning feathers. It melts with an increase of temperature. It yields by distillation, water, carbonate of ammonia, a thick fetid oil, carbonic acid, and carbonated hydrogen gas, with some traces of acetic acid. The coaly matter which remains behind burns with difficulty, on account of the phosphate of soda, phosphate and carbonate of lime, with which it is mixed.

2587 Acids. 4. Fibrina is soluble in the acids. The solution in sulphuric acid is of a deep brown colour; charcoal is precipitated, and acetic acid formed. When diluted nitric acid is added to fibrina, azotic gas is copiously disengaged. Fibrina kept by Mr Hatchet for 15 days in nitric acid diluted with 3 times its weight of water, gave to the solution a yellow colour, and it resembled in its properties the solution of albumen in the same acid. By this process, after being dissolved in boiling water, and concentrated by evaporation, the fibrina is converted into gelatine, which is soluble in hot water, and is precipitated by tan. The fibrina in this state also is almost entirely dissolved by ammonia, and the solution is of an orange colour. Fibrina is dissolved in boiling nitric acid, in which ammonia produces a precipitate, composed chiefly of oxalate of lime. During the action of the nitric acid, prussic acid passes over, with carbonic acid gas and nitrous gas. Oxalic acid is formed, and a fatty matter appears on the surface. Fibrina is also soluble in muriatic acid, with which it forms a green-coloured jelly. It is dissolved also in acetic, oxalic, tartaric, and citric acids, with the assistance of heat; and is converted, by concentrating the solutions, into a gelatinous mass. Alkalies precipitate fibrina from its solution in the acids, in the form of flakes which have the properties of gelatine, and are soluble in hot water.

5. Concentrated potash or soda, boiled upon fibrina, forms a deep brown coloured solution, which has the properties of soap. During the process ammonia is given out.

6. Fibrina is composed of carbon, hydrogen, azote, and oxygen, but the proportions are unknown. It is found only in the blood and muscular parts of animals.

IV. Of Urea.

1. The nature and properties of urea have been chiefly investigated by Fourcroy and Vauquelin. It is obtained from urine. It may be extracted by the following process.

2588 Method of preparing. If a quantity of human urine which has been passed a few hours after taking food, be evaporated with a gentle heat, to the consistence of a thick syrup, and allowed to cool, it concretes into a crystalline mass. Add to this mass in separate portions four times its weight of alcohol; with the application of a gentle heat, great part is dissolved, and what remains consists of different saline substances. Separate the solution from the undissolved part, and introduce it into a retort. Distil with the heat of a sand bath, and continue

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the boiling till the liquid is reduced to the form of a thick syrup. The matter which remains in the retort crystallizes as it cools. The crystals thus formed are *urea*.

2589 Properties.

2. Urea, which is prepared by this process, is crystallized in the form of plates, crossing each other. It is viscid, resembling thick honey, and of a yellowish white colour. It has a strong acid taste, and a fetid alliaceous smell. It deliquesces in the air, and by attracting moisture is converted into a thick brown liquid. It is very soluble in water, and also in alcohol. The solution in water concentrated is of a brown colour. This solution is gradually decomposed, air is emitted, which is partly composed of ammonia, and acetic acid is formed in the liquid. If the solution in water be boiled, and as the evaporation goes on fresh portions of water be added, the urea is decomposed; carbonate of ammonia is disengaged, while acetic acid is formed and charcoal precipitated.

2590 Action of heat.

3. By the action of heat urea soon melts, enlarges in bulk, and evaporates, emitting an extremely fetid smell. By distillation, benzoic acid first passes over, afterwards carbonate of ammonia, carbonated hydrogen gas, with a small portion of prussic acid and oil. What remains behind consists of charcoal, muriates of ammonia and of soda. The benzoic acid, the muriate of ammonia and muriate of soda, are considered as extraneous matter, so that the products of urea by distillation consist of the carbonate of ammonia, carbureted hydrogen gas, and charcoal. The component parts of urea, therefore, are supposed to be,

2591 Composition.

Oxygen	39.5
Azote	32.5
Carbon	14.7
Hydrogen	13.3
	100.0

2592 Action of acids.

4. If one-fourth of its weight of diluted sulphuric acid be added to the solution of urea, and heat be applied, an oily matter appears on the surface, which concretes on cooling. Acetic acid is found in the liquid which is collected in the receiver, and sulphate of ammonia remains in the retort. The whole of the urea may be converted into acetic acid and ammonia by repeated distillation.

Nitric acid produces a violent effervescence with the crystals of urea. The liquid becomes dark red, and during effervescence nitrous gas, azotic gas, and carbonic acid gas, are evolved. A concrete white matter remains after the effervescence has ceased, mixed with a small portion of the red liquid. The residuum produces a detonation with the application of heat.

Urea is soluble in muriatic acid, but it remains unchanged. A diluted solution of urea absorbs very rapidly oxymuriatic acid gas. Whitish flakes appear, which soon become brown, and adhere to the sides of the vessel. After the absorption, the solution gives out carbonic acid and azotic gases. Muriate and carbonate of ammonia remain in the liquid after the effervescence ceases.

2593 Alkalies.

5. Urea is readily dissolved in solutions of potash or soda. Ammonia is also disengaged, when urea is dissolved in solutions of barytes, lime, or magnesia. It is also disengaged by triturating pure potash in the solid state, with urea. Heat is produced at the same time. The mixture assumes a brown colour, and an oily matter is deposited.

Muriate of soda, dissolved in a solution of urea in water, affords, by evaporation, crystals in the form of regular octahedrons; but muriate of ammonia, dissolved in the same way, crystallizes in the form of cubes.

V. Of Sugar.

1. Sugar has only been discovered among animal matters in milk and in the urine of persons labouring under *diabetes*. Sugar is obtained from milk by evaporating fresh whey to the consistence of honey. When it cools, it concretes into a solid mass. This is to be dissolved in water, and being previously clarified with the white of eggs, to be filtered and evaporated to the consistence of syrup. Crystals of sugar of milk are deposited on cooling.

2. When sugar of milk is pure, it is of a white colour, has a sweetish taste, but no smell. It crystallizes in the form of regular parallelopipeds, terminating in four-sided pyramids. The crystals are semitransparent. The specific gravity is 1.543. It is soluble in seven times its weight of water.

3. When it is burnt, it exhibits the same appearances as vegetable sugar, giving out at the same time the odour of caromel. Similar products are obtained by distillation as from vegetable sugar; but the empyreumatic oil has the odour of benzoic acid.

4. By means of nitric acid the sugar of milk is partly converted into saclactic acid.

Sugar from diabetic urine.—This is obtained by evaporating the urine of persons labouring under diabetes. One twelfth of the weight of urine of a sweet-tasted substance of the consistence of honey has been obtained by this process. When this substance is treated with nitric acid, it affords oxalic acid in the same proportion as vegetable sugar; but no saclactic acid is formed, as when sugar of milk is treated in the same way. It has not been crystallized.

VI. Of Oils.

1. The oils which have been detected in animals have the characters of fixed oils. Sometimes they exist in the solid state, and sometimes they are liquid. Fat is a copious animal production, which has different degrees of consistence, as it is obtained from different animals. To purify it, it is cut into small pieces, which are to be well washed with water, and the membranous and vascular parts separated. It is then put into a shallow vessel along with some water, and kept melted till the whole of the water is evaporated. It is then of a pure white colour, without taste or smell.

2. It melts at different temperatures. Hogs lard requires only a temperature of 97°, while the fat extracted from meat by boiling requires a temperature of 127°. When the heat is raised to 400°, a white smoke is given out; as the heat increases it is decomposed, and becomes black. When hogs lard is distilled in a retort, carbonated hydrogen and carbonic acid gases, accompanied

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accompanied with a very offensive smell, pass over. A portion of water is also obtained, and a white oil which concretes in the receiver. Acetic acid and a portion of sebacic acid are also found in the receiver. A black mass remains behind in the retort.

2601 Acids. 3. Fat is insoluble in water and alcohol. It is dissolved and decomposed by the strong acids. If nitric acid be poured upon fat, and a moderate heat applied, the acid is decomposed, and the fat is converted into a yellow coloured ointment. Fourcroy calls this an oxide of fat; the oxygen of the acid having combined with the oily matter.

2602 Alkalies. 4. Fat combines with the alkalies in the same way as other oily substances, and with them it forms soap.

2603 Composition. 5. The constituent parts of fat, as appears from the products which are obtained from its decomposition, are oxygen, hydrogen, and carbon.

There are besides some other oily substances obtained from different parts of animals, as spermaceti from the head of the spermaceti-whale, spermaceti-oil, which is separated in the purification of the spermaceti, and train oil, extracted from the blubber of the whale, and from other sea animals.

VII. Of Resins.

1. Resinous substances are found in different parts of animals, or rather they exist in those substances which are secreted by animals.

2. A resinous substance is extracted from the bile of animals. It is extracted from the fresh bile of the ox, by muriatic acid, in the proportion of one part of the latter to 32 of the former. The mixture remains for some hours, is filtered, and a white coagulated substance is separated. The filtered liquid, which has a fine green colour, is to be evaporated in a glass vessel with a gentle heat. The evaporation is continued till a green-coloured substance precipitates, which is to be separated, and washed with pure water. This substance is the *resin of bile*.

2604 Properties. 3. It is of a dark-brown colour, but when spread thin, is of a fine green. The taste is extremely bitter.

2605 Action of heat. 4. When it is heated to the temperature of 122°, it melts. By increasing the heat, it takes fire and burns. It is soluble in cold and hot water, and also in alcohol; but it is precipitated from the latter by water. The alkalies also dissolve this substance, and form a compound which has the properties of soap. This substance is precipitated from all these solutions by means of diluted acids.

A resinous substance has also been discovered in human urine, in ambergris, which will be afterwards described, and in castor, civet, and musk.

VIII. Of Phosphorus.

2606 Given out during putrefaction. During the putrefaction of animal matters, phosphorus is given out in the state of phosphureted hydrogen gas, so that it must have entered as a constituent into these matters.

IX. Of Sulphur.

2607 Found in albumen. Albumen is always mixed with a portion of sulphur. It has been detected in the white of eggs and in milk, in the blood, in the urine and fæces, in the muscles, and in the hair. According to Proust, sulphur exists in the blood, in combination with ammonia, forming a hydrosulphuret of ammonia.

X. Of Acids.

No less than 12 different acids have been detected ready formed in animal bodies. These are, 2608 Enumeration of acids.

Sulphuric,	Malic,
Muriatic,	Benzoic,
Phosphoric,	Lactic,
Carbonic,	Uric,
Acetic,	Rosacic,
Oxalic,	Amniotic.

1. Sulphuric acid has been found combined with soda, forming sulphate of soda, in the liquor of the amnios of cows. Sulphate of lime has been detected in the urine of quadrupeds.

2. Muriatic acid exists in combination with soda in almost all the animal fluids, forming muriate of soda.

3. Phosphoric acid is found in great abundance in different parts of animals. The phosphate of lime constitutes the basis of the bones, and it exists also in almost all the solid parts of animals, and in most of the fluids. In the blood it is combined with iron.

4. Carbonic acid is found combined with lime in the urine of horses and cows. It has also been detected in fresh human urine.

5. Acetic acid is found in urine; but it has been detected in great abundance in the red ant, and was formerly called *formic acid*, at least combined with malic acid.

6. Oxalic acid has been found in urinary calculi.

7. Malic acid has been found in the liquid obtained from the red ant. This is obtained by bruising the ants, and macerating them in alcohol. The alcohol is driven off by distillation, and an acid liquid remains behind. By saturating this liquid with lime, and adding acetate of lead to the solution, a copious precipitate is formed, which is soluble in acetic acid, so that this liquid contains something besides acetic acid. If nitrate of lead be mixed with the acid liquid after it is saturated with lime, a precipitate is formed, which is the malic acid combined with lead.

8. Benzoic acid has been detected in human urine, and in considerable quantity in the urine of cows. It has been found in the blood, white of eggs, in glue, silk, or wool, in the sponge, and in mushrooms.

9. Lactic acid is obtained from milk, when it becomes sour. It is also said, that it has been found in new milk.

10. Uric acid exists in human urine, and forms one of the constituents of urinary calculi. One species of calculus, indeed, is composed entirely of this substance.

11. Rosacic acid is obtained from the urine of persons labouring under fevers and other disorders, when the urine deposits what is called a *lateritious sediment*.

12. Amniotic acid is obtained from the liquid of the amnios of the cow.

XI.

Component Parts of Animal Substances.

XI. Of Alkalies, Earths, and Metals.

2609 Alkalies. 1. The common alkalies have been found in animal fluids. Potash has been found in considerable abundance in the urine of quadrupeds. It has also been detected in the milk of cows. Soda is found in all the fluids. It is usually mixed with albumen. It is frequently combined with the phosphoric and muriatic acids. Ammonia also has been detected in urine.

2610 Earths. 2. The earths which have been detected in animals are, lime, magnesia, and silica. Lime forms, in combination with phosphoric acid, the basis of bones. It is also found in the same state in the other solid parts, as well as in most of the fluids. The shells of animals are composed chiefly of carbonate of lime. Magnesia has been found in human urine, combined with phosphoric acid and ammonia. It forms also one of the component parts of urinary calculi. Silica has only been found in similar concretions.

2611 Metals. 3. The only metal which has been detected in animals is iron, in combination with phosphoric acid, which forms a constituent part of the blood.

II. Fluid parts of Animals.

2512 Enumeration. We shall treat of the animal fluids in the following order:

1. Blood,
2. Bile,
3. Urine,
4. Milk,
5. Saliva,
6. Tears and mucus of the nose,
7. Humours of the eye,
8. Wax of the ear,
9. Synovia,
10. Semen,
11. Liquor of the amnios,
12. Fluids secreted by disease.

I. Of the Blood.

2613 Properties. 1. The blood is a fluid of a red colour, which circulates through the body, and is distributed by means of the arteries to every part of it, communicating, as we have seen, heat and nourishment. It is then reconveyed by the veins from the extremities to the heart. Human blood, and that of some other animals, is of a fine, purplish-red colour, has some degree of consistency, soft and soapy to the feel, of a sweetish saline taste, and a peculiar odour. The blood is found to vary in consistence, so that its specific gravity also varies from 1.053 to 1.126.

2614 Separates into two parts. 2. When blood, after it has been separated from the body, remains for some time at rest, it separates into two parts. One part, called the *clot* or *cruor*, is coagulated, and continues of a red colour; the other part, called the *serum*, remains fluid. The usual proportion of cruor to serum, is about one part of the former to three of the latter. This proportion, however, is subject to considerable variation.

2615 Action of acids. 3. The acids also coagulate blood, and decompose it. Concentrated sulphuric acid occasions a brown colour, with the production of charcoal. It is coagulated by nitric acid, with the evolution of azotic gas, and the production of carbonic and oxalic acids, besides some unctuous matter. Muriatic acid also coagulates blood, but without any perceptible change of colour. Oxymuriatic acid renders it as black as ink. Acetic acid also produces a coagulation.

4. The caustic alkalies dissolve the coagulum of blood, even when it has been produced by acids. If they are mixed with blood recently drawn, the coagulation is interrupted. Many saline bodies produce a similar effect by preventing coagulation, or decomposition. 2616 Alkalies.

5. The metallic oxides have little perceptible action on blood, except those which readily part with their oxygen. It is then coagulated. Almost all metallic solutions coagulate blood, and have the property, as well as the alkaline salts, of preserving it from putrefaction. 2617 Metallic oxides.

6. Many vegetable substances, when mixed with blood, prevent its putrefaction, such as sugar, volatile oils, camphor, resins. It is coagulated by solutions of gum and of starch. Tan produces a copious precipitate in blood, and gallic acid gives a black colour, owing to the iron which is contained in blood. The latter precipitate may be obtained by diluting the blood with a considerable proportion of water. 2618 Vegetable productions.

7. Blood, by remaining at rest, it has been observed, separates into two parts, the serum and the cruor. The serum is of a pale, greenish yellow colour, of a thinner consistence than blood; but retains its taste, smell, and soapy feel. The specific gravity is about 1.0287. In consequence of its containing a portion of soda, it gives a green colour to syrup of violets. Serum coagulates at the temperature of 156°. The same effect is produced by adding boiling water. This coagulum is of a grayish white colour, resembling the white of eggs. By breaking the coagulum to pieces, a fluid may be expressed from it, which has been called the *serosity* of blood. The residuum being washed with boiling water, exhibits the properties of albumen. 2619 Serum.

8. By diluting serum with six times its weight of water, and boiling it, the albumen is coagulated. The remaining liquid, if evaporated with a gentle heat, till it is considerably concentrated, assumes the form of jelly, and thus shews that it possesses the properties of gelatine. 2620 Gelatine.

9. By heating the coagulated serum in a silver vessel, the silver is blackened, in consequence of its conversion into a sulphuret, by combining with sulphur contained in the coagulum. It has been already mentioned, that this sulphur exists in the blood, in combination with ammonia, in the state of hydrosulphuret. 2621 Sulphur.

10. The serum of blood contains muriate of soda, carbonate of soda, phosphate of soda, and phosphate of lime. These salts may be obtained by mixing serum with double its weight of water, applying heat to coagulate the albumen, which being separated, and the remaining liquid filtered and evaporated, crystals are deposited on cooling. The soda exists in blood combined with gelatine and albumen, and is in its caustic state. It unites with the carbonic acid of the air during the evaporation. The component parts of serum, therefore, are the following: 2622 Different salts. 2623 Composition of serum.

Albumen,
Gelatine,
Hydrosulphuret of ammonia,
Soda,

Muriate

Component Parts of Animal Substances.

Muriate of soda,
Phosphate of soda,
Phosphate of lime.

2624 Cruor. 11. The cruor or clot of the blood, the other portion into which it spontaneously separates, is of a red colour, and has considerable consistence. Its specific gravity is about 1.245. By washing this substance with a small quantity of water, and continuing the process till the water passes off colourless, part of it is dissolved in the water, and part remains in the state of a solid white elastic substance, which is the fibrina of the blood. That part which is held in solution by the water contains the colouring matter. This solution converts the syrup of violets to a green colour. By exposure to the air it deposits albumen in the form of flakes. By the evaporation of this solution to dryness, and the addition of alcohol, part is dissolved. If this solution be evaporated, the residuum converts vegetable blues to green, and mixes with water like soap. This residuum contains albumen and soda. 2625 Albumen and soda.

2626 Iron. 12. If the watery solution be evaporated to dryness with a moderate heat, a quantity of iron remains behind, which may be separated by the magnet. It has been said that the quantity of iron in the blood of a healthy man amounts to more than two ounces; but this is little better than conjecture, founded on vague calculation. The iron in blood is combined with phosphoric acid. If the watery solution be evaporated to dryness, and the residuum obtained be calcined in a crucible, a red mass remains, which amounts to 0.0045 of the blood which was employed. Part of this residuum, which is phosphate of iron, is dissolved by digestion in nitric acid. From this it is precipitated of a white colour, by ammonia. With the addition of pure potash, the precipitate becomes red. By adding lime water to the solution which contains the potash, a precipitate is formed, which is phosphate of lime. By the action of these re-agents, it appears that the iron in the blood combined with phosphoric acid, is in the state of sub-phosphate. Phosphate of iron is insoluble in water, but soluble in the acids. It is partially decomposed by the alkalies, which carry off part of its acid, and leave the remainder with excess of iron. Thus it is that this salt is preserved in the state of sub-phosphate, by means of the soda which exists in the blood. 2627 Quantity conjectured.

2628 Fibrina. 13. The method of obtaining fibrina from blood has been already described. This substance may be separated by agitating, or stirring rapidly with a stick, the blood which has been newly drawn from the animal. The fibrina or fibrous matter being well washed and dried on paper, loses about two-fifths of its weight, and becomes hard and brittle. The mean proportion of fibrina in the blood of man has been estimated at 0.0028. The fibrina is formed in the blood as it passes through the lungs, and is deposited in the muscular part of animal bodies, of which it forms one of the principal constituents. When the fibrina is separated from the blood, the latter is no longer disposed to coagulate when it is left at rest. A flaky matter only is separated, which appears on the surface.

2629 Distillation. 14. Blood dried with a moderate heat, exhales a quantity of water which possesses a peculiar odour, owing to a portion of animal matter which it holds in solution. If the blood thus dried be distilled in a retort, a watery fluid passes over, afterwards carbonic acid gas, carbonate of ammonia, which crystallizes in the neck of the retort, a fluid oil, carbonated hydrogen gas, and an oily matter of the consistence of butter. A green powder is precipitated from sulphate of iron by the watery fluid. A portion of this powder is soluble in muriatic acid, and a small quantity of Prussian blue remains behind, from which it appears that prussic acid and an alkali are contained in the watery liquor.

A quantity of dried blood amounting to 9216 grs. was introduced into a large crucible, and being gradually heated, it became at first nearly fluid; it then swelled up, gave out abundance of yellowish-coloured fetid fumes, and at last took fire, and burnt with a white flame. The flame and the fumes ceasing to be emitted, were succeeded by a light, acrid smoke, which had the odour of prussic acid. When the matter had been deprived of about five-sixths of its weight, at the end of six hours it melted again; a purple flame appeared on the surface, with the evolution of dense acrid fumes, which being collected were found to possess the properties of phosphoric acid. One hundred and eighty-one grains of a deep black colour and metallic brilliancy constituted the residuum. It was attracted by the magnet. From these observations it appears that the constituent parts of the blood are the following. 2630 Action of heat. 2631 Composition.

1. Water,	6. Soda,
2. Fibrina,	7. Subphosphate of iron,
3. Albumen,	8. Muriate of soda,
4. Gelatine,	9. Phosphate of soda,
5. Hydrosulphuret of ammonia,	10. Phosphate of lime,
	11. Benzoic acid.

15. The constituent parts of blood vary considerably at different periods of life, and in different states of the body. The colouring matter of the blood of the fœtus has been found to be darker and more copious. It contains no fibrina or phosphoric acid. 2632 Varies at different periods, &c.

16. The blood of persons labouring under inflammatory disorders seems to possess different properties from that of persons in health. It then exhibits, soon after it is drawn from the body, what has been called by physicians the *buffy coat*, which is considered to be the characteristic of inflammation. This inflammatory crust has been found to consist of fibrina, so that the cruor deprived of this matter becomes soft, and is almost entirely soluble in water. The albumen of the serous part has also undergone some changes. It assumes a milky appearance when mixed with hot water, and does not coagulate when it is heated. 2633 Inflammatory.

17. The serum of the blood of persons labouring under diabetes, is deprived of its saline taste, has the appearance of whey, and somewhat of a saccharine taste. 2634 Diabetic.

II. Of Bile.

1. Bile is an important fluid in the animal economy. It seems to perform an essential part in the function of digestion. It is secreted from the liver, and is of a yellowish-green colour, has a soapy feel, a bitter taste, and 2635 Importance and properties.

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Component Parts of Animal Substances.

and a peculiar odour; but it varies in colour, and in some other of its properties, in different animals. It varies also in its specific gravity. It has been estimated at 1.0246. The experiments which have been made on bile relate chiefly to that obtained from the gall-bladder of the ox, hence denominated *ox-gall*. When bile is strongly agitated, it forms a lather like soap; and hence it has been called an *animal soap*. It mixes in all proportions with water, to which it communicates a yellow colour.

2536 Action of heat.

2. When bile is exposed to a moderate heat, it becomes thick, having lost a great part of its weight. The vapour it exhales has a peculiar offensive odour. A solid brown mass is thus obtained, which has a bitter, with somewhat of a sweetish taste, becomes soft with the heat of the hands, is ductile, attracts moisture from the air, and is soluble in water. This substance effervesces slightly with acids, and acquires a perceptible odour of musk or amber, when kept for some time. This has been called the *extract of bile*. When this process is conducted in close vessels, with the heat of a water bath, it gives out a clear aqueous fluid of a disagreeable odour, which undergoes no particular change by means of re-agents, if the distillation has not been carried too far, or the bile has not become in some degree putrid. If this latter circumstance has taken place, the watery product has frequently a strong odour of musk, and becomes turbid on cooling.

2537 Distillation.

When this extract of bile is heated in a retort, it is decomposed with peculiar appearances. When heat is gradually applied, a watery fluid, which is slightly muddy, and of a fetid odour, passes over. This fluid precipitates metallic salts, and contains almost always sulphurated hydrogen. The matter in the retort enlarges in volume, and the fluid which then comes over is of a brown colour, extremely fetid, and contains carbonate and zoonate of ammonia. Soon after an oil is evolved, which is at first liquid, and afterwards becomes of a brownish colour, thick, and empyreumatic, and of a most offensive fetid odour. At the same time carbonate of ammonia crystallizes on the sides of the receiver. There is then a copious evolution of an elastic fluid, composed of carbonic acid, carbonated and sulphurated hydrogen gases, holding in solution a small portion of oil. The carbonate of ammonia thus obtained, does not amount to the one-eighth part of the quantity which is extracted from the blood and from the bones of animals, from which it is supposed that the bile is less animalized than many other animal substances. There remains behind a black spongy mass of coal, which is easily burnt. This coaly matter, by exposure to the air, effloresces on the surface, which is found to be carbonate of soda. When it is well burnt, it preserves a deep gray colour; and there is separated, by means of cold water, nearly half its weight of carbonate of soda, a little muriate of soda, phosphate of soda, phosphate of lime, and some traces of iron.

3. Bile is decomposed by all the acids. A precipitate is formed, which is always of a green colour. Part
2538 Action of acids.
of this precipitate remains suspended in the solution, and is even dissolved by agitation. The solution being filtered, leaves on the filter a portion of coagulated albumen. By evaporation the liquid deposits a deep green flaky substance like pitch, which has considerable tenacity, swells up when put upon hot coals, readily takes fire, and burns like resinous matter. After the separation of this matter, the liquid affords by evaporation a salt with a base of soda.

Three different saline substances have been obtained by the action of acids on bile; the first with a base of soda, the second which crystallizes in small needles has lime for its base, and the third is a crystalline matter, of a slightly sweet taste, which is supposed to be similar to sugar. Thus it appears that acids act on bile in three different ways; they coagulate the albumen, which is precipitated; they combine with the soda by separating the oily matter which constituted the saponaceous part of the bile; and they decompose the phosphoric salts.

Concentrated sulphuric acid coagulates bile in the form of dense flakes, and communicates to it a deep colour. Nitric acid, after having formed a precipitate, of a green colour in the cold, assumes a golden yellow colour, when it is heated for a sufficient length of time. It converts a portion of bile into oxalic and prussic acids. Muriatic acid at first produces a green precipitate, which afterwards assumes a shade of a reddish violet colour, especially by means of heat. Oxymuriatic acid renders it white and turbid like milk. It changes the properties of the different constituents of bile, and occasions a precipitate similar to that matter which frequently constitutes *biliary calculi*. 2639

4. When the precipitate from bile by means of the acids is treated with alcohol, and every thing soluble in this liquid separated, there remains a whitish matter which is infusible, nearly insipid, insoluble, whether with cold or hot water, but soluble in solutions of the caustic fixed alkalies, which burns on red hot coals with the odour of horn, and which gives by analysis, similar products, especially carbonate of ammonia in considerable quantity. The coal which remains contains a portion of phosphate of lime. 2640

Phosphate of lime.

5. The alkalies deprive bile of its bitter taste; but they do not coagulate it.

Action of alkalies.

6. Thus it appears that the constituent parts of bile are the following.

Water,	Saccharine matter,
Albumen,	Muriate of soda,
Resin,	Phosphate of lime,
Soda,	Phosphate of soda,
Sulphurated hydrogen,	Iron.

2641 Uses.

7. Bile, it has been already observed, performs an important part in the function of digestion. The albuminous and saline parts combine with the chyle, and are conveyed to the blood. The resinous portion combines with the excrementitious part of the chyle, and is thrown out of the body.

Bile is employed in the arts for removing spots of grease and oil from woollen stuffs. It is also employed as a pigment. It is evaporated and reduced to the form of extract, and diluted with a little water, in which state it gives a brown colour.

III. Of Urine.

2642 Properties.

I. The properties of urine vary considerably, according to the constitution and health of the body, and the period when it is voided after taking food. The

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The urine of a healthy person is of a light orange colour, and uniformly transparent. It has a slightly aromatic odour, in some degree resembling that of violets. It has a slightly acrid, saline, bitter taste. The specific gravity varies from 1.005 to 1.033. The aromatic odour, which leaves it as it cools, is succeeded by what is called the *urinous smell*, which latter is converted to another, and finally to an alkaline odour. Urine converts the tincture of turnsole into a green colour, from which it is concluded that it contains an acid.

2643 Phosphate of lime.

2. By adding a solution of ammonia to fresh urine, a precipitate is formed in the state of white powder, which is found to be phosphate of lime. But if lime water be employed in place of ammonia, a more copious precipitate, of phosphate of lime, is obtained, from which it is concluded, that the phosphate of lime is held in solution with an excess of acid.

2644 Phosphate of magnesia.

3. A small portion of magnesia is also found mixed with the phosphate of lime which has been precipitated, derived from phosphate of magnesia, which has been decomposed by the alkali or lime.

2645 Carbonic acid.

4. The froth which appears when urine is evaporated is ascribed to the evolution of carbonic acid gas.

2646 Carbonate of lime.

5. Urine which has been kept in new casks, deposits small crystals, which effloresce in the air. These crystals have been found to possess the properties of carbonate of lime.

2647 Uric acid.

6. A brick-coloured precipitate is frequently formed in urine as it cools. This substance is uric acid, which exists in all urine, and may be obtained by evaporating fresh urine, dissolving it in pure alkali, and precipitating by means of acetic acid.

2648 Rosacic acid.

7. The urine of persons labouring under intermitting fevers, and some other diseases, deposits a copious sediment called the lateritious sediment, which consists of rosacic acid.

2649 Benzoic acid.

8. Benzoic acid also exists in urine. It is obtained by evaporating fresh urine to the consistence of a syrup, and adding muriatic acid. A precipitate is thus formed, which is benzoic acid. But it may be obtained by evaporating urine to dryness, separating the saline substances, and applying heat to the residuum. By this process the benzoic acid is sublimed, and crystallized in the receiver. The quantity of benzoic acid is more considerable in the urine of horses and cows than in human urine.

2650 Albumen and gelatine.

9. Albumen or gelatine has been found in urine, and is precipitated by means of an infusion of tan. The cloud which appears as urine cools, consists of these substances, which are increased in proportion during different diseases. The urine of persons labouring under dropsy contains a large quantity of albumen; and in the urine of those persons who are subject to indigestion, the albumen and gelatine are greatly increased.

2651 Urea.

10. Urea is the principal constituent of urine. The method of obtaining it from urine has been already described. It is to this substance that the taste, smell, and peculiar characters of urine are owing. If concentrated nitric acid be poured upon urine, evaporated to the consistence of syrup, crystals appear, which are the nitrate of urea. The quantity of urea secreted is very different in different circumstances.

2652 Resin.

11. A resinous substance resembling the resin of bile has been detected in urine, to which its colour is ascribed. Urine evaporated to the consistence of extract, mixed with sulphuric acid and distilled, gives out this resinous matter, which is soluble in water and in alcohol. When urea has been separated from urine by evaporation and crystallization, a saline mass remains. If this be dissolved in hot water, and spontaneously crystallized in a close vessel, two kinds of crystals are deposited. Those at the bottom are in the form of rhomboidal prisms, and consist of phosphate of ammonia mixed with a little phosphate of soda. The crystals in the upper part of the vessel are in the form of rectangular tables, composed chiefly of phosphate of soda. These were formerly called *sable salt of urine*, *microcosmic salt*.

2653 Muriate of soda.

12. Muriate of soda was the first saline substance detected in urine. It may be obtained by slowly evaporating it to the consistence of syrup. The salt crystallizes upon the surface, but in this case the form of the crystal is that of an octahedron, and not the cube, the usual form. The cause of this deviation is ascribed to the urea.

2654 Muriate of potash.

13. Muriate of potash is also found among the crystals which are formed during the evaporation of urine.

2655 Muriate of ammonia.

14. Muriate of ammonia is one of the salts which are found in urine. The crystals of this salt which are usually octahedrons, when they are formed in urine, assume that of the cube, a deviation which is also ascribed to the action of the urea.

2656 Sulphur.

15. Urine contains sulphur, which may be detected by holding paper stained with acetate of lead over urine when it is become putrid. The paper is blackened, which is owing to sulphur exhaled with the carbonic acid. Sulphate of soda and sulphate of lime have also been detected in urine.

2657 Component parts.

16. No less than 30 different substances have been detected in urine by chemical analysis, the principal of which are the following:

Water,	Rosacic acid,
Phosphoric acid,	Benzoic acid,
Phosphate of soda,	Benzoate of ammonia,
Phosphate of soda and ammonia,	Gelatine,
	Albumen,
Phosphate of ammonia,	Urea,
Phosphate of lime,	Resin,
Phosphate of magnesia,	Muriate of potash,
Phosphate of magnesia and ammonia,	Muriate of soda,
	Muriate of ammonia,
Carbonic acid,	Sulphur,
Carbonate of lime,	Sulphate of lime,
Uric acid,	Sulphate of soda.
Urate of ammonia,	

2658 Putrefaction of urine.

17. Urine is particularly prone to spontaneous decomposition. The time when this process commences, and the rapidity of the changes which take place, depend on the quantity of the gelatine and albumen. When the proportion of these substances is considerable, the decomposition is very rapid. This is owing to the great number of substances, and the united force of their attractions, overcoming the existing affinities of the different compounds of which fresh urine consists,

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Component Parts of Animal Substances.

consists, and especially to the facility with which urea is decomposed. This substance is converted during putrefaction into ammonia, carbonic acid, and acetic acid. Hence the smell of ammonia is always recognized while urine is undergoing these changes. Part of the gelatine is deposited in a flaky form mixed with mucilage. Ammonia combines with phosphoric acid, and the phosphate of lime is precipitated. It combines also with phosphate of magnesia, and forms a triple salt. The other acids, the uric, benzoic, the acetic and carbonic acids, are all saturated with ammonia. The following substances, therefore, are obtained from urine by putrefaction.

Ammonia,
Phosphate of ammonia,
Phosphate of magnesia and ammonia,
Carbonate of ammonia,
Urate of ammonia,
Acetate of ammonia,
Benzoate of ammonia,
Muriate of ammonia,
Muriate of soda.

Products nearly similar are obtained by the distillation of urine. The remarks, however, which we have formerly made, under the head of mineral waters, on the mode of combination of the ingredients of mixed saline solutions, apply to urine of all kinds, and in every state; i. e. the salts which are actually obtained, are not those which exist in the liquid, any more than other salts capable of being formed by different combinations of the acids and alkalies which are present. See N° 2225.

2659 Varies in different circumstances.

18. Such are the properties of human urine in its healthy state; the changes to which it is subject; and the products which are obtained, either by means of chemical analysis or spontaneous decomposition. But the nature and properties of urine vary considerably, according to the period of life, the time it is voided after taking food, different seasons of the year, the nature of the food, the influence of passions, and disease.

2660 Urine of infants.

In the urine of infants no phosphate of lime is found. The proportion of benzoic acid is considerable, and the quantity of urea is small. There is less acrimony, odour, and colour. As the period of life advances, the saline matters increase, especially the phosphate of lime, which is no longer required for the formation of bone.

2661 After taking food.

The urine, which is passed immediately after taking food, is white and colourless, and seems to contain little else but water. It is not till seven or eight hours after a repast, that the urine is completely formed.

2662 In warm seasons.

Urine voided during the warmer seasons of the year, or by persons who inhabit hot climates, is high-coloured and acrid, which is ascribed to a greater proportion of saline matter and urea. In winter also the urine is red and high-coloured, owing to a greater proportion of the earthy phosphates and of uric acid, which it then contains. It is no doubt considerably influenced by the modification of the action of the skin.

2663 Kinds of food.

The food frequently communicates its properties to the urine. The odour of garlic, of resinous substances and some aromatics, is often perceptible in the urine a few minutes after these substances are taken into the stomach, or even only applied to the skin. The fetid odour of the urine of those who have eaten asparagus, is well known. The colouring matters of some substances are communicated to the urine; such as the red colour of beet-root, the orange-yellow of rhubarb, or the colour of madder.

2664 Passions.

The passions of the mind have great influence on the secretion of urine, both in changing its properties and increasing its quantity. In these cases the urine is generally colourless, insipid, and without odour.

2665 Disease.

But the nature and properties of urine undergo still greater changes during disease. From these changes the empiric has attempted to form prognostics of the nature, progress, and termination of diseases.

At the commencement of fevers and inflammatory disorders, the urine is high-coloured and extremely acrid, scarcely becomes turbid on cooling, and deposits no sediment. In affections of the liver, such as jaundice, it is of a yellow orange colour, like saffron, and communicates its colour to the vessels into which it is received, or to those substances which are immersed in it. It is then called *bilious urine*. It seems to contain a portion of the colouring matter of bile. Towards the termination of febrile disorders, the quantity of urine is increased; and it deposits, as it cools, a crystalline or scaly matter, of the colour of peach flowers, which is called *critical urine*. The sediment is composed of phosphate of lime, rosacic and uric acids. During nervous affections, as in hysteria, the urine is perfectly limpid and colourless, inodorous and insipid. It has been observed, that the urine of gouty persons contains a smaller proportion of acid than usual. At the commencement of a paroxysm, the quantity of phosphoric acid seems to be diminished; but it gradually increases towards the termination of the fit, and is then in greater proportion than in ordinary health. The urine of persons labouring under rickets deposits a great portion of lime. The urine of an infant who died of worms, was found on analysis to contain oxalate of lime. In some cases of diabetes, the urine is colourless and insipid; in others it contains a great proportion of saccharine matter.

2666 Different animals.

19. The urine of other animals exhibits different characters from that of man, according to their nature, the diversity of their organs, their food, manner of respiration, and the medium in which they live.

2667 The horse.

The urine of the horse has a strong peculiar odour. It is turbid when voided, or soon after becomes muddy. A pellicle, which is carbonate of lime, forms on the surface when it is exposed to the air. It changes the syrup of violets to a green colour, effervesces with acids, and is precipitated by the alkaline carbonates. The urine of the horse yields no phosphorus. The component parts of the urine of this animal, as they have been ascertained by Fourcroy and Vauquelin, are the following:

Carbonate of lime	0.011
Carbonate of soda	0.009
Benzoate of soda	0.024
Muriate of potash	0.009
Urea	0.007
Water and mucilage	0.940
	1.000*

The

* Mém. Inst. ii. p. 44[illegible]

2668 The cow. The urine of the cow possesses nearly the same properties as that of the horse. It has a soapy feel, and a strong peculiar odour. It gives a green colour to syrup of violets, effervesces with acids, but is not altered by the alkaline carbonates. When it is exposed to the air, small crystals form on the surface. Its component parts are,

Carbonate of potash,
Sulphate of potash,
Benzoic acid,
Urea.

2669 The camel. The urine of the camel is more distinguished by its odour than any other, but it is analogous to that of the cow. It is not mucilaginous, and does not deposit carbonate of lime. The specific gravity of this urine is greater than any other. It produces a slight change on the infusion of violets, communicating a green colour. It effervesces with acids, and furnishes nitre, sulphate and muriate of potash, with the addition of sulphuric, nitric, and muriatic acids. It contains

Carbonate of potash,
Sulphate of potash,
Muriate of potash,
Urea.

2670 The rabbit. The urine of the rabbit, examined by Vauquelin, exhibits similar characters with that of the horse, the cow, and the camel. It becomes milky, and deposits carbonate of lime by exposure to the air. It converts vegetable blues to a green colour, and effervesces with acids. It contains the following substances:

Carbonate of lime,
Carbonate of magnesia,
Carbonate of potash,
Sulphate of potash,
Sulphate of lime,
Muriate of potash,
Urea,
Gelatine,
Sulphur,

2671 Guinea pig. The urine of the Guinea pig is analogous in its nature and properties to that of the larger animals already described.

2672 Graminivorous animals. It appears that the urine of graminivorous animals belonging to the class of mammalia, or which live on vegetables in general, contains no phosphoric salts, or uric acid; that it is loaded with carbonate of lime, salts having a base of potash, and benzoic acid. The only substance which the urine of these animals possesses in common with human urine is urea.

2673 Carnivorous. The urine of carnivorous animals, of which indeed scarcely any thing is known, is supposed to possess different properties from that of the animals just mentioned. The strong fetid odour of the urine of the cat is well known. Muriate of ammonia has been obtained from the urine of this animal by evaporation; but it is supposed, from the peculiar odour, that it contains urea.

2674 Of birds. The urine of birds affords a copious sediment, which seems to be carbonate of lime.

A substance which was found in the urinary bladder of the tortle, in the form of paste, and which was examined by Vauquelin, was composed of 2675 Turtle.

Muriate of soda,
Phosphate of lime,
Animal matter,
Uric acid.

IV. Of Milk.

1. Milk, which is secreted in particular organs by the females of viviparous quadrupeds and cetaceous fishes, included under the class *mammalia*, and destined for the nourishment of the offspring, is a white opaque fluid, varying in its properties according to the different species of animals, and the nature of their food. The milk of the cow, which is most easily and most abundantly procured, has been chiefly the subject of chemical investigation. To it, therefore, the following observations are chiefly applied. 2676 Properties.

2. Milk is distinguished by an agreeable sweetish taste, and a peculiar smell. But these properties belong to it only when it is just separated from the cow, for in the course of a few hours they are considerably different. The specific gravity varies at different periods. It is greater than that of water, and has been found to amount to 1.0324. The boiling and the freezing points of milk are also variable. 2677 Of cows milk.

3. If milk be left at rest for some time, it separates into two parts; an unctuous matter which floats on the surface, called *cream*, and a denser fluid which still retains many of the properties of milk. The quantity of cream obtained from milk, and the time it requires to separate, vary according to the nature of the milk and the temperature. 2678 Separation of cream.

4. Cream thus obtained is of a yellow colour, and acquires a greater consistence by being exposed to the air. It is lighter than water, has an unctuous feel, and becomes rancid like oils, by keeping. When it is boiled, a small portion of oil appears on the surface. Cream is not soluble in alcohol or in oils. When cream is agitated for a longer or shorter time, according to the temperature to which the milk has been exposed during its separation, and perhaps to some circumstances which have not yet been observed, it separates into two parts; one which has a solid consistence, is bitter, and another which remains fluid. 2679 Its properties.

5. Butter is of a yellow colour, and has all the properties of an oil, combined with a portion of the curd and serum of the milk. It melts at the temperature of 96°, and mixes readily with other oily matters. When butter is kept for some time, it is decomposed; it becomes rancid, which is ascribed to the whey and the curd with which it is combined; for when these substances are previously separated, it may be preserved sweet much longer. Butter yields by distillation water, an acid liquid, an oily substance, which is at first fluid, but becomes afterwards concrete. A small portion of carbonaceous matter remains behind. 2680 Butter.

6. When fresh cream, or the whole of the milk fresh drawn from the cow, is churned, it requires the process to be continued a much longer time than when the cream 2681 Changes in the process of churning.

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cream or milk is left to repose, as is usually the case, till it has acquired a slightly acid taste. But when cream which has become sour, is churned, the butter separated has no acid properties, and the milk which remains is even less sour than the cream previous to the commencement of the process. An acid, therefore, has been evolved, and this acid is supposed to be the carbonic. When fresh cream or fresh milk is subjected to this process, in which the acid has not been formed, it requires greater agitation to complete this previous part of the change which the cream or milk must undergo, before the separation of the oily part or the butter. The milk which remains after the butter has been separated, or, as it is called, the butter-milk, has all the properties of milk from which the cream has been separated.

2682 Coagulation.

7. The milk which remains after the separation of the cream, may be coagulated by the addition of several substances, particularly by the addition of runnet, which is in most common use, and which is prepared by digesting the inner coat of the stomach of young animals, especially that of the calf. This coagulum separates into two parts, the curd and the serum or whey.

2683 Curd.

Curd is a white solid substance, and somewhat brittle, when the whole of the whey is expressed. It is soluble in acids, but it is necessary that the mineral acids be greatly diluted, and the vegetable acids concentrated.

2684 Cheese.

Cheese is prepared from curd, by separating the whey by expression. The quality of the cheese depends upon the quantity of cream which remains in the milk. The best cheese is obtained by coagulating the milk at the temperature of about 100°, and expressing the whey slowly and gradually, without breaking down the curd.

If milk be not too much diluted with water, it may be coagulated by a great number of different substances. Among this number are acids, alcohol, neutral salts, gum arabic, and sugar.

2685 Whey.

8. Whey expressed from coagulated milk is of a yellowish green colour, and has an agreeable sweet taste. If it is boiled, a quantity of curd separates, and after being left at rest for some time the whole of it is precipitated, and the liquid remains transparent and colourless. By slow evaporation it deposits white-coloured crystals of sugar of milk, with some muriate of potash, muriate of soda, and a little phosphate of lime. The liquid which remains after the separation of the salts, is converted, by cooling, into a gelatinous substance. If whey be kept for some time, it becomes sour, by the formation of an acid, which is lactic acid. It is to this acid that the spontaneous coagulation of milk, after it remains at rest for some time, is owing.

2686 Koumiss.

9. If milk, after it has become sour, be kept in a proper temperature, it ferments, emitting carbonic acid gas, and exhibiting the other phenomena of fermentation. A vinous intoxicating liquor is thus prepared, which has been long known among the Tartars, and called by them *koumiss*. They prepare it from the milk of the mare.

2687 Vinegar.

10. Milk is susceptible of the acetous fermentation. If about six spoonfuls of alcohol be added to eight pints of milk, and the liquid be excluded from the air, vinegar will be formed in four or five weeks. Although the air is to be excluded, yet the carbonic acid gas must be allowed to escape as it is disengaged.

By the distillation of milk with the heat of a water-bath, water passes over, after which the milk coagulates, and an oily yellowish white substance remains behind, which, by increasing the heat, yields a transparent liquid, a fluid oil, ammonia, an acid, a thick black oil, and in the end carbonated hydrogen gas. The coaly matter in the retort contains potash, muriate of potash, phosphate of lime, and sometimes muriate of soda, with a small portion of magnesia and iron.

2688 Composition.

The constituent parts which enter into the composition of milk are the following:

1. Water,
2. Oil,
3. Curd,
4. Gelatine,
5. Sugar of milk,
6. Muriate of soda,
7. Muriate of potash,
8. Phosphate of lime,
9. Sulphur.

2689 Milk of different animals different.

11. Although the milk of different animals be composed nearly of the same substances, the proportions vary so much, as to give them very different properties.

The following are the results of the investigations of Deyeux and Parmentier with regard to the properties of the component parts of the milk of different animals compared together.

A. Every kind of milk, when left at rest, produces cream on the surface, but it is different in the milk of different animals.

a. In the milk of the cow it is copious, thick, and of a yellow colour.

b. In women's milk it is more liquid, white, and in small quantity.

c. In goats milk it is more abundant than in that of the cow, thicker and whiter.

d. In ewes milk it is nearly as abundant, and of the same colour as that of the cow, but has a peculiar taste.

e. In asses milk it is thick, less abundant, and in a great measure resembles that of women's milk.

f. In mares milk it is very fluid, and similar in colour and consistence to good cows milk before the cream appears on the surface.

2690 Butter.

B. Butter obtained from the milk of different animals, has the following comparative properties.

a. That of the cow is sometimes of a deep yellow, sometimes pale or white, and has always a considerable consistency.

b. It is difficult to separate the butter from the cream of women's milk. It is in small quantity, insipid, and of a pale yellow. It has been erroneously supposed that no butter could be obtained from this milk.

c. The butter of asses milk is always very white, soft, and disposed to become rancid.

d. The butter from goats milk is easily separated from the cream. It is abundant, always white, soft, and disposed to become rancid.

e. The butter from ewes milk is of a yellow colour, soft, and soon becomes rancid.

f. The butter of mares milk is difficult to be obtained, and in small quantity. It has little consistence, and is readily decomposed.

2691 Curd.

C. The curd of milk varies in different animals.

a. That from the milk of the cow is bulky, tremulous, and retains a great deal of the serum.

b. That

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b. That from women's milk is in small quantity, little coherent, has an unctuous feel, and retains but a small portion of the whey.

c. The curd of asses milk is similar to the former, but without being unctuous.

d. Curd from the milk of the goat is in great proportion, of a firmer consistence than that of the cow, and retains less whey.

e. Curd from ewes milk is fat, viscid, and communicates a soft paste to cheese.

f. The curd from mares milk is in very small quantity, and similar to that from women's milk.

2693 Whey. D. The serum or whey constitutes a very great proportion of the milk, and exhibits the following varieties.

a. Whey from the milk of the cow is of a greenish-yellow colour, a sweet taste, and contains sugar of milk and neutral salts.

b. The whey from women's milk has little colour, but has a very sweet taste, containing a considerable proportion of saccharine matter.

c. The whey of asses milk is colourless, and contains less salts and more sugar than that of the cow.

d. Whey of the goat is of a slight yellow colour, and contains very little sugar and saline matter. The latter consists almost entirely of muriate of lime.

e. The whey of ewes milk is always colourless, and contains the smallest quantity of sugar, and but a small portion of muriate and phosphate of lime.

f. The whey of mares milk has little colour, and contains a great proportion of saccharine matter and of saline substances *.

* *Fourcroy*, ix. 435.

V. Of Saliva.

2694 Properties. 1. The saliva which is secreted by peculiar glands, and which flows into the mouth, is a clear, viscid fluid, without taste or smell. Its specific gravity varies from 1.0167 to 1.080. It has generally a frothy appearance, being mixed with a quantity of air.

2695 Combines with oxygen. 2. Saliva has a strong attraction for oxygen, which by trituration it communicates to some metallic substances, as mercury, gold, and silver. When saliva is boiled in water, albumen is precipitated, and when it is slowly evaporated, muriate of soda is obtained. A vegetable gluten remains behind, which burns with the odour of prussic acid.

2696 Action of acids. 3. Saliva becomes thick by the action of acids. Oxalic acid precipitates lime. Saliva is also inspissated by alcohol. It is decomposed by the alkalies; and the nitrates of lead, of mercury, and of silver, precipitate muriatic and phosphoric acids.

2697 Distillation. 4. By distillation in a retort, it froths up, affords near four-fifths of its quantity of water nearly pure, a little carbonate of ammonia, some oil, and an acid. What remains behind consists of muriate of soda, phosphate of soda and of lime. The constituent parts of saliva are the following.

2698 Composition.

1. Water,	5. Phosphate of soda,
2. Mucilage,	6. Phosphate of lime,
3. Albumen,	7. Phosphate of ammonia.
4. Muriate of soda,	

2699 Saliva of the horse. 5. The saliva of the horse is of a greenish yellow colour, a disagreeable smell, a saline taste, and soapy feel. It is coagulated by the acids, alcohol, and boiling water. A black earthy residuum remains after spontaneous evaporation. By distillation it yields an insipid watery liquid, carbonate of ammonia, carbonated hydrogen and carbonic acid gases, and a black empyreumatic oil.

6. The pancreatic juice, it is supposed, possesses properties analogous to those of saliva, and is destined for similar purposes, namely, to contribute to the solution of alimentary substances, and to their conversion into chyme; but very little is known of its nature and uses. 2700 Pancreatic juice.

VI. Of the Humours of the Eye.

1. The eye is composed of three substances, which in anatomy have received the name of humours. These are the aqueous, the vitreous, and the crystalline humours or lens. The following observations are from Mr Chenevix's experiments on this subject *. 2701 Parts of the eye.

* *Phil. Trans.* 1802.

2. The aqueous humour of the eye of the sheep is transparent like water, and has scarcely any taste or smell. The specific gravity is 1.0090. It evaporates slowly when exposed to the air; a coagulum is formed by boiling. When 100 parts are evaporated to dryness, eight parts remain behind. None of the metallic salts produce any precipitate except nitrate of silver, which throws down the muriate of silver. Tan also produces a precipitate in the aqueous humour. The component parts, therefore, of this substance, are albumen, gelatine, and muriatic acid, or rather muriate of soda, as the acid is in combination with soda. The vitreous humour exhibits the same properties. 2702 Eyes of sheep.

3. The crystalline lens of the sheep is solid, composed of concentric coats, and transparent. The specific gravity is 1.1. When fresh it has scarcely any taste. It is soluble in water, and the solution is coagulated by heat. Tan produces a copious precipitate, both before and after coagulation. Its component parts are, therefore, albumen and gelatine, with water.

4. The human eye was found to be composed of the same substances. The specific gravity of the aqueous and vitreous humours is 1.0053; of the crystalline lens, 1.0790. The specific gravity of the aqueous and vitreous humours of the eye of the ox is 1.008; the crystalline lens 1.0765. The composition is the same as that of the sheep. 2703 Human eye.

VII. Of Tears and Mucus.

1. The tears are secreted by the lachrymal gland, for the purpose of lubricating the eye. This liquid is transparent and colourless, has no perceptible smell, but a saline taste. It communicates to vegetable blues a permanent green colour. When it is evaporated nearly to dryness, cubic crystals are formed, consisting of muriate of soda. The soda is in excess, for vegetable blues are converted by it to green. A portion of mucilaginous matter, which becomes yellow as it dries, remains after the evaporation. This liquid is soluble in water and alkalies. Alcohol produces a white flaky precipitate, and when it is evaporated, soda and muriate of soda remain behind. By burning the residuum, some traces of phosphate of lime and of soda are detected. The component parts of tears are, therefore, 2704 Properties.

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Water,	Muriate of soda,
Mucilage,	Phosphate of lime,
Soda,	Phosphate of soda.

2705 Composition. The mucilage of tears absorbs oxygen from the atmosphere, and becomes thick, viscid, and of a yellow colour. It is then insoluble in water. Oxymuriatic acid produces a similar effect. It is converted into muriatic acid, so that it has been deprived of its oxygen, or rather has acquired hydrogen from the water, the oxygen of which has combined with the mucilage.

2706 Mucus. 2. The mucus of the nose consists of the same substances as the tears; but being more exposed to the air, it acquires a greater degree of viscidity from the mucilage absorbing oxygen.

VIII. Of the Wax of the Ear.

2707 Properties. 1. The wax of the ear, or *cerumen*, is a liquid secreted by glands, which are situated in the internal ear. It is of a viscid yellow colour, and becomes concrete by exposure to the air. The taste is bitter; it melts with a moderate heat, gives out an aromatic smell, and stains paper like oil. When thrown upon burning coals, it gives out a white smoke, melts, swells, becomes dark-coloured, and gives out the odour of ammonia. A light coaly matter remains behind. It forms a kind of emulsion by agitation with water.

2708 Action of alcohol. 2. Alcohol dissolves a portion of cerumen; the undissolved part exhibits the properties of albumen mixed with oil. By evaporating the alcohol, an orange-coloured residuum, similar to turpentine, is left behind. It has the properties of resin of bile. This matter is also soluble in ether. By burning the albumen of the cerumen, some traces of soda and phosphate of lime are detected. The component parts of cerumen are,

2709 Composition.

Albumen,
Resin,
Colouring matter,
Soda,
Phosphate of lime.

IX. Of Synovia.

2710 Properties. 1. The liquid secreted within the capsular ligaments of the joints, to facilitate motion by lubricating these parts, is called *synovia*. The synovia of the ox is a viscid, semitransparent fluid, of a greenish-white colour, which soon acquires the consistence of jelly, and not long after becomes again fluid, depositing a filamentous matter.

2711 Action of water. 2. Synovia mixes with water, and renders it viscid. When this mixture is boiled, it becomes milky, and some pellicles are deposited on the sides of the vessel. Alcohol produces a precipitate when added to synovia. This precipitate is albumen. After this matter is separated, the liquid still remains viscid; but if acetic acid be added, the viscidity disappears, and it becomes transparent, depositing a white filamentous substance, which resembles vegetable gluten. It is soluble in cold water, and in concentrated acids and pure alkalies. This fibrous matter is precipitated by acids and alcohol in flakes.

2712 Acids. 3. The concentrated mineral acids produce a flaky precipitate, which is soon re-dissolved; but the viscidity of the liquid is not destroyed till they are so much diluted with water, that the acid taste is only perceptible.

2713 Salts separated. 4. When synovia is exposed to dry air, it evaporates, and cubic crystals remain in the residuum with a white saline efflorescence. The first are muriate of soda, and the latter carbonate of soda. This substance soon becomes putrid, giving out ammonia during its decomposition. By distillation in a retort, it yields water, which soon becomes putrid; water containing a portion of ammonia, and an empyreumatic oil, with carbonate of ammonia; by washing the residuum, muriate and carbonate of soda may be obtained. A small portion of phosphate of lime is found in the coaly matter. The constituent parts of synovia are the following:

2714 Composition.

Fibrous matter	11.86
Albumen	4.52
Muriate of soda	1.75
Soda	00.71
Phosphate of lime	00.70
Water	80.46
	100.00 *.

* Ann. de Chim. xiv. p. 123.

X. Of Semen.

2715 Properties. 1. Semen is secreted in the testes of male animals: but when it is ejected it is composed of two substances; the one is fluid and milky, and the other of a thick mucilaginous consistence, in which appear a great number of white silky filaments, especially if it be agitated in cold water. It has a disagreeable odour, and an acrid irritating taste. The specific gravity varies considerably, but is always greater than that of water. When it is rubbed in a mortar, it froths up, and acquires the consistence of pomatum from the air with which it mixes. It converts the flowers of mallow and of violets to a green colour, and it precipitates the calcareous and metallic salts; which shews, that it contains an uncombined alkali. The thick part of the semen, as it cools, becomes transparent, and assumes a greater degree of consistence; but it afterwards becomes entirely liquid, even without absorbing moisture from the air. This change takes place in about twenty minutes from the time of its emission.

2716 Action of air. 2. If semen be exposed to the air after it has become liquid at the temperature of 60°, it becomes covered with a transparent pellicle, and at the end of three or four days deposits fine transparent crystals of a line in length, crossing each other like radii from a center. When they are magnified, they appear to be four-sided prisms, terminated by long four-sided pyramids. When semen is exposed to a warm air, in considerable quantity, it is decomposed; it assumes the colour of the yolk of egg, and becomes acid, either by absorbing the oxygen from the atmosphere, or by a different combination and arrangement of its own constituent principles. It then emits the odour of putrid fish, and is covered with the *byssus septica*.

2717 Of heat. 3. Heat accelerates the liquefaction of semen; and when it has undergone this change it is no longer susceptible of coagulation. It is decomposed by the application of strong heat. Water is first separated; it then blackens, swells up, and emits yellow fumes, having

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having an empyreumatic, ammoniacal odour. A light coal remains behind, which burns readily to white ashes.

2718 Of water.

4. Before it has become fluid, semen is not soluble in water either cold or hot. To the latter it communicates an opal colour. But in the fluid state it combines readily with either hot or cold water, from which it is separated by alcohol or oxymuriatic acid in the form of white flakes. The alkalies promote the solution of semen in water.

2719 Of lime.

5. No ammonia is disengaged from fresh semen by means of quicklime; but when it has been exposed for some time to a warm and moist air, it is separated in great abundance, so that ammonia is formed during its exposure to the air.

2720 Acids.

6. The acids readily dissolve semen, and this solution is not decomposed by the alkalies; nor indeed is the alkaline solution of semen decomposed by the acids. Wine, cyder, and urine, also dissolve semen, but it is in consequence of the acid which is combined with these liquids. Water acidulated with sulphuric acid acquires the same property. Oxymuriatic acid coagulates semen in white flakes, which are insoluble in water and in acids. The same acid produces the coagulation of fluid semen. This is owing to the absorption of oxygen derived from the acid, which is converted into muriatic acid.

2721 Salts.

7. Barytic salts are not decomposed by the seminal fluid which has been liquefied in a close vessel; but when it has undergone this change in the open air, rhomboidal crystals are formed with the addition of these salts. The calcareous and metallic salts are decomposed by semen in both conditions. From these facts it appears that semen contains an uncombined alkali, which has not the property of decomposing the barytic salts till it has combined with the carbonic acid from the atmosphere.

2722 Semen contains phosphate of lime.

8. The crystals which form in semen by spontaneous evaporation in the open air, and which are entangled in the viscid matter, may be separated by adding water. These crystals have neither smell nor taste. They melt under the blow-pipe into a white opaque globule, which is surrounded with a yellowish flame. This salt is insoluble in water, and is not acted on by the alkalies; but is soluble in the mineral acids without effervescence, from which solutions, lime water, the alkalies, and oxalic acid, throw down a precipitate. Alcohol added to the concentrated muriatic solution of this substance, dissolves part of it, which exhibits all the characters of muriate of lime; and there remains another substance which melts under the blow-pipe into a green transparent glass, soluble in water, which precipitates lime water and reddens vegetable blues. This salt, therefore, as is demonstrated from these experiments, is phosphate of lime. After the formation of the above salts, a great number of small, white, opaque bodies, appear on the surface. They are also phosphate of lime.

2723 And soda.

9. By burning 40 grains of dried semen in a crucible, it first became soft, and then gave out the odour of burnt horn accompanied with yellow fumes. It blackened and emitted the odour of ammonia. The coaly matter which remained was lixiviated with water. This was evaporated, and afforded crystals in the form of rhomboidal plates, which effervesced with acids; with sulphuric acid afforded sulphate of soda, and with muriatic acid formed muriate of soda. The alkali, therefore, was soda.

10. The alkaline matter being separated, the residuum was still exposed to strong heat, and furnished 13 grs. of white ashes, which had the following properties. By the action of the blow-pipe it is converted into an opaque white enamel, which attracts moisture from the air, is soluble in acids, and the solution has all the characters of phosphate of lime. The component parts of semen, therefore, are,

2724 Composition.

Water	90
Mucilage	6
Soda	1
Phosphate of lime	3
	100*

* *Vauquetin, Ann. de Chim.* ix. 64—80.

XI. Of the Liquor of the Amnios.

1. This liquid is secreted in the *amnios* or bag which surrounds the fœtus in the uterus. It is very different in different animals, so far at least as its nature and properties have been investigated. The liquor of the amnios of women and cows only has been examined. The following are the results of the experiments of Vauquelin and Buniva on these liquids *.

* *Ann. de Chim.* xxxiii. 269.

2725 Properties.

2. This liquid in women is of a milky colour, an agreeable odour, and a saline taste. It becomes transparent by filtering and separating some coagulated matter which is suspended in it, and which communicates the white colour. The specific gravity is 1.005. It seems to contain both an acid and an alkali; for it converts syrup of violets to a green colour, and reddens the tincture of turnsole. It froths when agitated, becomes opaque when heated, and exhales the odour of the white of egg.

2726 Action of heat.

2727 Acids.

3. It is rendered more transparent by acids; but alcohol and the alkalies occasion a flaky precipitate, which is like glue when it is dried. The infusion of nut-galls gives a copious brown precipitate; and nitrate of silver produces a white precipitate, which being insoluble in nitric acid, is muriate of silver.

4. By slow evaporation this liquid assumes a milky appearance; a transparent pellicle forms on the surface, and a very small residuum is left. By adding water to the residuum, and evaporating the solution, muriate and carbonate of soda are obtained. The ashes which remain, after burning the residuum, consist of carbonate of soda, phosphate and carbonate of lime. During the burning, a strong, fetid, ammoniacal odour is exhaled.

2728 Composition.

5. From these experiments, it appears that this liquid consists of a great proportion of water, of albumen, muriate of soda, of soda, phosphate of lime, and lime.

2727 Crust on the fœtus.

6. A white shining soft substance, somewhat resembling soap, is deposited on the body of the fœtus in the uterus. It is insoluble in water, alcohol, and oils. The caustic alkalies dissolve a portion of it, and form a kind of soap. It decrepitates on burning coals, then dries, blackens, and gives out the odour of an empyreumatic oil. It leaves behind a coaly matter, which burns with difficulty. When it is heated in a crucible of platina, it decrepitates, while an oily matter

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matter exudes. It then curls up like horn, inflames, and leaves behind gray ashes, which effervesce with acids, and which seem to be composed chiefly of carbonate of lime.

2730 Composition. 7. This matter seems to be a mixture of animal mucilage and fat, originating from the albumen, which has undergone some peculiar change. The parts of a fœtus which have remained in the uterus after death, have been found converted into a fatty matter.

2731 Characters. *Liquor of the amnios of the cow.*—1. This liquid differs from the former in being of a reddish brown colour, in having an acid bitter taste, an odour resembling the extracts of some vegetables, and the viscidity of a solution of gum. The specific gravity is 1.028. It reddens the tincture of turnsole, forms a copious precipitate with muriate of barytes, and with alcohol a precipitate of a reddish matter.

2732 Amniotic acid. 2. When it is evaporated, a thick scum forms on the surface, which is easily separated, and which, on cooling, is found to contain white crystals of a slightly acid taste. A viscid matter like honey appears, by continuing the evaporation. When this matter is treated with boiling alcohol, it furnishes, on cooling, an acid which crystallizes in shining needles. This is the *amniotic acid* which has been already described. The matter which remains after the separation of the crystals is insoluble in alcohol, and is firm and tenacious.

2733 Sulphate of soda obtained. 3. Having extracted the whole of the acid, if the evaporation be continued till the liquor acquire the consistence of a syrup, large transparent crystals are formed, which have a bitter taste, and are soluble in water. These crystals were found to be sulphate of soda, which are obtained in a state of purity, by burning the residuum of a quantity of the liquid evaporated to dryness, dissolving the coaly residuum in water, and evaporating.

2734 Animal matter. 4. The animal matter which accompanies the saline substances, is of a reddish brown colour and a peculiar taste, very soluble in water, but insoluble in alcohol, which even separates it from water. It neither combines with tan, nor is it susceptible of being converted into jelly, so that it does not possess the properties of animal mucilage. When it is heated strongly it swells up; exhales at first the odour of burning mucilage; afterwards that of ammonia and an empyreumatic oil; and at last that of prussic acid. When it is burnt, there remains behind a bulky coal, the ashes of which are white, and contain phosphate of magnesia and a small portion of phosphate of lime.

2735 Composition. 5. The constituent parts of the liquor of the amnios of the cow are the following.

Water,
Acid,
Sulphate of soda,
Animal matter.

XII. Of Fluid Morbid Secretions.

1. During the diseased action of the vessels of different parts of the body, liquids are secreted, as for instance when the muscular or bony parts are wounded, a matter is exuded, which continues to flow till the wound is healed up; in dropsical diseases a liquid is secreted in the different cavities of the body; and when the skin is irritated by the action of blisters, a fluid collects between the cuticle and true skin.

Liquor of dropsy.—This liquid is of a yellowish green colour, has sometimes considerable transparency, but is sometimes turbid. In its chemical properties it seems to correspond with the serum of the blood.

Liquor of blisters.—The liquor which is secreted by the action of blisters is usually transparent. The constituent parts are the same as those of the serum of the blood. Two hundred parts of this liquid yielded

Albumen	36
Muriate of soda	4
Carbonate of soda	2
Phosphate of lime	2
Water	156
	200 *

* Ann. de Chim. ix. 225.

Pus.—What is called healthy pus is about the consistence of cream, and of a yellowish-white colour, an insipid taste, and when it is cold, without smell. It produces no change on vegetable blues.

2736 Action of heat. 2. When pus is exposed to a moderate heat, it dries, and assumes the appearance of horn. By distillation it gives out water in considerable proportion, ammonia and some gaseous substance, and an empyreumatic oil; a shining coaly matter remains behind, the ashes of which, after being burnt, afford some traces of iron.

2737 Of air and acids. 3. When this liquid is exposed to the air, it becomes acid. It is soluble in sulphuric acid, forming with it a purple-coloured solution. With the addition of water the pus separates, and the dark colour disappears. With concentrated nitric acid it forms a yellow coloured solution, which effervesces during the combination. Water produces a precipitate. Pus is also soluble in muriatic acid, and is separated by means of water. Pus is not soluble in alcohol, but it is thickened; nor is it soluble in the oils.

2738 Of alkalies. 4. A whitish ropy fluid is formed by the addition of a solution of the fixed alkalies, and by adding water the pus is precipitated. Pure ammonia forms with pus a transparent jelly, and dissolves it in considerable proportion.

2739 Metallic salts. 5. A precipitate is occasioned by means of nitrate of silver, and it is still more copious with nitrate and oxymuriate of mercury.

2740 To distinguish pus. 6. The following tests have been given to distinguish pus from mucus, which is of considerable importance in cases where the formation of pus is suspected in the lungs.

(1.) Pus is soluble in sulphuric acid, and precipitated by water. Mucus swims. (2.) Pus may be diffused through water, diluted sulphuric acid, and brine; but mucus is not. (3.) Pus is soluble in alkaline solutions, and is precipitated by water; but this is not the case with mucus.

2741 Varies in its properties. 7. These are the properties of pus when it is secreted from a sore which is said to be in good condition, or in a disposition to heal. Its properties are very different in what are called ill-conditioned sores. In these cases the matter secreted is thin, fetid, and acrid. Matter secreted by cancerous sores, which has been examined, converts the syrup of violets to a green colour, and

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from this matter sulphurated hydrogen gas is separated by means of sulphuric acid. This gas is supposed to exist in combination with ammonia.

Subdivision III. Of the Solid Parts of Animals.

2742 Enumeration. The following are the solid parts of animals, which we shall treat of in the order in which they are enumerated.

1. Bones,
2. Skin,
3. Muscles,
4. Cartilage, tendons, &c.
5. Brain and nerves,
6. Hair and nails,
7. Morbid concretions,

1. Of the Bones.

2743 Of different density. 1. The bones are those parts of animals which give firmness, strength, and shape to the body. Bones are very different with regard to solidity and density, not only in different parts of the body, but even in the same bone. The specific gravity, therefore, of bones, must be various. They are of a white colour, of a lamellated structure, and inflexible.

2744 Action of heat. 2. When bones are burnt, they are converted into a white, porous, insipid substance, which still retains the shape of the bone.

2745 Contains fat. 3. When bones are broken into small pieces, and boiled in water, a considerable quantity of fat rises to the surface; an oily matter, therefore, is one of the constituent parts of bones.

2746 Gelatine. 4. If the boiling be continued for a greater length of time, the water dissolves another substance, which, being concentrated and left at rest, assumes a gelatinous form. Bones, therefore, contain a portion of gelatine.

2747 Cartilage. 5. If bone is kept for some time in diluted muriatic acid, it is converted into a white flexible substance, which retains the shape of the bone. It becomes brittle and semitransparent when dried; it is soluble in nitric acid, and when this acid is diluted, it is converted by its action into gelatine. It forms a soap with the fixed alkalies. From these properties it resembles coagulated albumen. This substance, which is called cartilage, is the first part of the bone which is formed.

2748 Salts. 6. Besides these substances, bones contain a considerable proportion of earthy salts. These are phosphate of lime, which is in great proportion; carbonate of lime in smaller proportion, with a still smaller of sulphate of lime.

2749 Composition. 7. The component parts of bones, therefore, are earthy salts, cartilage, gelatine, and fat. The following table exhibits the proportions of these constituent parts in the bones of different animals. It was drawn up by Merat-Guillot. A hundred parts of bones were employed, and as much dried as possible, and to this quantity the proportions specified refer *.

* Ann. de Chim. xxxiv. 71.

Names.	Gelatine.	Phosphate of lime	Carbonate of lime.	Loss.
Human bones taken from a burying ground.	16.	67	1.5	15.5
Human bones dried but not buried.	23.	63	2	2
Bones of the ox	3.	93	2	2
——— calf	25.	54	—	21
——— horse	9.	67.5	1.25	22.25
——— sheep	16.	70.0	0.5	13.5
——— elk	1.5	90.0	1.0	7.5
——— hog	17.82	52.0	1.0	30.0
——— hare	9.0	80.5	1.0	5.0
——— pullet	6.0	72.0	1.5	20.5
——— pike	12.0	64.0	1.0	23.0
——— carp	6.0	45.0	0.5	28.5

8. The human teeth have been analyzed by Mr Pepys, and he found the constituents of different teeth, and different parts of teeth, to be the following. 2750 Of teeth.

	Teeth of adults.	Shedding teeth of children.	Roots of the teeth.
Phosphate of lime	64	62	58
Carbonate of lime	6	6	4
Cartilage	20	20	28
Loss.	10	12	10
	100	100	100

He found the following to be the component parts of the enamel of the teeth.

Phosphate of lime	78
Carbonate of lime	6
Loss and water	16
	100

But according to Fourcroy and Vauquelin, the enamel is composed of

Phosphate of lime	72.9
Gelatine and water	27.1
	100.0

II. Of the Skin.

1. The skin, which forms the external covering of animals, consists of three parts; the epidermis or cuticle, the true skin, and a soft substance called the *rete mucosum*, which lies between the cuticle and true skin. 2751 Consists of three parts.

2. The epidermis, which may be separated from the cutis, by macerating the skin in hot water, is a thin elastic substance, which is insoluble in water and in alcohol. 2752 Epidermis.

3. Sulphuric and muriatic acids have little action for some time on this substance; but it is immediately converted into a yellow colour by means of nitric acid, and 2753 Action of acids, &c.

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and at last entirely decomposed. It is entirely soluble in the caustic fixed alkalies. From these properties the epidermis is supposed to be coagulated albumen in a peculiar state of modification.

2754 Cutis. 4. The cutis or true skin is denser and thicker. When it is heated, it first contracts, then swells, exhaling a fetid odour, and leaving behind a dense mass of charcoal. By distillation the same products are obtained as from fibrina.

2755 Action of heat. 5. The skin is softened by weak acids, is rendered transparent, and is at last dissolved. It is converted into oxalic acid and fat by nitric acid, with the evolution of azotic gas and prussic acid. It is converted by means of the concentrated alkalies into oil and ammonia.

2756 Contains gelatine. 6. After maceration for some time in water, a small proportion of gelatine may be obtained, by evaporating the water; but if the skin be boiled for a considerable time in water, it is entirely dissolved, and the liquid, by evaporation, assumes the consistence of jelly. The skin is thus converted into glue. It is from the skin of animals that glue is chiefly extracted; and it is obtained of different degrees of strength from the skin of different animals.

2757 Tanning. 7. As skin consists chiefly of gelatine, it combines readily with tan. This compound forms leather; and the process by which it is effected is called *tanning*, for the detail of which see the article TANNING.

2758 Rete mucosum. 8. The mucous substance, or *rete mucosum*, lies between the epidermis and true skin. It is this which gives the black colour to the skins of negroes. It is deprived of its colour, even in the living body, by means of oxymuriatic acid. The foot of a negro became nearly white by being kept for some time in water impregnated with this acid. The black colour, however, returned in a few days.

III. Of the Muscles.

2759 Structure. 1. The muscular, or fleshy parts of animals, are of a reddish-white colour, and fibrous structure. If a

2760 Action of cold water. quantity of muscular substance is separated into small pieces, it becomes white. If the water be heated, it coagulates. Albumen and a portion of fibrina are obtained. It becomes gelatinous by farther evaporation; and when the process is carried on to dryness, and alcohol added, a peculiar matter is dissolved; which, after the alcohol is expelled by heat, appears of a reddish-brown colour, has an aromatic smell, and a very acrid taste; and it is soluble both in water and alcohol. The gelatine formed in the mass evaporated to dryness, with a little phosphate of soda and ammonia, remains undissolved by the alcohol. When this extractive matter is distilled, it affords an acid, which is combined with ammonia.

2761 Boiling. By boiling the same muscular matter for some time in water, another portion of albumen is obtained; and, when the water is concentrated by evaporation, it is converted into a jelly; and by treating with alcohol as before, after evaporating to dryness, the extractive matter is taken up, and the gelatine and phosphoric salts remain undissolved. The fibres of the muscle are then of a gray colour, insoluble in water, and become brittle when dry. This substance is fibrina, which constitutes the chief part of muscular matter.

2. If muscular matter be dissolved in nitric acid, and ammonia added to the solution, a precipitate of phosphate of lime is obtained; but no phosphate of lime is obtained, when treated in this way, after being long boiled in water, for it is either combined with the 2762 gelatine, or is thus rendered soluble. Carbonate of Nitric acid. lime, however, is found after boiling the muscular substance, and is converted into oxalate of lime by means of nitric acid.

3. The constituent parts of muscular matter are the following: 2763 Composition.

Fibrina,	Phosphate of soda,
Albumen,	Phosphate of ammonia,
Gelatine,	Phosphate of lime,
Extractive,	Carbonate of lime.

4. From the difference of solubility of the substances which enter into the composition of muscular matter, and the different effects of heat on these substances, the sensible qualities at least must vary considerably, according to the manner in which this matter is prepared for food. Accordingly, when the flesh of animals is boiled, those parts which are soluble in water combine with it. These are, the gelatine, the extractive matter, and part of the saline bodies. It is to these that the nutritious property of soups is ascribed. But when the flesh of animals is roasted, it has a much higher flavour, in consequence of these substances not being separated from it, and particularly the extractive matter, on which the odour and flavour depend. This extractive matter, according to Fourcroy, composes the brown crust which is formed on flesh during its roasting. 2764 Properties of muscular matter for food. 2765 Boiled. 2766 Roasted.

5. The muscular part of different animals, from its sensible qualities at least, seem to possess very different properties. Hence the difference in the taste, flavour, and nutritious quality, of the flesh of different animals. 2767 Different properties.

6. When the muscular parts of animals are exposed for a considerable length of time to the action of running water, they are converted into a peculiar substance, resembling in some measure spermaceti. The same change, indeed, in similar circumstances, takes place on the other soft parts of animals. This was first observed in the year 1786, in the Innocents burying-ground in Paris, where great numbers of bodies were thrown together into the same pit. The time which was required for this conversion was supposed to be in general about thirty years. But it has since been found, that animal matters are converted into a substance exactly similar, and in a much shorter period, by exposing them to the action of running water. 2768 Conversion of muscular matter into spermaceti.

7. The matter produced by this change is of a white colour, soft and unctuous to the feel, and melts like tallow. It is decomposed by diluted acids; and an oily matter, with which it is mixed, is separated. By the action of alkalies and lime, ammonia is evolved. By exposure to the air, it is deprived of its white colour; the ammonia is almost entirely carried off, and a substance resembling wax remains behind. The oily matter, which is separated by a diluted acid, is of a white colour, and concrete. It becomes of a grayish brown colour by drying, and assumes a crystalline, lamellated texture, like spermaceti. At the temperature of 126° it 2769 Properties.

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Component Parts of Animal Substances. it melts. It is soluble in alcohol at the temperature of 120°. It forms a soap with alkalies, and burns like oil; but exhales a disagreeable odour, which is the chief objection to its use as a substitute for oil, as it is supposed it may be obtained at a cheaper rate. A manufacture indeed has been established at Bristol for the preparation of this substance.

IV. Of Membranes, Tendons, and Ligaments.

2770 Membranes 1. Membranes are those parts of the body which include some of the internal parts of animals. Many of them are extremely thin, and they possess different degrees of transparency. They become pulpy by maceration in water, and by boiling are almost entirely converted into gelatine, so that they are chiefly composed of this substance. No phosphate of lime or other saline matter has been detected in the membranous substances hitherto analyzed.

2771 Tendons. 2. Tendons are reduced by boiling to a gelatinous substance, so that they are composed of a similar matter with membranes.

2772 Ligaments. 3. The ligaments afford a portion of gelatine by boiling, but are not, like the two former, entirely reduced to a jelly, so that some other substance besides gelatine enters into the composition of ligaments.

V. Of the Brain and Nerves.

2773 Action of water, &c. 1. The matter of the brain and nerves has a soft, soapy feel, and a close texture. When exposed to the air at the temperature of 60°, it soon becomes putrid, exhaling an offensive smell, and giving out a considerable quantity of ammonia. It is not soluble in cold water; but triturated with water in a mortar, a part is dissolved, and if this be heated moderately it coagulates. If sulphuric acid be added to this solution, white flakes appear on the surface, and the liquid assumes a red colour. Similar flakes are produced by the action of nitric acid, but the colour of the liquid is yellow. If nitric acid be added till a slight acidity is produced, a coagulum of a white colour separates, which is insoluble in water and alcohol, is softened by heat, and becomes transparent when it is dried. This matter, therefore, possesses many of the properties of albumen.

2774 Sulphuric acid. 2. If a quantity of brain be triturated with diluted sulphuric acid, part is dissolved, and part is coagulated. The liquid part is colourless, and when it is evaporated, it becomes black, while superfluous acid is exhaled, and crystals are formed. When it is evaporated to dryness, a black mass remains behind. By diluting this with water, charcoal separates. The matter therefore is entirely decomposed, ammonia is disengaged, and combines with the acid, forming sulphate of ammonia. By evaporating the water, sulphate of ammonia and sulphate of lime, phosphoric acid, and phosphates of soda and ammonia, are obtained; and these salts may be separated by means of alcohol. These salts, however, exist in brain in small

2775 Nitric acid. proportion. By treating in the same way a quantity of brain with nitric acid, part is dissolved, and part coagulated. When the solution, which is transparent, is evaporated till the acid is concentrated, carbonic acid and nitrous gases are evolved; a great quantity of ammonia is separated with effervescence, and charcoal remains behind, mixed with oxalic acid.

3. If a quantity of brain be evaporated to dryness with a gentle heat, a portion of transparent liquid separates, and the residuum assumes a brown colour when 2776 it is dried. The weight of this residuum does not ex- Of heat. ceed one-fourth of the quantity employed. If the residuum be repeatedly boiled with alcohol, more than one-half is dissolved; and when the alcohol cools, it deposits a yellowish white substance in the form of shining plates, which may be reduced to a kind of ductile paste. It becomes soft with the heat of boiling water, and blackens with an increase of temperature, exhaling empyreumatic and ammoniacal fumes; a charred matter remains behind. By evaporating the alcohol, a yellowish black matter is deposited, which reddens paper stained with turnsole.

4. Brain is soluble in concentrated caustic potash; 2777 Alkalies. and during the solution, a great quantity of ammonia is given out.

VI. Of Hair and Nails.

1. If we include all those substances which form the 2778 Different in covering of animals, as bristle, hair, wool, and down, appearance. under the general name of hair, and particularly as they possess nearly the same properties, we shall find that it varies greatly in size, in length, and colour, in different animals, and even in different parts of the body of the same animal.

2. If hair be boiled in water, a quantity of gelatine 2779 Action of is obtained, and, by continuing the boiling, the hair water. becomes so brittle, that it crumbles to pieces. The part which remains, after the gelatine has been separated, seems to be coagulated albumen. But besides gelatine and albumen, it appears from the combustion of hair, that it contains a portion of oily matter. Berthollet obtained by the distillation of a quantity of hair, carbonate of ammonia, water having the smell of burnt hair, some oil, and elastic fluids, which were probably carbonated hydrogen and carbonic acid gases. The oil was of a brownish colour, and was concrete in the ordinary temperature of the atmosphere. 2780 It was soluble in alcohol, and burnt with a vivid flame. Distillation The charcoal which remained could scarcely be calcined, but some of its particles were attracted by the magnet.

3. The acids soften and destroy the colour of hair. 2781 Acids. It is decomposed by sulphuric acid with the assistance of heat; charcoal is deposited, and carbonic acid gas given out. Nitric acid communicates a yellow colour to hair, and dissolves it with the aid of heat. An unctuous matter is separated, and oxalic acid is formed. Muriatic acid at first whitens hair; but it becomes yellow when it dries. Oxymuriatic acid also bleaches hair; but at the same time destroys its texture. It is converted into a pulp when it is introduced into oxymuriatic acid gas.

4. Hair is soluble in the alkalies, and is converted 2782 Alkalies. into a reddish-coloured soap, with the evolution of ammonia. If muriatic acid be added to the solution of hair in potash, sulphurated hydrogen gas is evolved, from which it appears that hair contains sulphur. Silver is blackened by the same solution.

5. The metallic oxides also have the effect of black- 2783 Metallic oxides. ening

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ening hair. It is in this way that the hair is dyed black. The red oxide of lead, the acetate of lead, and sometimes even the nitrate of lead, and the nitrates of mercury and silver, are employed for this purpose.

2784 Nails. *Nails.*—The nails are considered as an elongation of the epidermis. They are attached to it, and separate when it is removed. They become soft by long maceration in water. There is no precipitate formed in this solution with tan. Nails are soluble in the acids and the alkalies. They are stained with metallic oxides, and combine with colouring matters. 2785 Composition. From these properties the nails are considered as a kind of coagulated albumen, with a small proportion of phosphate of lime, and, according to some, carbonate of lime.

VII. Of Morbid Concretions.

2786 Found in different parts of the body. 1. Earthy matters are frequently found in different parts of animal bodies, which are to be considered as extraneous, and occasioning, at least in the human body, some of the severest disorders to which it is subject. These earthy matters are generally combined with an acid, and in some cases entirely composed of an acid. These substances, which have been called *concretions* and *calculi*, are formed, sometimes in the solid parts of the body, but chiefly among the fluids.

2787 Pineal. *Pineal concretions.*—These concretions are almost always found in the pineal gland of the human brain. They are indeed so rarely wanting in the brain, that they are considered as natural, as they do not seem to produce any inconvenience or disease. They have been found to consist of phosphate of lime, mixed with some animal matter.

2788 Salivary. *Salivary concretions.*—Concretions form in the salivary glands, and in the ducts which convey the secreted fluid from these glands to the mouth. The component parts of these concretions have been found to be also phosphate of lime and animal mucilage.

2789 Tartar of the teeth. The tartar of the teeth is composed of the same substance. When this was examined with the microscope, it seemed to be composed of small shining grains united to each other, and containing a great number of pores or small angular cavities, resembling the cells of polypi, on account of which some naturalists have ascribed its formation to insects; but it is more natural to suppose that it is merely a crystalline arrangement of the saline matter of which it is composed.

Concretions have also been found in the pancreas, and its ducts, and are supposed to consist of the same materials.

2790 Pulmonary. *Pulmonary concretions.*—These concretions are formed in the lungs during asthmatic and phthisical disorders. They are small hard bodies, unequal and rough, of a gray or reddish colour, which become white as they dry in the air. They are also composed of phosphate of lime mixed with animal matter.

2791 Intestinal. *Intestinal concretions.*—These are more rarely met with in the human body. When they are found, they have been generally formed on the stones of fruits, or some other hard body which has been swallowed. They are more frequent in the intestines of the inferior animals, as in those of the horse. Some that have been examined were of a gray colour, and of a radiated or crystallized structure. The component parts of a stone of this description, analyzed by Berthollet, were the following: Composition.

Magnesia	18.0
Phosphoric acid	26.0
Ammonia	3.2
Water	46.0
Animal matter	4.0
	67.2 *

* Ann. de Chim. xi. 13.

Biliary concretions. *Biliary concretions.*—Biliary concretions, or calculi, are formed, either in the liver itself, in the gall-bladder, or in the gall ducts, hence they have also been called *gall-stones.* Some found in the liver itself are composed of phosphate of lime combined with some animal matter. The calculi which have been found in the gall-bladder are different, both in structure and composition. Some of them seem to be composed of concentric layers of inspissated bile. These have different degrees of consistence; they are sometimes friable, and of a brown or reddish colour. The gall-stones of the ox, which are used by painters, are of this kind. Another kind of biliary calculi differ only from the former in having a smooth whitish or grayish covering, resembling spermaceti. They are sometimes found in considerable numbers in the gall-bladder.

A third species is of a white or gray colour, opaque, or semitransparent. These are composed of shining crystalline plates, or have a radiated structure. They are frequently solitary, and are then about the size, and have the form, of a pigeon's egg. The nucleus of this kind of gall-stone is composed of inspissated bile.

A fourth species is composed of different proportions of the spermaceti substance and the concrete bile. These are the most frequent of all the kinds of gall-stones, and are also the most numerous. They are of a deep green or olive colour. Sometimes they exhibit, internally, small shining plates of a deep yellow colour.

Action of alkalies, &c. All these calculi are soluble in the caustic alkalies, in solutions of soap, in fixed and volatile oils, in alcohol, and partially in ether.

Urinary calculi. *Urinary concretions.*—1. These concretions, which are frequently formed in the urinary bladder of man, and produce one of the most excruciating disorders to which he is subject, have long attracted attention, with a view to prevent their formation, or to effect their dissolution after they have been formed. Little, however, has yet been done, to accomplish either of these ends; but the nature of the concretions themselves has been carefully investigated, and their component parts minutely examined by different chemists. Found in different parts of the organs. Among these the labours of Fourcroy and Vauquelin are not the least conspicuous. Urinary calculi are found, either in the kidneys, the ureters, or the urinary bladder itself. Calculi, as found in the kidneys, vary considerably in size, form, colour, and internal structure. They are usually small, round, concrete bodies, smooth and shining externally, of a reddish-yellow colour, and so hard as to be susceptible of a polish. They pass readily along the ureters to the bladder, and from thence are ejected along with the urine. It is the formation of these small concretions

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tions which constitutes the disease called *gravel*. Some of these concretions sometimes remain in the kidneys, and increasing in volume by receiving new additions of matter, form large calculi. This happens, however, but rarely. The calculi which have been found in the ureters have originated from the kidneys, and being too large to pass along the ureters, receive new additions of matter as it is deposited from the urine, and enlarge in size, at the same time dilating the ureter.

But by far the most common are those which are found in the bladder itself. These calculi have either originated from small concretions formed in the kidneys, and these passing along the ureters into the bladder, form a nucleus on which successive layers of matter are deposited from the urine; or they have their origin and complete formation in the bladder itself, or have been formed on some extraneous substance introduced into the bladder through the urethra. The first are the most frequent.

2801 Physical properties.

2. The form of urinary calculi is various, but they are frequently of a spheroidal or egg-shape, or compressed on two sides. Sometimes they are polygonal, which happens when there are several in the bladder at the same time. Some have been found of nearly a cubical form. Their extremities are frequently either pointed or obtuse. Their size is extremely various. Sometimes they are not larger than small beans, while some have been of such an extraordinary size as to fill the bladder itself; but they are most frequently from the size of a pigeon's egg, to that of a hen's egg. Some are of a yellowish-brown colour, resembling wood. These are composed of uric acid. Those which are white, or grayish-white, consist of the earthy phosphates, and those which are of a deep gray or blackish colour, are composed of oxalate of lime. Some exhibit all these different shades mixed together. The surface of urinary calculi is sometimes smooth and polished; sometimes it is rough and unequal, and tuberculated. Some urinary calculi having their surface mamellated, are called *mulberry stones*, from some resemblance to a cluster of mulberries. Some of the white calculi are soft and smooth, semitransparent, and covered with shining crystals. The specific gravity varies from 1.213 to 1.976. The odour of urinary calculi is sometimes perceptibly urinous and ammoniacal, which is discovered by rasping or sawing them; sometimes it is faint and earthy, as in the white calculi; and sometimes it resembles that of ivory sawed or rasped, and is analogous to the odour of semen. Mulberry calculi are distinguished by this odour.

2802 Constituent parts.

3. The following substances have been discovered in urinary calculi.

Uric acid,	Oxalate of lime,
Urate of ammonia,	Carbonate of lime,
Phosphate of lime,	Silica,
Phosphate of magnesia and ammonia,	Animal matter.

2803 Uric acid.

Uric acid exists in almost all urinary calculi. Many calculi indeed are entirely formed of it; but it is found in greater or smaller proportion, in almost all that have been analyzed. The nature and properties of this acid have been already described. The calculi composed of it are of a brown colour, are smooth and polished, and have the appearance of wood. When this substance is triturated with a concentrated solution of potash or soda, it forms a thick saponaceous matter, which is precipitated by diluted acids. It is dissolved by nitric acid, and is converted into a red colour. This acid is a compound of azote, carbon, hydrogen, and oxygen; and when decomposed by chemical agents, it is converted into ammonia, malic, oxalic, prussic, and carbonic acids.

2804 Urate of ammonia.

Urate of ammonia, the next substance found in urinary calculi, is also soluble in potash and soda, but the solution is accompanied with a copious evolution of ammonia. Calculi composed of this substance, consist of thin layers, and are not always smooth. They are generally of a small size, and resemble an infusion of coffee. The earthy phosphates are frequently interposed between the layers of calculi composed of this substance, and it is often mixed with phosphate of ammonia and magnesia.

2805 Phosphate of lime.

Phosphate of lime frequently enters into the composition of calculi. It is usually in thin layers, which are friable, and have little consistency. They are of a grayish-white colour, and opaque, without taste or smell. The phosphate of lime is usually mixed with gelatinous matter; is soluble in different acids, and is precipitated by the alkalies. Some calculi have been discovered entirely composed of phosphate of lime.

2806 Of ammonia.

Phosphate of ammonia and magnesia is in the form of white, semitransparent layers, and it is sometimes found crystallized on the surface of calculi in the form of prisms. When reduced to powder it is of a brilliant white, very soluble in diluted acids, and is decomposed by the fixed alkalies.

2807 Oxalate of lime.

Oxalate of lime is usually mixed with phosphate of lime and uric acid, but sometimes it is combined only with animal matter in mulberry calculi. The calculi composed of it are of a dark green colour, and extremely hard. It dissolves with difficulty in diluted nitric acid, and is decomposed by the carbonates of potash and soda.

2808 Carbonate of lime.

The carbonate of lime constitutes the greatest part of some urinary calculi.

2809 Silica.

Silica has been rarely found in calculous concretions. It was detected mixed with phosphate of lime, only in two mulberry calculi, which were extremely hard.

2810 Animal matter.

In all calculous concretions there is a quantity of animal matter, which unites or cements together the layers or particles of the hard substances of which they are composed. This animal matter seems to possess the properties of albumen. Sometimes it seems to be composed of albumen mixed with urea, of coagulated albumen, or gelatine.

2811 Divided into three genera and 12 species.

4. Fourcroy and Vauquelin have analyzed more than 600 calculi, and by comparing the properties of each, they have arranged them into three genera and 12 species. The first genus comprehends those species which are composed of one substance. These are the three following:

1. Uric acid,
2. Urate of ammonia,
3. Oxalate of lime.

The second genus includes those species which are composed

composed of two substances. It consists of the following seven species:

1. Uric acid and the earthy phosphates, in distinct layers.
2. Uric acid and the earthy phosphates intimately mixed together.
3. Urate of ammonia and the phosphates in distinct layers.
4. The two preceding intimately mixed.
5. Earthy phosphates mixed or in thin layers.
6. Oxalate of lime and uric acid in layers.
7. Oxalate of lime and earthy phosphates in layers.

The third genus consists of two species, which are composed of three or four substances.

1. Uric acid or urate of ammonia, earthy phosphates, and oxalate of lime.
2. Uric acid, urate of ammonia, earthy phosphates, and silica.

We shall now state the general characters of these different species.

Genus I.

Species I. *Uric acid.*—These calculi are easily known by their colour, which resembles wood. It is reddish, or yellowish. They are of a radiated, dense, fine texture, completely soluble in pure alkalies, without emitting any odour. They vary greatly in size, and have generally a smooth polished surface. The specific gravity is from 1.276 to 1.786. It usually exceeds 1.5. Of 600 calculi which were analyzed by Fourcroy and Vauquelin, 150 consisted of pure uric acid. The sand or gravel which is formed in the kidneys usually belongs to this species.

2. *Urate of ammonia.*—Calculi composed of this substance are usually of small size, soluble in caustic fixed alkalies, with the evolution of ammonia, of the colour of the infusion of coffee, and are composed of fine layers which are easily separated. The surface is commonly smooth, and sometimes shining and crystalline. The specific gravity is from 1.225 to 1.720. They are soluble in hot water, at least when reduced to powder. The external layer is sometimes pure uric acid. This species is rare.

Oxalate of lime.—This species is easily recognized by its rough, mamellated surface, from which those calculi have received the name of mulberry stones. The colour is brown, they are of a close hard texture, and when rasped or sawed, emit the odour of semen. They are soluble with difficulty in acids, and are insoluble in the pure alkalies. The specific gravity is from 1.428 to 1.976. This species frequently constitutes the nucleus of other calculi.

Genus II.

Species 1. *Uric acid and earthy phosphates in distinct layers.*—This species is known by its surface, which is white like chalk, friable, and semitransparent. The external layer is composed of the phosphate of lime, or of ammonia and magnesia. The nucleus consists of uric acid, and when the calculus of this species is sawed asunder, two substances of which it is composed are distinctly seen. It is indeed only then that the species can be recognized. Calculi of this description are not uncommon, and they are generally of the largest size of all the urinary calculi. The specific gravity is very variable.

2. *Uric acid and earthy phosphates intimately mixed.*—This species contains numerous varieties, from the different proportion of the constituent parts. Sometimes the uric acid and the earthy phosphates are arranged in layers so thin, that they are scarcely perceptible. Sometimes they are so mixed together that they can only be detected by analysis. But sometimes the layers are sufficiently distinct. The specific gravity is from 1.213 to 1.739. This species of calculus is common.

3. *Urate of ammonia and the phosphates in distinct layers.*—In this species the nucleus consists of urate of ammonia; and the external layers are most frequently composed of the earthy phosphates mixed together, or more rarely of phosphate of ammonia and magnesia. This species is usually of small size; its specific gravity is from 1.312 to 1.761. It is not very common.

4. *Urate of ammonia and earthy phosphates mixed.*—The calculi belonging to this species are very rare. They are of a pale yellow colour, and of less specific gravity than the second species of this genus, which they resemble in external characters. When they are treated with potash, ammonia is disengaged. This species is usually of small size.

5. *Earthy phosphates mixed, or in thin layers.*—This species is distinguished by its pure white colour. They are of a friable texture, insoluble in alkalies, and soluble in diluted acids. This species is pretty common, and often of a large size. The concretions formed on extraneous matters introduced through the urethra into the bladder, are of this kind. The specific gravity varies from 1.138 to 1.471.

6. *Oxalate of lime and uric acid in distinct layers.*—In this species the nucleus consists of oxalate of lime, and it is covered with a layer of uric acid. From external appearance they are not distinguished from those entirely composed of uric acid, till they are sawed asunder. The specific gravity varies from 1.341 to 1.754.

7. *Oxalate of lime and earthy phosphates in layers.*—The oxalate of lime constitutes the nucleus, and the earthy phosphates compose the external covering in this species of calculus. It can only be distinguished by being sawn asunder. The calculi belonging to this species vary greatly in form and size, but they are always white externally. The specific gravity is from 1.168 to 1.752.

Genus III.

Species 1. *Uric acid, urate of ammonia, the earthy phosphates, and oxalate of lime.*—In this species there are frequently three distinct layers. The centre or nucleus is composed of oxalate of lime; the next of uric acid or urate of ammonia; and the outermost of the earthy phosphates, which are usually mixed with uric acid, or urate of ammonia. The calculi of this species can only be distinguished by sawing them in two. There are many varieties of this species, from the different proportions and the different arrangement of the constituent parts.

2. *Uric acid, urate of ammonia, earthy phosphates, and*

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Component Parts of Animal Substances.

and silica.—In the calculi belonging to this species, the silica seems to hold the place of the oxalate of lime. It is mixed with uric acid and urate of ammonia, and covered with the phosphate of lime. This is the rarest species of all that have been examined.

2812 Causes of urinary calculi.

3. The investigation of the cause of the formation of calculous concretions has occupied a great deal of the attention of physiologists and physicians, and undoubtedly it is one of the most important on which their researches can be employed; for by obviating the cause of this disorder, its terrible effects might be prevented. Unfortunately, however, little is yet known on this intricate subject. In many cases, indeed, the formation of urinary calculi is obviously owing to the introduction of some extraneous substance into the bladder by the urethra. But this mode of formation is comparatively rare, and the calculi thus formed are composed of the earthy phosphates, which are deposited from the urine. All urine contains uric acid. This forms one of the most common species of calculi. The particles of gravel which are formed in the kidneys consist of this acid, so that it very often forms the nucleus of calculous concretions. But the production of an excessive quantity of uric acid, in whatever way this takes place, seems to be the most powerful cause of the production of urinary calculi. It has been observed, too, that the urine of those persons in whom these concretions are most frequent, is loaded with an unusual proportion of animal matter. This forms the cementing substance of these concretions. In the formation of these concretions, it would appear that the different substances of which they are composed, are secreted at different times, or in different proportions, since the different successive layers of calculi are composed of totally distinct substances. It is perhaps difficult or impossible to explain the formation of those calculi in which oxalic acid is a constituent part. This acid has scarcely ever been detected in the urine, at least of adults, so that it must be produced by some morbid action, by which some of the animal fluids are converted into this substance.

2813 Solvents.

4. It has long been an object with physicians, to discover the means of dissolving these substances after they have been formed; and the empiric has not been idle in offering his nostrums, which are held out as solvents of the stone, and which it is no wonder are eagerly received with the hope of relief from one of the most dreadful maladies which can afflict mankind. Nothing, however, can be done with this view on rational principles, without previously knowing the nature and properties of the substances which are to be dissolved; and even when this is known, it must appear, from considering the function of digestion, and the changes which all substances taken into the stomach undergo, that little can be expected from the exhibition of remedies in this way. After being subjected to the different processes of digestion, respiration, and secretion, the properties of these substances are totally changed, so that they can only produce some general effect on the system, and can have no specific action on particular organs. It has therefore been proposed by the French chemists, to employ these substances which possess the property of dissolving urinary calculi out of the body, by injecting them through the urethra into the bladder.

It has been found by experiment, that calculi composed of uric acid, or urate of ammonia, are soluble in solutions of pure potash and soda, even when these solutions are so much diluted with water that they may be taken internally, without producing any inconvenience.

Experiments have also shewn, that calculi composed of the earthy phosphates are soluble in nitric and muriatic acids, so much diluted that they may be taken internally without the smallest injury.

Calculi composed of oxalate of lime are less easily dissolved. They are, however, soluble in diluted solutions of carbonate of potash or soda. 2814

Methods of using.

The first difficulty, however, which presents itself in the use of these solvents, is to discover the nature and composition of the concretion to be dissolved. This can only be done by employing some of the solutions, and examining them after they have remained for some time, or as long as they can be retained in the bladder. If a weak solution of potash has been injected, it is to be filtered, as soon as it is thrown out; and if on the addition of a little diluted muriatic acid, or vinegar, a white precipitate appears, the calculus is to be considered as composed of uric acid. But if this solution has been employed for some time, and no precipitate is produced in this way, the solution for the phosphates is then to be employed, and when it is passed, after remaining some time in the bladder, a precipitate will be formed with the addition of ammonia. This precipitate will be phosphate of lime.

If no effect is produced by any of these solutions, and if the severity of the symptoms continues, there is some probability that the calculus consists of oxalate of lime. This, it has been observed, is the most difficult of solution. It may be dissolved, however, although slowly, in nitric acid greatly diluted with water, or in weak solutions of the carbonates of potash or soda. These solutions, therefore, must be employed when the others have failed. The effects of these solutions must be judged of by the alleviation of the symptoms, or by the actual examination of the stone itself at different times, by means of the catheter, or sound. Whatever solution is employed, it ought to be of the temperature of the body, and so much diluted as not to irritate or injure the internal surface of the bladder to which it is applied. Before the injection is made, the urine should be evacuated, and the injection retained, for at least a quarter of an hour, from that to an hour, or as long as it can be done without inconvenience. The injections should be repeated at first three or four times a day, and afterwards increased to six or eight times. As calculous concretions are frequently several years in forming, it is obvious that they must require a long time to dissolve them, so that the use of injections, if any relief is to be obtained from them, must be long continued. 2815

In other animals.

5. Calculous concretions are not unfrequent in the urinary organs of other animals. They have been found in the horse, in the dog, the rabbit, the hog, and the rat. They are most frequently composed of carbonate of lime with some animal matter; sometimes of phosphate of lime, of phosphate of ammonia, and of carbonate of lime and phosphate of lime; but no traces of uric acid have yet been detected in these concretions.

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Component Parts of Animal Substances.

Gouty concretions.—1. Concretions, which are commonly called *chalk stones*, are sometimes formed in the joints of those who have been long subject to the gout. They have been discovered by chemical analysis to be
2816 Chalk stones. composed of uric acid and soda.

2. These concretions are of a white colour, irregular in their form, and of a fine granulated texture. When
2817 Properties. they are boiled for a few minutes, in 100 times their weight of water, they are entirely dissolved. Sulphuric acid added to this solution produces a white precipitate, which asumes the form of small needles, which are crystals of uric acid. The remaining liquid, by
2818 Action of alkalies. being evaporated, affords sulphate of soda.

3. By treating a quantity of gouty concretion with 100 times its weight of a concentrated solution of potash with the aid of heat, it is almost entirely dissolved, exhaling at the same time the faint odour of animal matter. When the liquid is filtered, and muriatic acid added, it produces a white precipitate, which is uric acid. From this it appears, that gouty concretions possess similar properties with those formed in the urinary organs, excepting that they contain a greater proportion of animal matter.

2819 Acids, &c. 4. When it is dissolved in a small quantity of diluted nitric acid, it tinges the skin with a rose colour, and when evaporated, leaves a rose-coloured deliquescent residuum. By distillation this substance yields ammonia, prussic acid, and an acid sublimate.

2820 Artificial formation. 5. If a small portion of uric acid be triturated with soda and a little warm water, they combine; and after the superfluous alkali has been washed out, the remainder has all the chemical properties of gouty matter *.

* Phil. Trans. 1797, p. 386.

Subdivision IV. Of Substances peculiar to Different Animals.

Having briefly detailed the nature and properties of those substances which are common to animals, we shall now take a general view of some substances which are peculiar to different animals, and we shall treat of these according to the order in which they are arranged in natural history.

I. Of Substances peculiar to the Class Mammalia.

The substances peculiar to this class of animals are the following:

1. Ivory,	6. Civet,
2. Horn,	7. Castor,
3. Hartshorn,	8. Ambergris,
4. Wool,	9. Spermaceti,
5. Musk,	10. Bezoards.

2821 Ivory. 1. *Ivory*, which is the teeth of the elephant, is a bony substance, of a fine compact texture, white colour, and so hard as to be susceptible of a fine polish. It is composed, like the bones, of gelatinous matter and phosphate of lime, and when it is distilled, it furnishes water, a thick oil, and carbonate of ammonia; and when calcined to whiteness, it leaves pure phosphate of lime.

The component parts of ivory, are, according to Merat-Guillot, the following:

Phosphate of lime	64.0
Carbonate of lime	0.1
Gelatine	24.0
Loss	11.9
	100.0

2822 Horn. 2. *Horn.*—The substance called horn possesses different properties from that of bone. This matter is produced in the horns of different animals, as those of oxen, sheep, and goats. It has some degree of transparency, and when heated it becomes so soft and flexible, that it may be made to assume different shapes, and formed into different instruments and utensils. Horn yields a very small proportion of earthy matter. The other constituent parts seem to be coagulated albumen and gelatine.

The following are the proportions of the constituents of hartshorn:

Phosphate of lime	57.5
Carbonate of lime	1.0
Gelatine	27.0
Loss	14.5
	100.0

2823 Hartshorn. 3. *Hartshorn.*—The constituent parts of hartshorn, from the analysis which has been made, are exactly the same as those of bone, but they contain a greater proportion of gelatinous matter.

2824 Wool. 4. *Wool* is a kind of long hair, very fine and soft, which is a covering to different animals, especially the sheep. It has been considered as nearly analogous in its nature and properties to hair. It is entirely soluble in the caustic alkalies, and forms with them a soapy matter, which has been employed, it is said, with advantage, as a substitute for soap, in different manufactures.

2825 Musk. 5. *Musk* is a substance which is secreted in a bag situated near the umbilical region of the musk deer (*moschus moschifer*). It has an unctuous feel, is of a dark-reddish brown colour, has a very bitter taste, and is distinguished by a strong aromatic smell. It is partially soluble in water, to which it communicates the odour. A small portion of it also may be dissolved in alcohol, but it does not retain the odour. Musk is soluble in sulphuric and nitric acid; but in these solutions the odour is dissipated. The smell of ammonia is given out by the action of the fixed alkalies on musk. When it is laid on red hot iron, it takes fire, and is almost entirely consumed, leaving only a small portion of gray ashes. During its combustion it gives out the fetid odour of urine. Musk seems to possess many of the properties of the volatile oils, but its component parts have not been determined.

2826 Civet. 6. *Civet.*—This substance is extracted from a small bag near the anus of the *viverra civeta*, or *civet cat*. It is of a yellow colour, and of the consistence of butter. When first extracted it is said to be white. It has a very strong smell, and slightly acrid taste; it combines readily with oils, and is much employed as a perfume.

2827 Castor. 7. *Castor.*—This substance is extracted from two bags situated near the anus of the beaver. The best

castor

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Component Parts of Animal Substances.

castor is obtained from the large bag; that which is secreted in the small bag is said to be of an inferior quality. When castor is first taken from the animal, it is nearly fluid, and of a yellow colour. After it is exposed for some time to the atmosphere, it becomes hard, and of a darker colour, assuming a resinous appearance. It has an acrid, bitter, and nauseous taste, and a strong aromatic smell, which it loses by drying. It becomes soft in water, and communicates to it a pale yellow colour. This infusion converts vegetable blues to a green colour. When it has been long macerated in water, the infusion becomes of a deeper colour, and yields by evaporation extractive matter, which is soluble in alcohol and in ether. A resinous matter is precipitated from the solution in alcohol, by means of water, which has similar properties with the resin of bile. According to the analysis of Lagrange, the component parts of castor are the following:

Carbonate of potash,
——— lime,
——— ammonia,
Iron,
Resin,
Mucilaginous extractive matter,
Volatile oil.

2828 Ambergris. 8. *Ambergris.*—This is a substance which is supposed to be formed in the intestines of the spermaceti whale. It is frequently found floating in the sea. For its natural history, see AMBERGRIS, and CETOLOGY *Index.*

It is a soft light substance, of an ash-gray colour, with brownish-yellow and white streaks. It has an insipid taste, but an agreeable odour. The specific gravity is from 0.844 to 0.849. It melts at the temperature of 122°, and with the heat of boiling water is completely dissipated in white smoke, leaving a small trace of charcoal. By distillation an acid fluid is first obtained, and a light volatile oil; and there remains behind a voluminous mass of charcoal. By sublimation benzoic acid is separated.

Ambergris is insoluble in water. Concentrated sulphuric acid separates a small portion of charcoal. It is dissolved in nitric acid. During the solution, nitrous gas, azotic gas, and carbonic acid gas are evolved. A resinous matter is obtained by evaporating the solution. Ambergris is soluble in the alkalies, with the assistance of heat. It is also soluble in the oils, in

2829 Composition. alcohol and ether. By the analysis of Bouillon la Grange, the constituent parts of ambergris are the following:

Adipocire	52.7
Resin	30.8
Benzoic acid	11.1
Charcoal	5.4
	100.0 *

* *Annal. de Chim.* xlvii. 84.

The substance called *adipocire* possesses the mixed or intermediate properties of fat and wax. This name was first given by Fourcroy to the matter into which the dead bodies found in the Innocents burying-ground were converted. In appearance and some of its properties it also resembles spermaceti.

2830 Spermaceti. 9. *Spermaceti.*—This is a production of the same whale which yields the preceding substance. It is an oily matter which surrounds the brain. It is separated from a fluid oil, with which it is mixed, by expression. Spermaceti is also found in other cetaceous fishes, and in other parts of the body, mixed with the oil.

2831 Properties. It is a fine white substance of a crystallized texture, very brittle, and has little taste or smell. It crystallizes in the form of shining silvery plates. It melts at the temperature of 112°. With a greater heat it may be distilled without change; but, by repeated distillation, it is decomposed, and partly converted into a brown acid liquid. It is soluble in boiling alcohol, but it separates when the solution cools. It is also soluble in ether, both cold and hot. In the hot solution it concretes on cooling into a solid mass.

2832 Action of acids, &c. Spermaceti is scarcely at all soluble in the acids. It combines readily with the pure alkalies, with sulphur, and with the fixed oils. By exposure to the air it becomes rancid. The uses of spermaceti are well known, and particularly in the manufacture of candles.

2833 Bezoards. 10. *Bezoards.*—These are calculous concretions which are found in the intestines of different animals belonging to this class, particularly the horse. Some of very large size have been found in the elephant and the rhinoceros. These substances were once celebrated on account of their medical virtues, and they were formerly distinguished into oriental and occidental. The first were most highly valued, and frequently bore a high price, especially the bezoards obtained from a species of goat which inhabits the Asiatic mountains. Some that have been examined were composed entirely of vegetable matter. In general the nucleus is of vegetable matter, on which phosphate of ammonia and magnesia or phosphate of lime have been deposited. These substances are distinguished by a strong aromatic odour when they are rubbed or reduced to powder. The brown or golden-coloured matter which has been observed on the grinding teeth of ruminating animals, is found to be of the same nature with the bezoards which are formed in the intestines.

II. Of Substances peculiar to the Class of Birds.

The substances which are peculiar to this class of animals are the following:

1. Eggs,
2. Feathers,
3. Excrement,
4. Membrane of the stomach.

2834 Eggs. 1. *Eggs.*—In a chemical view, three parts of an egg merit attention. These are the shell or external covering, the white, and the yolk. The white of egg, which consists of albumen, has been already described, so that it now only remains to give some account of the shell and the yolk.

2835 Shells. The shells of the eggs of birds which have been analyzed are composed of similar constituents with bone, but in very different proportions. The following is the result of the analysis of Vauquelin.

Carbonate

Component Parts of Animal Substances.

Carbonate of lime	89.6
Phosphate of lime,	5.7
Animal matter	4.7
	100.0 *

* Ann. de Chim. xxix. 6.

2836 Yolk. The yolk of egg is of a soft consistence, a yellow colour, and of a mild oily taste. It becomes solid by boiling, and crumbles easily into small particles. By heating gently after it has been boiled, and by expression, an oily liquid of a yellow colour, and insipid taste, is obtained. It is distinguished by the properties of fixed oil. What remains after separating the oil is albumen, still coloured with a small portion of oil. By boiling
2837 Composition. this residuum in water, a portion of gelatine is obtained, so that the yolk of egg is composed of oil, albumen, gelatine, and water.

2838 Feathers. 2. *Feathers*—are considered as possessing similar properties with hair, According to some, the solid part, or quill, may be reduced to the gelatinous state by boiling; but according to others, no gelatine whatever can be detected. The quill part is therefore supposed to consist chiefly of coagulated albumen. It becomes soft by the action of acids and the alkalies.

2839 Excrement. 3. *Excrement*.—This matter in birds is very different from that of the animals included in the class mammalia. It is generally of a white colour, less liquid, and less fetid. It is commonly accompanied with a glairy matter of different degrees of transparency, analogous to the white of egg. This seems to be owing to a quantity of albumen which is secreted in the oviduct. The white part of this matter is composed of carbonate and phosphate of lime and albumen. The colouring matter seems to be part of the food.

2840 Membrane of the stomach. 4. *Membrane of the stomach*.—The internal surface of the gizzard, or muscular part of the stomach of birds, is covered with a wrinkled membrane, which is susceptible of considerable extension, and through the pores of which gastric juice is copiously secreted. This membrane is easily separated from the muscular part. When it is boiled in water, it is converted into jelly, and communicates to the water the property of reddening vegetable blues, and coagulating milk. When it is dried and reduced to powder, it produces the same effect.

III. Of Matters peculiar to Animals in the Amphibious Class.

2841 Poison of the viper. 1. *Poison of the Viper*.—Some of the animals belonging to the snake tribe secrete a peculiar fluid in the mouth, which is of a poisonous quality. The poison of the viper is a yellow viscid liquid, somewhat resembling oil. It is secreted in two small bags, and from them conveyed to the fangs of the animal, which are hollow and perforated, and when it bites, the liquid is squeezed out of the bag, and flows through the teeth into the wound. It has no smell. It becomes thick by exposure to the air, and is converted into a transparent jelly; but it retains its poisonous property long after it is separated from the animal. It is soluble in water by agitation, but if thrown into the water when extracted from the vesicle, it falls instantly to the bottom like a heavy oil. It is soluble in warm water after it is dried, but not soluble in alcohol, or coagulated by boiling water. Acids and alkalies produce no perceptible change upon this matter. It is precipitated from its solution in water by alcohol. It resembles gum in so many of its properties, that it has been called an *animal gum*.

2. *Liquid secreted from the tubercles on the head of the Toad*.—It has been long supposed that the liquid secreted on the head of the toad is of a poisonous quality; but although it is said by some naturalists, that this fluid, brought in contact with the skin, produces inflammation, yet there seems to be no positive proof of this effect.

3. *Tortoise-shell*.—This substance, which forms a strong covering and defence to the body of the turtle, possesses many of the properties of horn; for it may be softened with heat, or in boiling water, and shaped into any form which may be wanted. It is composed of a number of hard plates or membranes, of different degrees of thickness, closely applied to each other. It becomes soft by maceration in nitric acid, and by burning it yields a very small proportion of phosphate of lime and soda, with some slight traces of iron.

IV. Of Substances peculiar to Fishes.

1. *Scales*—generally possess a silvery whiteness, and are composed of different laminæ. In many of their properties they resemble horn. By long boiling in water they become soft, and when they are kept for some hours in nitric acid, they are converted into a transparent membraneous substance. By saturating the acid with ammonia, a precipitate is formed, which is phosphate of lime. The constituent parts of scales, therefore, are membrane and phosphate of lime.

2. *Bones of fishes*.—These are composed of the same constituents as those of other animals, but have a greater proportion of animal matter. In some they are soft, flexible, and semitransparent, and hence they are called *cartilaginous*. In others they are hard and solid, having the usual appearance of bone.

3. *Fish oil*.—A great quantity of oil is extracted from the soft parts of different kinds of fish, and especially from the blubber of the whale. It is usually denominated *train oil*. It is obtained, either by expression, or by boiling. It is supposed that the oil obtained from the blubber of the whale, and from other fishes, possesses different properties, which are ascribed to the difference in the function of respiration of cetaceous and other fishes; but how far this difference really exists, does not seem to have been accurately ascertained. Fish oil is distinguished by a disagreeable smell, and it has long been an object to deprive it of this odour, as it is much employed in domestic economy and in many arts. By agitating the oil with a small portion of sulphuric acid, and adding water, the oil when left at rest, rises to the surface considerably purified. A portion of coagulated matter has separated, and the water is milky.

V. Of Substances peculiar to Insects.

1. *Wax*.—The nature and properties of this substance have already been described as a vegetable production.

2. *Propolis*.—This is a substance collected by bees, and with which they cover the bottom of the hive, or any

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Component Parts of Animal Substances. any foreign matters which happen to be introduced into it, which they cannot remove. It is the substance which they collect on their legs and thighs. It is perhaps more properly to be considered as a vegetable production. It possesses more tenacity than wax, but has much of its ductility. It is insipid to the taste, but is distinguished by an aromatic odour. It is partially soluble in alcohol, to which it communicates a red colour. Another portion is dissolved in boiling alcohol, and part precipitates as the solution cools, which has the properties of wax. A resinous mass is obtained by concentrating the solution in alcohol and boiling in water. It is semitransparent and brittle. An acid was detected in the water in which it was boiled. The resinous substance is soluble in fixed and volatile oils. The following are the constituent parts of propolis.

Pure resin	57
Pure wax	14
Extraneous matter	14
Loss and acid	15
	100 *

* Nichol. Jour. v. p. 49.

2845 Honey. 3. *Honey.*—This also has been considered as a vegetable production, as it is collected from plants by bees. It is of white or yellowish colour, of a granular soft consistence, and has an aromatic smell; but these properties vary according to the plants from which it is collected, or the climate in which they grow. By distillation honey yields nearly the same products as sugar. It is converted into oxalic acid by means of nitric acid. It is very soluble in water, and is even somewhat deliquescent. It readily passes to the vinous fermentation, and affords a fermented liquor which has been called *hydromel*. It is partially soluble in alcohol, and by this means sugar may be extracted from it. The component parts of honey are sugar, mucilage, and an acid. If pure honey be melted, and carbonate of lime be added till the effervescence ceases, the sugar is separated, and is deposited in crystals.

2846 Cantharides. 4. *Cantharides* are a species of fly (the *meloe vesicatorius*, Lin.) which are much employed, from a peculiar property they possess, to raise blisters on the skin. For this purpose the whole of the insect is reduced to powder. Cantharides have been subjected to analysis; and by successive treatment with water, alcohol, and ether, four different substances have been extracted. 1. Three-eighths of their weight consist of extractive matter, of a reddish-yellow colour, very bitter, and which yields by distillation an acid liquor. 2. A little more than one-tenth of the weight consists of a concrete oil, something of the nature of wax, which is of a green colour and very acrid taste. To this is owing the peculiar odour of cantharides. This substance yields, by distillation, a very pungent acid substance and a thick oil. 3. About one-fiftieth of a yellow concrete oil, which seems to communicate the colour to the insect, is also obtained. 4. About one half the weight of a solid matter remains, the nature of which has not been ascertained. The blistering effect of cantharides seems to depend on the green waxy matter, part of which is extracted by means of warm water, and it is entirely soluble in ether.

Millepedes.—These insects, which are different species of oniscus, were formerly employed in medicine. By distillation with the heat of a water bath, they yield a watery liquid, which converts the syrup of violets to a green colour, and by this process they are deprived of five-eighths of their weight. By treating them afterwards with water and alcohol, they furnish one-fourth of their weight of an extractive and waxy matter; the latter is soluble in ether. The muriates of potash and lime have been detected in the expressed juice of these insects. 2847 Millepedes.

Ants.—These insects contain an acid liquid, which they emit from the mouth when they are irritated, or when they are bruised on paper. This liquid converts vegetable blues to red; and it has been observed that streaks of the same colour are communicated to blue flowers, over which the insects creep. The acid obtained from ants, and particularly from the *formica rufa*, or red ant, was formerly considered as possessing peculiar properties, and thence denominated *formic acid;* but it has been lately ascertained to consist of a mixture of acetic and malic acids. 2848 Ants.

Lac.—This is a substance which is formed on the branches of several plants, as the *ficus indica*, the *ficus religiosa*, and especially the *croton lacciferum*. It is produced by the puncture of an insect, but is considered as belonging to vegetable substances, among which the general properties have been already described, as well as the properties of an acid obtained from it, among the acids. 2849 Lac.

Silk.—This is the production of several insects, either for the purpose of covering up their eggs, or forming a net to catch their prey, as is the case with many of the spider tribe, or to cover up the insect during one of the stages of its metamorphosis. The silk of commerce is usually obtained from the *phalæna bombyx*, or silk-worm. This substance is prepared in the body of the larva of the insect, from which it is protruded through several small orifices in very fine threads; and with this it forms a covering for itself while it remains in the state of chrysalis or pupa. 2850 Silk.

Silk is a very elastic substance, and is of a white or reddish-yellow colour, when it is produced by the insect. The elasticity of silk has been ascribed to a varnish with which it is covered, of a gummy or gelatinous nature, which is precipitated by tan and muriate of tin. The yellow colour of silk is ascribed to a resinous matter which is soluble in alcohol. By distillation silk yields a large proportion of ammonia. It is soluble in sulphuric, nitric, and muriatic acids. By nitric acid it is partly converted into oxalic acid, and a fatty matter which swims on the surface.

Cochineal.—This is an insect which breeds on the leaves of the *cactus coccinelliferus*, Lin. sometimes called opuntia or nopal. The plant is cultivated in Mexico, for the purpose of rearing the insects, which are collected, dried, and employed as a beautiful dye stuff. By burning, the same results are obtained as from other animal matters; but with boiling water it gives a crimson violet colour, which becomes red and yellow by the action of acids, while a precipitate is formed of the same colour. The metallic solutions added to this decoction also produce a coloured precipitate. The muriate of tin throws down a beautiful red precipitate. The evaporated residuum of the decoction 2851 Cochineal.

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coction of cochineal, treated with alcohol, gives a fine red colour, and this, by evaporating the alcohol, assumes the form of a resin. Oxymuriatic acid converts the solution of this substance into a yellow colour, from which the proportion of colouring matter may be in some measure estimated, by the quantity of acid requisite to destroy its colour. Cochineal is well known by its producing a beautiful scarlet colour. It may be kept for any length of time, at least in a dry place, without being deprived of its colouring matter. It has retained this property for 130 years. Cochineal is employed in the preparation of the beautiful lake called *carmine*.

2852 Kermes. *Kermes.*—This also is an insect which is employed in dyeing, from whence it has been called *coccus infectorius*. It is the *coccus ilicis*, Lin. and is produced on a small kind of oak, the *quercus coccifera*. The insect attaches itself to the bark of the tree by a soft substance, which possesses many of the properties of caoutchouc.

When the living insect is bruised, it gives out a red colour. It has a slightly bitter, rough, pungent taste, but its smell is not unpleasant. The dried insect, or the kermes, imparts this odour and taste to water and to alcohol, and communicates also to these liquids a deep red colour. By evaporation, an extract of the same colour is obtained. It is employed in dyeing, and has been also used in medicine.

2853 Crabs eyes. *Crabs eyes.*—The substance which has received this name, merely from its form, is a concrete body, convex on one side, and concave on the other. Two of these bodies are usually found in the stomach of the crab, about the time that it changes its shell. After the shell is fully formed, they are no longer found, so that they are supposed to furnish the materials of the new shell. They are entirely composed of carbonate of lime, a small proportion of phosphate of lime, and gelatine.

The crustaceous coverings of the crab, lobster, and similar animals, are composed of carbonate of lime, phosphate of lime, and animal matter, or cartilage.

VI. Of Substances peculiar to Testaceous Animals.

The only substances to be mentioned peculiar to this class of animals are shells, mother of pearl, and pearl.

2854 Shells. 1. *Shells.*—Such as have been particularly examined by Mr Hatchett are divided into two classes. In the one he includes those which have the appearance of porcelain, and have an enamelled surface, which he calls *porcellaneous shells*. Such are the various species of *voluta* and *cypræa*. These shells were found by analysis to be composed of carbonate of lime, with a small portion of animal gluten.

2855 Mother of pearl. 2. *Mother of pearl.*—The second class comprehends those which are generally covered with a strong epidermis, under which is the shell, composed chiefly of the substance called *nacre*, or *mother of pearl*. Such are the *oyster*, the *river mussel*, the *haliotis iris*, and the *turbo olearcus*. In these the proportion of carbonate of lime is smaller, and that of the animal matter greater.

2856 Pearl. 3. *Pearl.*—This is a concretion formed in several species of shells, as in some species of the oyster and the mussel. It is considered by some as a morbid concretion, owing to an excess of the shelly matter, or to a wound of the shell containing the animal. Pearls are of a silvery or bluish-white colour, iridescent and brilliant. The refraction of the light is ascribed to the lamellated structure, for they consist of concentric layers of carbonate of lime and membrane alternately arranged. The constituent parts of pearl are the same as mother of pearl.

VII. Substances peculiar to Zoophytes.

2857 Zoophytes. The zoophytes, many of which have been examined by Mr Hatchett, are composed of carbonate of lime, phosphate of lime, and animal matter of different degrees of consistency. In some the constituents are only carbonate of lime and a gelatinous matter. Such are some species of the madrepore, as the *madrepora muricata*, *virginea*, and *labyrinthica*; some species of millepore, as the *millepora cerulea* and *alcicornis*, and the *tubipora musica*. Others again are composed of carbonate of lime and a membranaceous substance. Such are the *madrepora fascicularis*, the *millepora cellulosa* and *fascialis*, and the *iris hippuris*. White coral and articulated coralline are composed of similar substances. Another division of zoophytes is composed of carbonate of lime, a small portion of phosphate of lime and membrane. Such are the *madrepora polymorpha*, the *gorgonia nobilis* or *red coral*, and the *gorgonia setosa*; but some of the zoophytes are also found to consist chiefly of animal matter, with scarcely any portion of earthy substance. To this division belong some species of gorgonia and many species of sponge.

Chap. XX. *Of Arts and Manufactures.*

In this chapter it was intended to give a general view of the application of the principles of chemistry to different arts and manufactures, such as the manufacture of soap, of glass, and porcelain; the arts of dyeing, bleaching, and tanning. In this view it was proposed to explain the principles of these arts and manufactures, so far as they depend upon chemistry, leaving the detail to the different treatises on those subjects in the course of the work. But the unavoidable length to which this article has extended, obliges us to refer our readers for the whole to the different treatises.

APPENDIX.

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APPENDIX.

2858 Oxygenation of acids and of water. ONE of the most interesting trains of experimental research in chemistry that have recently occurred, is that of Thenard on the oxygenation of the acids and of water; of which we shall subjoin an account, as it is more recent than the date even of the Chemistry in our SUPPLEMENT, and the subjects which it implies are some of the most important novelties in this science. This eminent chemist has found, in the first place, that several of the acids are capable of being made to combine with an additional quantity of oxygen; and in the second, that water is susceptible of a similar combination. The leading instrument by which he was enabled to accomplish these combinations was the peroxide of barium, a compound discovered by himself, consisting of the metallic base of barytes (barium), in combination with a larger quantity of oxygen than that which constitutes this earth. That peroxide is formed simply by subjecting pure barytes to a high temperature in contact with pure oxygenous gas. The gas is absorbed, and the peroxide adapted to the following curious purposes is obtained. Diluted muriatic acid, poured slowly on this substance, dissolves it without setting at liberty any of its oxygen; we have then an oxygenated muriate of barytes. When to this we gradually add sulphuric acid, the barytes is precipitated in union with this last-mentioned acid, i. e. the sulphate of barytes, a very insoluble compound, is formed. This process is continued till the whole earth is precipitated.

2859 Oxygenated muriatic acid. The additional dose of oxygen which had made it a peroxide is neither evolved in the form of gas, nor precipitated with the earth; it remains in solution in union with the muriatic acid. Nitric acid is capable of being oxygenated by a similar process.

2860 Sulphuric acid. The oxygenation of sulphuric acid was not effected with equal simplicity. When that acid is brought in contact with peroxide of barium, it forms sulphate of barytes, by combining with that earth which is a protoxide of barium; and the overplus of oxygen is disengaged in the gaseous form, exactly in the same way as this acid operates on the peroxide (the black oxide) of manganese, combining with the deutoxide of that metal, and setting oxygenous gas at liberty. In order to effect the oxygenation of the sulphuric acid, we first procure an oxygenated muriatic acid. We must also be provided with liquid sulphate of silver. This solution is added to the oxygenated muriatic acid. A muriate of silver, a very insoluble precipitate, is formed by the combination of the oxide of silver with the muriatic acid. The sulphuric acid retains the liquid state; but the superabundant oxygen is transferred to it from the muriatic. We have now an oxygenated sulphuric acid.

2861 Oxygenated matter. When the substance last mentioned is treated with an aqueous solution of barytes, the sulphuric acid is precipitated in combination with this earth, and the oxygen remains in union with the water. The same portion of water may receive additional combinations of oxygen by a repetition of the same process. This combination is singular in this respect, that the oxygen is not so easily separated by certain processes as we might be apt to anticipate, while there are others which disengage it with astonishing rapidity. When oxygenated water is placed within the exhausted receiver of an air-pump, the oxygen is not liberated as it would be if it were retained in its state of union with that fluid in any degree by the pressure of the atmosphere. What is more, if it be placed in an exhausted receiver, which at the same time contains a bason of sulphuric acid, the water is gradually raised in vapour, while the oxygen continues united to the remaining portion. We can thus procure oxygenated water in a highly concentrated state, and are presented with a view of its properties in a more striking form. This fluid is heavier than pure water; it sinks in it like sulphuric acid, and has the same heavy and sluggish consistence.

2862 Properties. The substances which most readily induce a separation of the oxygen, are some of the metallic oxides: when these are added to it, the oxygen flies off with a sudden explosion; and it is a curious additional circumstance that the oxygen of the oxide is liberated along with it, and the metal reduced to a state of purity. Another singular fact is, that even the pure metal thrown into oxygenated water effects a separation of the oxygen. In order to account for such an agency in a substance which does not in consequence enter into any new chemicals tate, Thenard sagaciously suggests, that the agency exerted must be of an electrical nature. This subject, probably, presents much scope for farther ingenious research.

It is to be observed, that pure water does not retain this additional oxygen so strongly as the acids; and hence has arisen a question, whether in the latter this principle is in union with the acid as well as with the water. It appears, however, that other impregnations, such as saccharine and gummy substances, dissolved in water, give it, like the acids, the power of retaining the oxygen more strongly. The experiments on this part of the subject, however, do not yet seem to have been greatly extended.

2863 Uses. Oxygenated water has the property of removing the dark colour induced on white lead by sulphureted hydrogen, which in many cases occasions serious injury to ancient paintings. This purpose it fulfils so completely, without affecting the generality of other colours with which the white lead is in contact on the canvas, that it has been hailed by amateurs as a truly precious discovery.

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EXPLANATION OF THE PLATES.

Plate CXLII.

Fig. 1. Represents Harrison's pendulum, constructed on the principle of the unequal expansion of metals.

Fig. 2. The calorimeter of Lavoisier and Laplace, see page 476.

Fig. 3. Iron bottle and bent gun-barrel for procuring oxygen gas from manganese. The black oxide is reduced to powder, and introduced into the bottle A. The bent tube is put on the mouth of the bottle at C, and luted with the materials described at the foot of page 490. The bottle is then exposed to a red heat, and the gas which comes over is received in jars on the pneumatic apparatus.

Fig. 3. and 4. represent the apparatus for the decomposition of water. See page 496.

Fig. 5. Pneumatic trough for collecting gaseous bodies. Suppose a quantity of sulphurated hydrogen gas is to be collected, which is described in page 505. The iron filings and sulphur which were melted together in a crucible, and which then form a black brittle mass, are to be introduced into the glass vessels. Fig. 6. B is a bent tube ground to fit the mouth D, and is air-tight. To the other mouth C is fitted the ground stopper A. One end of the bent tube is fitted into the mouth D, and the other placed under the glass jar F on the shelf of the pneumatic trough E, which is filled with water about an inch above the surface of the shell. The jar is also previously filled with water, cautiously inverted, and set on the shelf. The apparatus being thus adjusted, muriatic acid is poured into the opening C, and the ground stopper is immediately replaced. A violent effervescence takes place, a great quantity of gas is disengaged, and as there is no other way for it to escape it passes into the glass jar. When this is filled, it is removed to another part of the shelf; another jar which was previously filled with water is put into its place, and so on till the whole gas is collected.

Fig. 7. Papin's digester. A is the body of the vessel, which has been generally made of copper or iron, very thick and strong. BB are two strong bars fixed to the sides of the vessel. To the upper end of these bars is fixed the cross bar C, through which passes a strong screw D, which presses on the lid of the vessel at E, so that it is enabled to resist the elastic force of the vapour: and the water can thus be raised to a higher temperature than the ordinary boiling point.

Fig. 8. This represents an apparatus for distillation. A is the furnace, B is the body of the still, which is generally made of copper; C is the top or head, made of the same metal. The vapour, as it rises from the liquid by the application of heat, passes along the tube D, which communicates with a spiral tube in the refrigeratory E, which being filled with cold water, the vapour is condensed, and passes out at the other extremity of the tube F, and is received in the vessel G.

Plate CXLIII.

Fig. 9. Glass Retort.
Fig. 10. Tubulated Retort.
Fig. 11. Glass Alembic.
Fig. 12. Solution Glass.
Fig. 13. Crucible.

Fig. 14. Apparatus for obtaining muriatic acid from muriate of soda by sulphuric acid. The muriate of soda is introduced into the retort A, and by means of the bent tube B the sulphuric acid is added. The matrass C is adapted to the retort, to receive the portion of impure sulphuric acid and muriatic acid which passes over towards the end of the operation. D, E, and F, are bottles containing water; the quantity of which should be equal in weight to that of the salt employed. These bottles are furnished with tubes of safety GG; or the tube of safety may be applied as H in the bottle E.

Fig. 15. Apparatus for impregnating fluids with gases. A is a tubulated retort which is joined to B, a tubulated receiver, from which a bent tube C passes to the second receiver D. This last communicates with the bottle F by means of the bent tube E. The end of the tube C which enters the receiver D is furnished with a valve, which prevents the return of any gas from the receiver D to the receiver B, in case a vacuum should take place in the course of the operation in the receiver B, or in the retort A. The gas which is not absorbed by the water in the receiver D, passes through the tube E to the bottle F.

Fig. 16. A gazometer, which is a convenient apparatus for holding gases. It is usually made of tin plate. A is an inverted vessel, which exactly fits another, which is fixed within the cylinder B. When it is pressed down to the bottom of the cylinder, water is poured in, by which means the small quantity of air which remains in the intermediate spaces, is forced out, and the gas to be preserved may be introduced at the lower stop-cock C. The vessel A is nearly balanced by the weights DD, which are connected with it by means of the cords *a a a a*, which move on the pulleys *b b b b*. As the gas enters the apparatus, it forces up the vessel A, and in this way it may be completely filled. It is forced out by turning the stop-cock E, and pressing down the vessel A, and may be conveyed into a pneumatic apparatus, and received in jars by means of the flexible tube F.

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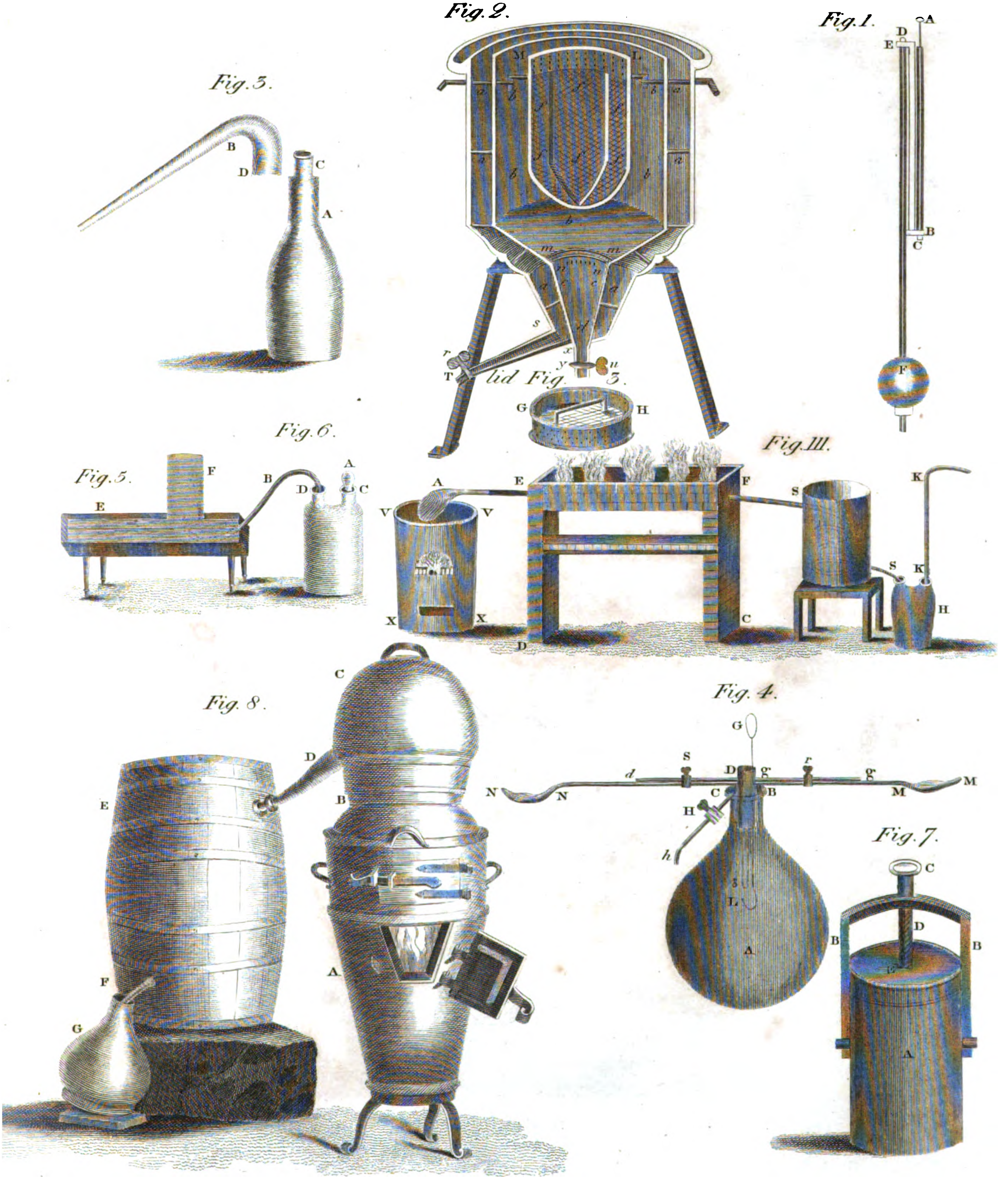

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Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

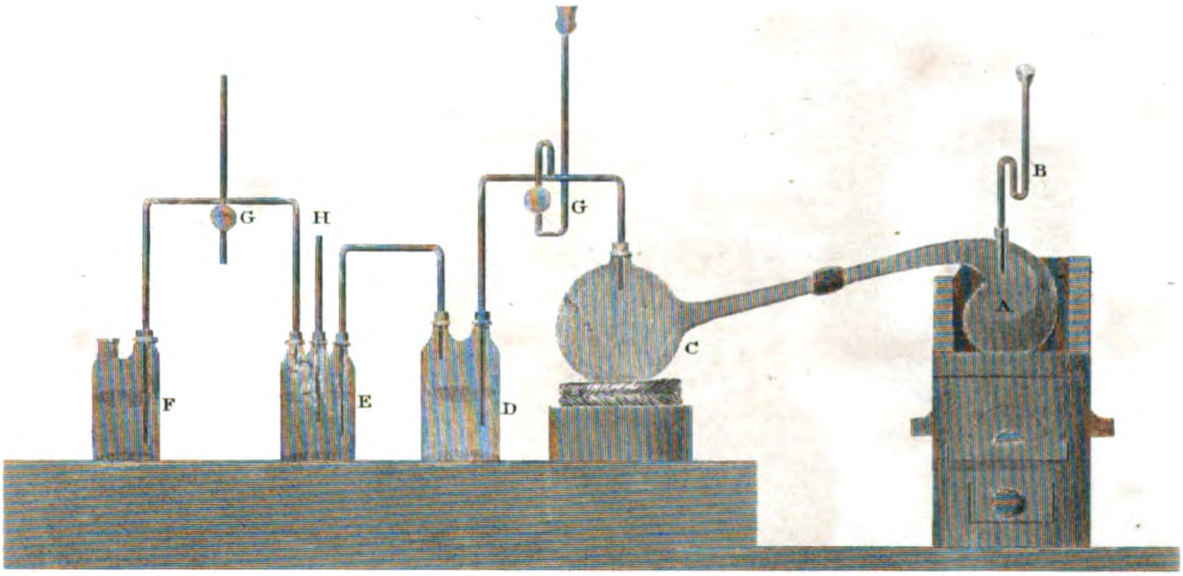


Fig. 15.

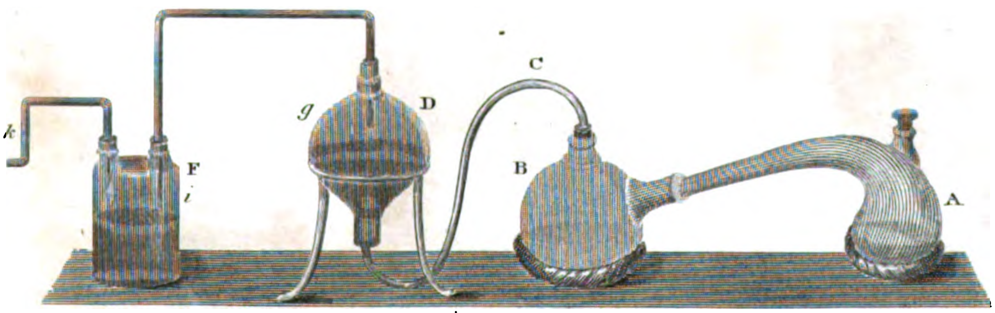
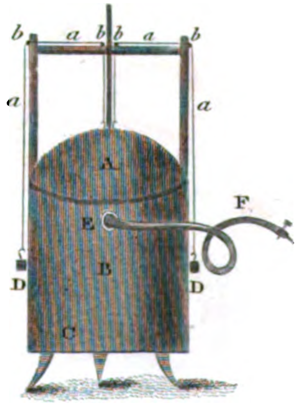


Fig. 16.



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CHEMNITZ, Martin, a famous Lutheran divine, the disciple of Melancthon, was born at Britzen in Brandenburg, in 1522. He was employed in several important negotiations by the princes of the same communion; and died in 1589. His principal work is the Examen of the Council of Trent, in Latin.

CHEMOSH. See Chamos.

CHEMOSIS, a disease of the eyes, proceeding from an inflammation; wherein the white of the eye swells above the black, and overtops it to such a degree, that there appears a sort of gap between them. Others define it differently.

CHENIER, Marie Joseph de, a French writer on politics and general literature. See Supplement.

CHENOPODIUM, Goose-Foot, or *Wild Orach.* See Botany *Index.*

CHEPELIO, an island in the bay of Panama and province of Darien, in South America, situated about three leagues from the city of Panama, which it supplies with provisions. W. Long. 81. N. Lat. 9.

CHEPSTOW, a market town of Monmouthshire in England, seated on the river Wye, with 2581 inhabitants in 1811. W. Long. 2. 40. N. Lat. 51. 40.

CHEQ, or Cherif, the prince of Mecca, who is, as it were, high-priest of the law, and sovereign pontiff of all the Mahometans of whatever sect or country they be. See Caliph.

The grand signior, sophis, moguls, khans of Tartary, &c. send him yearly presents, especially tapestry to cover Mahomet's tomb withal, together with a sumptuous tent for himself, and vast sums of money to provide for all the pilgrims during the 17 days of their devotion.

CHERASCO, a strong and considerable town of Italy, in Piedmont, and capital of a territory of the same name, with a strong citadel, belonging to the king of Sardinia, where he retired in 1706, during the siege of Turin. It is seated at the confluence of the rivers Sturia and Tanaro, upon a mountain. E. Long. 7. 55. N. Lat. 44. 35.

CHERBURG, a seaport town of France, in Normandy, with a harbour and Augustine abbey. It is remarkable for the sea-fight between the English and French fleets in 1692, when the latter were beat, and upwards of twenty of their men of war burnt near Cape la Hogue. The British landed here in August 1758, and took the town, with the ships in the bason, demolished the fortifications, and ruined the other works which had been long carried on for enlarging the harbour. The work was resumed in 1783, upon the the plan of sinking large conical masses of stone in the sea, to break the force of the waves. They were, however, thrown down, and the work was abandoned, about 1808. Since that an artificial harbour, capable of holding 50 sail of the line, has been excavated out of the solid ground. E. Long. 1. 38. N. Lat. 49. 38.

CHEREM, among the Jews, is used to signify a species of annihilation. See Annihilation.

The Hebrew worm *cherem*, signifies properly to *destroy, exterminate, devote*, or *anathematise.*

Cherem is likewise sometimes taken for that which is consecrated, vowed, or offered to the Lord, so that it may no longer be employed in common or profane uses. No devoted thing that a man shall devote unto the Lord, of all that he hath of man and beast, and of the field of his possession, shall be sold or redeemed; every devoted thing is most holy to the Lord; none devoted, which shall be devoted of men, shall be redeemed, but shall surely be put to death. There are some who assert that the persons thus devoted were put to death; whereof Jephtha's daughter is a memorable example. Judges xi. 29. &c.

Cherem is also used for a kind of excommunication in use among the Jews. See Niddui.

CHERESOUL, or Chahrzul, a town in Turkey in Asia, capital of Curdistan, and the seat of a beglerbeg. E. Long. 45. 15. N. Lat. 36. 0.

CHERILUS, of Samos, a Greek poet, flourished 479 years before Christ. He sung the victory gained by the Athenians over Xerxes, and was rewarded with a piece of gold for every verse. His poem had afterwards the honour of being rehearsed yearly with the works of Homer.

CHERLERIA. See Botany *Index.*

CHERLESQUIOR, in Turkish affairs, denotes a lieutenant general of the grand signior's armies.

CHERMES, in *Zoology*, a genus of insects belonging to the order of insecta hemiptera. See Entomology *Index.*

Chermes Mineral. See Kermes.

Cherry-island, an island in the northern ocean; lying between Norway and Greenland, in E. Long. 20. 5. N. Lat. 75. 0.

Cherry-Tree. See Prunus, Botany *Index.*

CHERSON, a town in Europe, in Russia, situated on the Dnieper, about 60 miles from its mouth. It was founded in 1778, and increased rapidly for some time; but owing to the unhealthiness of the situation, and the difficulty of navigating the river, it has since declined. E. Long. 33. 5. N. Lat. 46. 20.

CHERSONESUS, among modern geographers, the same with a peninsula; or a continent almost encompassed round with the sea, only joining to the main land by a narrow neck or isthmus. The word is Greek χερσονησος; of χερσος, *land;* and νησος, *island;* which signifies the same. In ancient geography, it was applied to several peninsulas; as the Chersonesus Aurea, Cimbrica, Taurica, and Thracica, now thought to be Malacca, Jutland, Crim Tartary, and Romania.

CHERT, Petrosilex, *Lapis Corneus*, the *Hornstein* of the Germans. See Mineralogy *Index.*

CHERTZEY, a market town of Surry in England, about seven miles west from Kingston upon Thames. W. Long. 30. N. Lat. 51. 25.

CHERUB, (plural, Cherubim); a celestial spirit, which in the hierarchy is placed next to the seraphim. See Hierarchy.

The term *cherub*, in Hebrew, is sometimes taken for a calf or ox. Ezekiel sets down the face of the cherub as synonymous to the face of an ox. The word *cherub*, in Syriac and Chaldee, signifies to *till* or *plow*, which is the proper work of oxen. Cherub also signifies *strong* and *powerful.* Grotius says, that the cherubim were figures much like that of a calf. Bochart thinks likewise, that the cherubim were more like to the figure of an ox than to any thing besides; and Spencer is of the same opinion. Lastly, St John, in the Revelation, calls cherubim *beasts.* Josephus says the cherubim were extraordinary creatures, of a figure unknown to mankind. Clemens of Alexandria believes,

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lieves, that the Egyptians imitated the cherubim of the Hebrews in the representations of their sphinxes and their hieroglyphical animals. All the several descriptions which the scripture gives us of cherubim, differ from one another; but all agree in representing them as a figure composed of various creatures, as a man, an ox, an eagle, and a lion. Such were the cherubim described by Ezekiel. Those which Isaiah saw, and are called *seraphim* by him, had the figure of a man with six wings; with two whereof they covered their faces, with two more they covered their feet, and with the two others they flew. Those which Solomon placed in the temple at Jerusalem are supposed to have been nearly of the same form. Those which St John describes in the Revelation were all eyes before and behind, and had each six wings. The first was in the form of a lion, the second in that of a calf, the third of a man, and the fourth of an eagle. The figure of the cherubim was not always uniform. since they are differently described in the shapes of men, eagles, oxen, lions, and in a composition of all these figures put together. Moses likewise calls these symbolical or hieroglyphical representations, which were embroidered on the veils of the tabernacle, *cherubim* of costly work. Such were the symbolical figures which the Egyptians placed at the gates of their temples and the images of the generality of their gods, which were commonly nothing but statues composed of men and animals.

CHERVIL. See CHÆROPHYLLUM, BOTANY *Index*.

CHESAPEAK, in America, one of the largest bays in the known world. Its entrance is between Cape Charles and Cape Henry in Virginia, 12 miles wide; and it extends 270 miles to the northward, dividing Virginia and Maryland. Through this extent it is from 7 to 18 miles broad, and generally about 9 fathoms deep; affording many commodious harbours, and a safe and easy navigation. It receives the waters of the Susquehannah, Potomak, Rappahannock, York, and James rivers, which are all large and navigable.

CHESELDEN, WILLIAM, an eminent anatomist and surgeon, was born at Burrow on the Hill, in the county of Leicester, descended from an ancient family in the county of Rutland, whose arms and pedigree are in Wright's "History of Rutland." He received the rudiments of his professional skill at Leicester; and married Deborah Knight, a citizen's daughter, by whom he had one daughter, Williamina Deborah. In 1713 he published his Anatomy of the Human Body, one volume 8vo; and in 1723, A Treatise on the High Operation for the Stone. He was one of the earliest of his profession who contributed by his writings to raise it to its present eminence. In the beginning of 1736, he was thus honourably mentioned by Mr Pope: "As soon as I had sent my last letter, I received a most kind one from you, expressing great pain for my late illness at Mr Cheselden's. I conclude you was eased of that friendly apprehension in a few days after you had dispatched yours, for mine must have reached you then. I wondered a little at your query, Who Cheselden was? It shows that the truest merit does not travel so far any way as on the wings of poetry: he is the most noted and most deserving man in the whole profession of chirurgery; and has saved the lives of thousands by his manner of cutting for the stone." He appears to have been on terms of the most intimate friendship with Mr Pope, who frequently, in his Letters to Mr Richardson, talks of dining with Mr Cheselden, who then lived in or near Queen Square. In February 1737, Mr Cheselden was appointed surgeon to Chelsea hospital. As a governor of the Foundling Hospital, he sent a benefaction of 50l. to that charity, May 7. 1751, inclosed in a paper with the following lines:

'Tis what the happy to th' unhappy owe;
For what man gives, the gods by him bestow. POPE.

He died at Bath, April 11. 1752, of a disorder arising from drinking ale after eating hot buns. Finding himself uneasy, he sent for a physician, who advised vomiting immediately; and if the advice had been taken, it was thought his life might have been saved. By his direction, he was buried at Chelsea.

CHESHIRE, a maritime county of England, bounded by Lancashire on the north; Shropshire and part of Flintshire on the south; Derbyshire and Staffordshire on the east and south-east; and Denbighshire and part of Flintshire on the west and north-west. It extends in length about 44 miles, in breadth 25; and is supposed to contain 676,600 acres. Both the air and soil in general are good. In many places of the country are peat mosses, in which are often found trunks of fir-trees, sometimes several feet under ground, that are used by the inhabitants both for fuel and candles. Here also are many lakes and pools well stored with fish; besides the rivers Mersey, Weaver, and Dee. The number of inhabitants in 1811 was 227,031. This county also abounds with wood: but what it is chiefly remarkable for, is its cheese, which has a peculiar flavour, generally thought not to be inferior to any in Europe; (see CHEESE). The princicipal towns are, Chester the capital, Cholmondely, Namptwitch, &c.

William the Conqueror erected this county into a palatinate, or county palatine, in favour of his nephew Hugh Lupus, to whom he granted the same sovereignty and jurisdiction in it that he himself had in the rest of the island. By virtue of this grant, the town of Chester enjoyed sovereign jurisdiction within its own precincts; and that in so high a degree, that the earls held parliaments, consisting of their barons and tenants, which were not bound by the acts of the English parliament: but the exorbitant power of the palatinates was at last reduced by Henry VIII.; however, all cases and crimes, except those of error, foreign plea, foreign voucher, and high-treason, are still heard and determined within the shire. The earls were anciently superiors of the whole county, and all the landholders were their vassals, and under the like sovereign allegiance to them as they were to the kings of England; but the earldom was united to the crown by Edward III. since which time, the eldest sons of kings of England have always been earls of Chester, as well as princes of Wales. Cheshire sends four members to parliament; two for the county, and two for the capital. See CHESHIRE, SUPPLEMENT.

CHESNE, ANDREW DU, styled the father of French history,

history, was born in 1584. He wrote, 1. A history of the popes. 2. A history of England. 3. An inquiry into the antiquities of the towns of France. 4. A history of the cardinals. 5. A bibliotheca of the authors who have written the history and topography of France, &c. He was crushed to death by a cart, in going from Paris to his country house at Verriere, in 1640.

CHESNUT-TREE. See FAGUS, BOTANY *Index*.

CHESS, an ingenious game performed with different pieces of wood, on a board divided into 64 squares or houses; in which chance has so small a share, that it may be doubted whether a person ever lost a game but by his own fault.

Each gamester has eight dignified pieces, viz. a king, a queen, two bishops, two knights, and two rooks, also eight pawns; all which, for distinction's sake, are painted of two different colours, as white and black.

As to their disposition on the board, the white king is to be placed on the fourth black house from the corner of the board, in the first and lower rank; and the black king is to be placed on the fourth white house on the opposite, or adversary's, end of the board. The queens are to be placed next to the kings, on houses of their own colour. Next to the king and queen, on each hand, place the two bishops; next to them, the two knights; and last of all, on the corners of the board, the two rooks. As to the pawns, they are placed, without distinction, on the second rank of the house, one before each of the dignified pieces.

Having thus disposed the men, the onset is commonly begun by the pawns, which march straight forward in their own file, one house at a time, except the first move, when it can advance two houses, but never moves backwards: the manner of their taking the adversary's men is sidewise, in the next house forwards; where having captivated the enemy, they move forward as before. The rook goes forward or crosswise through the whole file, and back again. The knight skips backward and forward to the next house, save one, of a different colour, with a sideling march, or a slope, and thus kills his enemies that fall in his way, or guards his friends that may be exposed on that side. The bishop walks always in the same colour of the field that he is placed in at first, forward and backward, aslope, or diagonally, as far as he lists. The queen's walk is more universal, as she takes all the steps of the before-mentioned pieces, excepting that of the knight; and as to the king's motion, it is one house at a time, and that either forward, backward, sloping, or sidewise.

As to the value of the different pieces, next to the king is the queen, after her the rooks, then the bishops, and last of the dignified pieces comes the knight. The difference of the worth of pawns, is not so great as that of noblemen; only, it must be observed, that the king's bishop's pawn is the best in the field, and therefore the skilful gamester will be careful of him. It ought also to be observed, that whereas any man may be taken, when he falls within the reach of any of the adversary's pieces, it is otherwise with the king, who, in such a case, is only to be saluted with the word *check*, warning him of his danger, out of which it is absolutely necessary that he move; and if it so happen that he cannot move without exposing himself to the like inconveniency, it is check-mate, and the game is lost. The rules of the game are,

1. In order to begin the game, the pawns must be moved before the pieces, and afterwards the pieces must be brought out to support them. The king's, queen's, and bishop's pawns, should be moved first, that the game may be well opened; the pieces must not be played out early in the game, because the player may thereby lose his moves: but above all, the game should be well arranged before the queen is played out. Useless checks should also be avoided, unless some advantage is to be gained by them, because the move may be lost, if the adversary can either take or drive the piece away.

2. If the game is crowded, the player will meet with obstructions in moving his pieces; for which reason he should exchange pieces or pawns, and castle (A) his king as soon as it is convenient, endeavouring at the same time to crowd the adversary's game, which may be done by attacking his pieces with the pawns, if the adversary should move his pieces out too soon.

3. The men should be so guarded by one another, that if a man should be lost, the player may have it in his power to take one of the adversary's in return; and if he can take a superior piece in lieu of that which he lost, it would be an advantage, and distress the adversary.

4. The adversary's king should never be attacked without a force sufficient; and if the player's king should be attacked without having it in his power to attack the adversary's, he should offer to make an exchange of pieces, which may cause the adversary to lose a move.

5. The board should be looked over with attention, and the men reconnoitred, so as to be aware of any stroke that the adversary might attempt in consequence of his last move. If, by counting as many moves forward as possible, the player has a prospect of success, he should not fail doing it, and even sacrifice a piece or two to accomplish his end.

6. No man should be played till the board is thoroughly examined, that the player may defend himself against any move the adversary has in view; neither should any attack be made till the consequences of the adversary's next move are considered; and when an attack may with safety be made, it should be pursued without catching at any bait that might be thrown out in order for the adversary to gain a move, and thereby cause the design to miscarry.

7. The queen should never stand in such a manner before the king, that the adversary, by bringing a rook or bishop, could check the king if she were not there; as it might be the loss of the queen.

8. The

(A) *Castle his king*, is to cover the king with a castle; which is done by a certain move which each player has a right to whenever he thinks proper.

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8. The adversary's knight should never be suffered to check the king and queen, or king and rook, or queen and rook, or the two rooks at the same time; especially if the knight is properly guarded: because, in the two first cases, the king being forced to go out of check, the queen or the rook must be lost; and in the two last cases a rook must be lost at least for a worse piece.

9. The player should take care that no guarded pawn of the adversary's fork two of his pieces.

10. As soon as the kings have castled on different sides of the board, the pawns on that side of the board should be advanced upon the adversary's king, and the pieces, especially the queen and rook, should be brought to support them; and the three pawns belonging to the king that is castled must not be moved.

11. The more moves a player can have as it were in ambuscade, the better; that is to say, the queen, bishop, or rook, is to be placed behind a pawn or a piece, in such a position as that upon playing that pawn or piece a check is discovered upon the adversary's king, by which means, a piece or some advantage is often gained.

12. An inferior piece should never be guarded with a superior, when a pawn would answer the same purpose; for this reason, the superior piece may remain out of play; neither should a pawn be guarded with a piece when a pawn would do as well.

13. A well-supported pawn that is passed often costs the adversary a piece; and when a pawn or any other advantage is gained without endangering the loss of the move, the player should make as frequent exchanges of pieces as he can. The advantage of a passed pawn is this: for example, if the player and his adversary have each three pawns upon the board, and no piece, and the player has one of his pawns on one side of the board, and the other two on the other side, and the adversary's three pawns are opposite to the player's two pawns, he should march with his king as soon as he can, and take the adversary's pawns: If the adversary goes with his king to support them, the player should go on to queen with his single pawns; and then if the adversary goes to hinder him, he should take the adversary's pawns, and move the others to queen (B).

14. When the game is near finished, each party having only three or four pawns on each side of the board, the kings must endeavour to gain the move in order to win the game. For instance, when the player brings his king opposite to the adversary's with only one square between, he will gain the move.

15. If the adversary has his king and one pawn on the board, and the player has only his king, he cannot lose the game, provided he brings his king opposite to the adversary's, when the adversary is directly before or on one side of his pawn, and there is only one square between the kings.

16. If the adversary has a bishop and one pawn on the rook's line, and this bishop is not of the colour that commands the corner square the pawn is going to, and the player has only his king, if he can get into that corner, he cannot lose; but on the contrary, may win by a stale (C).

17. If the player has greatly the disadvantage of the game, having only his queen left in play, and his king happens to be in a position to win, as above-mentioned, he should keep giving check to the adversary's king, always taking care not to check him where he can interpose any of his pieces that make the stale; by so doing he will at last force the adversary to take his queen, and then he will win the game by being in a stale-mate.

18. The player should never cover a check with a piece that a pawn pushed upon it may take, for fear of getting only the pawn in exchange for the piece.

19. A player should never cover his adversary up with pieces, for fear of giving a stale-mate inadvertently, but always should leave room for his king to move.

By way of corroborating what has been already said with respect to this game, it is necessary to warn a player against playing a timid game. He should never be too much afraid of losing a rook for an inferior piece; because, although a rook is a better piece than any other except the queen, it seldom comes into play to be of any great use till at the end of the game; for which reason it is often better to have an inferior piece in play, than a superior one to stand still, or moving to no great purpose. If a piece is moved, and is immediately drove away by a pawn, it may be reckoned a bad move, because the adversary gains a double advantage over the player, in advancing at the same time the other is made to retire; although the first move may not seem of consequence between equal players, yet a move or two more lost after the first, makes the game scarcely to be recovered.

There never wants for variety at this game, provided the pieces have been brought out regularly; but, if otherwise, it often happens that a player has scarce any thing to play.

Many indifferent players think nothing of the pawns, whereas three pawns together are strong; but four, which constitute a square, with the assistance of other pieces, well managed, make an invincible strength, and in all probability may produce a queen when very much wanted. It is true, that two pawns with a space between are no better than one; and if there should be three over each other in a line, the game cannot be in a worse way. This shows that the pawns are of great consequence, provided they are kept close together.

Some middling players are very apt to risk losing the game in order to recover a piece; this is a mistake; for it is much better to give up a piece and attack the enemy in another quarter; by so doing, the player has a chance of snatching a pawn or two from, or

(B) To *queen*, is to make a queen; that is, to move a pawn into the adversary's back row, which is the rule at this game when the original one is lost.

(C) When the king is blocked up so as to have no move at all.

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Chess. or gaining some advantage over the adversary, whilst his attention is taken up in pursuing this piece.

If the queen and another piece are attacked at the same time, and that by removing the queen the piece must be lost; provided two pieces can be gained in exchange for the queen, the queen should be given up, it being the difference of three pieces, and consequently more than the value of the queen. By losing the queen, the game is not thrown into that disorder which it would otherwise have been; in this case it would be judicious to give the queen for even a piece, or a pawn or two; it being well known among good players, that he who begins the attack, and cannot maintain it, being obliged to retire, generally loses the game.

A player should never be fond of changing without reason, because the adversary, if he is a good player, will ruin his situation, and gain a considerable advantage over him. But rather than lose a move, when a player is stronger than the adversary, it is good play to change, for he thereby increases his strength.

When the game is almost drawn to a conclusion, the player should recollect that his king is a capital piece, and consequently should keep him in motion; by so doing, he generally gets the move, and often the game.

As the queen, rook, and bishop, operate at a distance, it is not always necessary in the attack to have them near the adversary's king.

If a man can be taken with different pieces, the player should take his time, and consider which of those pieces is the best to take it with.

If a piece can be taken almost at any time, the player should not be in a hurry about it, but try to make a good move elsewhere before he take it.

A player should be cautious how he takes his adversary's pawn with his king, as it often happens to be a safeguard to it.

After all that has been said, it is still necessary for us to advise those who would play well at this game, to be very cool and attentive to the matter in question; for it is impossible that any person in the universe can be capable of playing at chess if their thoughts are employed elsewhere. The laws at this game are,

1. If a player touches his man, he must play it; and if he quits it, he cannot recal it.

2. If by mistake or otherwise a false move is played, and the adversary takes no notice of it till he hath played his next move, it cannot be recalled by either of the parties.

3. If a player misplaces the men, and he plays two moves, it is at the option of the adversary to permit him to begin the game or not.

4. If the adversary plays or discovers a check to a player's king, and give no notice of it, the player may let him stand still till he does.

5. After the king is moved, a player cannot castle.

Sarasin has an express treatise on the different opinions of the origin of the Latin *schacchi*, whence the French *echecs*, and our *chess*, is formed. Menage is also very full on the same head. Leunclavius takes it to come from *Uscoches*, famous Turkish robbers. P. Sirmond, from the German *scache*, "theft;" and that from *calculus*. He takes *chess* to be the same with the *ludus latrunculorum* of the Romans, but mistakenly. This opinion is countenanced by Vossius and Salmasius, who derive the word from *calculus*, as used for *latrunculus*. G. Tolosanus derives it from the Hebrew, *scarch*, *valavit* and *mat*, *mortuus;* whence *check* and *checkmate*. Fabricius says, a celebrated Persian astronomer, one Schatrenscha, invented the game of *chess;* and gave it his own name, which it still bears in that country. Nicod derives it from *scheque*, or *xeque*, a Moorish word for lord, king, and prince. Bochart adds that *scach* is originally Persian; and that *scachmat*, in that language, signifies the king is dead.—The opinion of Nicod and Bochart, which is likewise that of Seriverius, appears the most probable.

Mr Twiss mentions a small treatise on chess, written, as he supposes, about 400 years ago; at the end of which is a representation of a round chess-board, with directions for placing the men upon it. In this the knight can cover the 64 squares on the board at as many moves. The board is divided into these 64 parts by four concentric circles, having an empty space in the middle; and each of these is divided into 16 parts. Number 1 is placed in the outermost circle; number 2 in the third circle counting inwards, in the division to the right hand of the former; number 3 is placed in the outermost circle, in the division to the right hand of 2; 4 in the third circle, counting inwards to the right hand of three; and thus alternately from the first to the third, and from the third to the first circle, till the round is completed by 16 on the third circle to the left hand of 1. Number 17 is then placed on the division of the innermost circle to the right hand of 1; 18 on the second circle counting inwards, to the right hand of 17; and thus alternately from the fourth to the second, and from the second to the fourth circles, until the round is completed by 32, directly below number 1. Number 33 then is placed on the third circle directly to the right hand of number 2; 34 on the fourth circle, to the right hand of 4; and thus alternately between the third and fourth circles, until the round is again completed by 48 on the fourth circle, directly below number 33. The numbers are now placed in a retrograde fashion; 50 on the outer circle in that division immediately to the right hand of 1; 51 on the third circle to the left hand of 2; and directly below number 32; 52 is then placed on the outer circle, immediately on the left hand of 1; 53 on the third circle directly to the left hand of 16; and thus alternately on the first and third circles, until the last ground is completed by 64 between the number 3 and 5. On this round chess-board, supposing the black king to be placed in number 48 on the fourth circle, the queen stands on number 17 at his left hand; the bishops in 33 and 2; the knights 18 and 47; the castles in 3 and 20; the pawns on 19, 4, 49, 64, and 46, 51, 32, 1. The white king will then stand in 25, opposite to the black queen; the white queen in 40 opposite to the black king, and so on. In playing on a board of this kind, it will be found, that the power of the castle is double to that in the common game, and that of the bishop only one half; the former having 16 squares to range in, and the last only 4. The king can castle only one way; and it is very difficult to bring the game to a conclusion.

With regard to the origin of the game at chess, we are much in the dark. Though it came to us from the

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the Saracens, it is by no means probable that they were the original inventors of it. According to some, it was invented by the celebrated Grecian hero Diomedes. Others say, that two Grecian brothers, Ledo and Tyrrheno, were the inventors; and that being much pressed with hunger, they sought to alleviate the pain by this amusement.

According to Mr Irwin it is a game of Chinese invention. During his residence in India, he found that a tradition of this nature existed among the Bramins, with whom he frequently played the game. While he was at Canton in 1793, he gives the following account of the information which he acquired relative to the origin of the game of chess. 'A young mandarin, of the profession of arms, having an inquisitive turn, was my frequent visitor; and what no questions could have drawn from him, the accidental sight of an English chess-board effected. He told me, that the Chinese had a game of the same nature; and on his specifying a difference in the pieces and board, I perceived, with joy, that I had discovered the desideratum of which I had been so long in search. The very next day my mandarin brought me the board and equipage; and I found, that the Bramins were neither mistaken touching the board, which has a river in the middle to divide the contending parties, nor in the powers of the king, who is entrenched in a fort, and moves only in that space, in every direction. But, what I did not before hear, nor do I believe is known out of this country, there are two pieces, whose movements are distinct from any in the Indian or European game. The mandarin, which answers to our bishop, in his station and sidelong course, cannot, through age, cross the river, and a rocket-boy, still used in the Indian armies, who is stationed between the lines of each party, acts literally with the motion of the rocket, by vaulting over a man, and taking his adversary at the other end of the board. Except that the king has his two sons to support him, instead of a queen, the game, in other respects, is like ours; as will appear in the plan of the board and pieces I have the honour to enclose, together with directions to place the men and play the game.

"As the young man who had discovered this to me was of a communicative and obliging disposition, and was at this time pursuing his studies in the college of Canton, I requested the favour of him to consult such ancient books as might give some insight into the period of the introduction of chess into China; to confirm, if possible, the idea that struck me of its having originated here. The acknowledged antiquity of this empire, the unchangeable state of her customs and manners, beyond that of any other nation in the world; and more especially the simplicity of the game itself, when compared to its compass and variety in other parts, appeared to give a colour to my belief. That I was not disappointed in the event, I have no doubt will be allowed, on the perusal of the translation of a manuscript extract, which my friend Tinqua brought me, in compliance with my desire; and which, accompanied by the Chinese manuscript, goes under cover to your lordship. As the mandarin solemnly assured me that he took it from the work quoted, and the translation has been as accurately made as possible, I have no hesitation to deliver the papers as authentic.

"From these premises I have therefore ventured to make the following inferences:—That the game of chess is probably of Chinese origin. That the confined situation and powers of the king, resembling those of a monarch in the eastern parts of the world, countenance this supposition; and that, as it travelled westward, and descended to later times, the sovereign prerogative extended itself, until it became unlimited, as in our state of the game. That the agency of the princes, in lieu of the queen, bespeaks forcibly the nature of the Chinese customs, which exclude females from all power or influence whatever; which princes, in its passage through Persia, were changed into a single vizier, or minister of state, with the enlarged portion of delegated authority that exists there; instead of whom, the European nations, with their usual gallantry, adopted a queen on the board (D). That the river between parties is expressive of the general face of the country, where a battle could hardly be fought without encountering an interruption of this kind, which the soldier was here taught to overcome; but that, on the introduction of the game into Persia, the board changed with the dry nature of the region, and the contest was decided on terra firma. And lastly, that in no account of the origin of chess, that I have read, has the tale been so characteristic or consistent as that which I have the honour to offer to the Irish academy. With the Indians, it was designed by a Bramin to cure the melancholy of the daughter of a rajah. With the Persians, my memory does not assist me to trace the fable; though, if it were more to the purpose, I think I should have retained it. But, with the Chinese, it was invented by an experienced soldier, on the principles of war. Not to dispel love-sick vapours, or instruct a female in a science that could neither benefit nor inform her; but to quiet the murmurs of a discontented soldiery; to employ their vacant hours in lessons on the military art, and to cherish the spirit of conquest in the bosom of winter-quarters. Its age is traced by them on record near two centuries before the Christian era; and among the numerous claims for this noble invention, that of the Chinese, who call it by way of distinction, *chong kè*, or *the royal game*, appears alone to be indisputable."

Translation of an Extract from the Concum, or Chinese Annals, respecting the Invention of the Game of Chess, delivered to me by Tinqua, a soldier Mandarin of the Province of Fokien.

"Three hundred and seventy-nine years after the time

(D) That on the acquisition of so strong a piece as the vizier, the pao were suppressed, this possessing powers unintelligible, at that time, to other nations; and three pawns added, in consequence, to make up the number of men; and that as discipline improved, the lines, which are straggling on the Chinese board, might have been closed on ours.

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Chess.

time of Confucius, or one thousand nine hundred and sixty-five years ago, Hung Cochu, king of Kiangnan, sent an expedition into the Shensi country, under the command of a mandarin, called Hansing, to conquer it. After one successful campaign, the soldiers were put into winter-quarters; where, finding the weather much colder than what they had been accustomed to, and being also deprived of their wives and families, the army, in general, became impatient of their situation, and clamorous to return home. Hansing, upon this, revolved in his mind the bad consequences of complying with their wishes. The necessity of soothing his troops, and reconciling them to their position, appeared urgent, in order to finish his operations in the ensuing year. He was a man of genius, as well as a good soldier; and having contemplated some time on the subject, he invented the game of chess, as well for an amusement to his men in their vacant hours, as to inflame their military ardour, the game being wholly founded on the principles of war. The stratagem succeeded to his wish. The soldiery were delighted with the game; and forgot, in their daily contests, for victory, the inconveniences of their post. In the spring the general took the field again; and, in a few months, added the rich country of Shensi to the kingdom of Kiangnàn, by the defeat and capture of its king, Choupayuen, a famous warrior among the Chinese. On this conquest Hung Cochu assumed the title of emperor, and Choupayuen put an end to his own life in despair.

Explanation of the Position, Powers, and Moves of the Pieces on the Chinese Chess-board, or Chong Ke (Royal Game).

"As there are nine pieces instead of eight, to occupy the rear rank, they stand on the lines between, and not within, the squares. The game is consequently displayed on the lines.

"The king, or chong, stands on the middle line of this row. His moves resemble those of our king, but are confined to the fortress marked out for him.

"The two princes, or sou, stand on each side of him, and have equal powers and limits.

"The mandarins, or chong, answer to our bishops, and have the same moves, except that they cannot cross the water or white space in the middle of the board to annoy the enemy, but stand on the defensive.

"The knights, or rather horses, called *mēā*, stand and move like ours in every respect.

"The war-chariots, or tchè, resemble our rooks or castles.

"The rocket-boys, or paö, are pieces whose motions and powers were unknown to us. They act with the direction of a rocket, and can take none of their adversary's men that have not a piece or pawn intervening. To defend your men from this attack, it is necessary to open the line between, either to take off the check on the king, or to save a man from being captured by the paö. Their operation is, otherwise, like that of the rook. Their stations are marked between the pieces and pawns.

"The five pawns, or ping, make up the number of the men equal to that of our board. Instead of taking sideways, like ours, they have the rook's motion, except that it is limited to one step, and is not retrograde. Another important point, in which the ping differs from ours, is that they continue in *statu quo*, after reaching their adversary's head-quarters. It will appear, however, that the Chinese pieces far exceed the proportion of ours; which occasions the whole force of the contest to fall on them, and thereby precludes the beauty and variety of our game, when reduced to a struggle between the pawns, who are capable of the highest promotion, and often change the fortune of the day. The posts of the ping are marked in front *."

Chess.

But according to Sir William Jones, this game is of Hindoo invention. "If evidence were required to prove this fact (says he †), we may be satisfied with the testimony of the Persians, who, though as much inclined as other nations to appropriate the ingenious inventions of a foreign people, unanimously agree that the game was imported from the west of *India* in the sixth century of our era. It seems to have been immemorially known in *Hindostan* by the name of *Cheturanga*, i. e. the four *angá's*, or members of any army; which are these, *elephants*, *horses*, *chariots*, and *foot soldiers*; and in this sense the word is frequently used by epic poets in their description of real armies. By a natural corruption of the pure Sanscrit word, it was changed by the old Persians into *Chetrang*; but the Arabs, who soon after took possession of their country, had neither the initial nor final letter of that word in their alphabet, and consequently altered it further into *Shetranj*, which found its way presently into the modern *Persian*, and at length into the dialects of India, where the true derivation of this name is known only to the learned. Thus has a very significant word in the sacred language of the Brahmins been transformed by successive changes into *axedrez*, *scacchi*, *échecs*, *chess*, and, by a whimsical concurrence of circumstances, has given birth to the English word *check*, and even a name to the *exchequer* of Great Britain."

* Irish Trans. vol. v.

† Asiatic Researches, vol. ii. mem. 9.

It is confidently asserted, that Sanscrit books on *chess* exist in Bengal; but Sir William had seen none of them when he wrote the memoir which we have quoted. He exhibits, however, a description of a very ancient *Indian* game of the same kind, but more complex, and in his opinion more modern, than the simple chess of the *Persians*. This game is also called *Chaturanga*, but more frequently *Chaturaji*, or the *four kings*, since it is played by four persons representing as many princes, two allied armies combating on each side. The description is taken from a book called *Bhawishya Purán*; in which the form and principal rules of this fictitious warfare are thus laid down: "Eight squares being marked on all sides, the *red* army is to be placed on the east, the *green* to the south, the *yellow* to the west, and the *black* to the north. Let the *elephant* (says the author of the *Purán*) stand on the left of the *king*; next to him the *horse*; then the *boat*; and before them all, four *foot soldiers*; but the *boat* must be placed in the angle of the board."

"From this passage (says the president) it clearly appears, that an army with its four *angás* must be placed on each side of the board, since an *elephant* could not stand, in any other position, on the left hand of each *king*; and RADHACANT (a Pandit) informed me, that the

the board consisted, like ours, of 64 squares, half of them occupied by the forces, and half vacant. He added, that this game is mentioned in the oldest law books, and that it was invented by the wife of a king, to amuse him with an image of war, while his metropolis was besieged, in the second age of the world. A *ship* or *boat* is absurdly substituted, we see, in this complex game, for the *rat'h*, or armed *chariot*, which the *Bengalese* pronounce *rot'h*, and which the Persians changed into *rokh;* whence came the *rook* of some European nations; as the *vierge* and *fal* of the French are supposed to be corruptions of *ferz* and *fil*, the *prime minister* and *elephant* of the Persians and Arabs."

As fortune is supposed to have a great share in deciding the fate of a battle, the use of dice is introduced into this game to regulate its moves; for (says the Puran) "if *cinque* be thrown, the *king* or a *pawn* must be moved; if *quatre*, the *elephant;* if *trois*, the *horse;* and if *deux*, the *boat*. The *king* passes freely on all sides, but over *one* square only; and with the same limitation the *pawn* moves, but he advances straight forward, and kills his enemy through an angle. The *elephant* marches in all directions as far as his driver pleases; the *horse* runs obliquely, traversing the squares; and the *ship* goes over two squares diagonally." The *elephant*, we find, has the powers of our *queen*, as we are pleased to call the *general* or *minister* of the Persians; and the *ship* has the motion of the piece to which we give the unaccountable appellation of *bishop*, but with a restriction which must greatly lessen its value.

In the *Purán* are next exhibited a few general rules and superficial directions for the conduct of the game. Thus, "the *pawns* and the *ship* both kill and may be voluntarily killed; while the *king*, the *elephant*, and the *horse*, may slay the foe, but must not expose themselves to be slain. Let each player preserve his own forces with extreme care, securing his *king* above all, and not sacrificing a superior to keep an inferior piece." Here (says the president) the commentator on the *Pur'an* observes, that the *horse*, who has the choice of *eight* moves from any central position, must be preferred to the *ship*, which has only the choice of *four*. But the argument would not hold in common game, where the *bishop* and *tower* command a whole line, and where a knight is always of less value than a tower in action, or the bishop of that side on which the attack is begun. "It is by the overbearing power of the *elephant* (continues the *Purán*) that the king fights boldly; let the whole army, therefore, be abandoned in order to secure the *elephant*. The king must never place one *elephant* before another, unless he be compelled by want of room, for he would thus commit a dangerous fault; and if he can slay one of two hostile elephants, he must destroy that on his left hand."

What remains of the passage, which was copied from Sir William Jones, relates to the several modes in which a partial success or complete victory may be obtained by any one of the four players; for, as in a dispute between two allies, one of the kings may sometimes assume the command of all the forces, and aim at a separate conquest. First, "When any one king has placed himself on the square of another king (which advantage is called *sinhasana* or the *throne*), he wins a stake, which is doubled if he kill the adverse monarch when he seizes his place; and if he can seat himself on the throne of his ally, he takes the command of the whole army." Secondly, "If he can occupy successively the thrones of all the three princes, he obtains the victory, which is named *cheturaji;* and the stake is doubled if he kill the last of the three, just before he takes possession of his throne; but if he kill him on his throne, the stake is quadrupled. Both in giving the *sinhasana* and the *cheturaji*, the king must be supported by the *elephants*, or by all the forces united." Thirdly, "When one player has his own king on the board, but the king of his partner has been taken, he may replace his captive ally, if he can seize both the adverse kings; or if he cannot effect their capture, he may exchange his king for one of them, against the general rule, and thus redeem the allied prince, who will supply his place." This advantage has the name of *nripacrishta*, or *recovered by the king*. Fourthly, "If a *pawn* can march to any square on the opposite extremity of the board, except that of the king, or that of the ship, he assumes whatever power belonged to that square." Here we find the rule, with a slight exception, concerning the advancement of *pawns*, which often occasions a most interesting struggle at our common chess; but it appears that, in the opinion of one ancient writer on the Indian game, this privilege is not allowable when a player has three pawns on the board; but when only one pawn and one ship remains, the pawn may advance even to the square of a king or a ship, and assume the power of either. Fifthly, According to the people of *Lanct*, where the game was invented, "there could be neither victory nor defeat if a king were left on the plain without force; a situation which they named *cacacasht'ha*." Sixthly, "If three ships happen to meet, and the fourth ship can be brought up to them in the remaining angle, this has the name of *vrihannauca;* and the player of the fourth seizes all the others."

The account of this game in the original Sancrit is in verse.

This game was very fashionable in former times in every part of Europe; though in this country it is not now very common, probably on account of the intense application of thought required to play at it. It has long been a favourite of the Icelanders and other northern people. There is little difference between their game and ours.

The game of chess has been generally practised by the greatest warriors and generals; and some have even supposed that it was necessary for a military man to be well skilled in this game. It is a game which has something in it peculiarly interesting. We read that Tamerlane was a great chess-player, and was engaged in a game during the very time of the decisive battle with Bajazet the Turkish emperor, who was defeated and taken prisoner. It is also related of Al Amin, the caliph of Bagdad, that he was engaged at chess with his freedman Kuthar at the time when Al Mamun's forces were carrying on the siege of that city with so much vigour that it was on the point of being carried by assault. Dr Hyde quotes an Arabic history of the Saracens, in which the caliph is said to have cried out when warned of his danger, Let me alone, for I see checkmate against Kuthar! We are told that Charles I. was at chess when news were brought of the final intention of the Scots to sell him to the English; but so little was he discomposed by this alarming intelligence,

telligence, that he continued his game with the utmost composure; so that no person could have known that the letter he received had given him information of any thing remarkable. King John was playing at chess when the deputies of Rouen came to acquaint him that their city was besieged by Philip Augustus; but he would not hear them until he had finished his game.

The following remarkable anecdote we have from Dr Robertson in his History of Charles V. John Frederic, elector of Saxony, having been taken prisoner by Charles, was condemned to death. The decree was intimated to him while at chess with Ernest of Brunswic, his fellow-prisoner. After a short pause, and making some reflection on the irregularity and injustice of the emperor's proceedings, he turned to his antagonist, whom he challenged to finish the game. He played with his usual ingenuity and attention; and having beat Ernest, expressed all the satisfaction that is commonly felt on gaining such victories. He was not, however, put to death, but set at liberty after five years confinement.

In the Chronicle of the Moorish kings of Granada we find it related, that in 1396, Mehemed Balba seized upon the crown in prejudice of his elder brother, and passed his life in one continual round of disasters. His wars with Castile were invariably unsuccessful; and his death was occasioned by a poisoned vest. Finding his case desperate, he dispatched an officer to the fort of Salabreno to put his brother Juzaf to death, lest that prince's adherents should form any obstacle to his son's succession. The alcayde found the prince playing at chess with an *alfaqui* or priest. Juzaf begged hard for two hours respite, which was denied him; at last with great reluctance the officer permitted him to finish the game; but before it was finished, a messenger arrived with the news of the death of Mehemed, and the unanimous election of Juzaf to the crown.

We have a curious anecdote of Ferrand count of Flanders; who having been accustomed to amuse himself at chess with his wife, and being constantly beaten by her, a mutual hatred took place; which came to such a height, that, when the count was taken prisoner at the battle of Bovines, she suffered him to remain a long time in prison, though she could easily have procured his release.

The game of chess has undergone considerable variations since it was first invented. We have it on good authority, that, among the eastern nations, the piece now called the *queen* was formerly called the *vizir* or king's minister, and that the powers of the queen herself were but very small. The chess-boards used by Tamerlane were larger, and contained many more squares than those at present in use. Carrera invented two new pieces to be added to the eight commonly in use. One of these, which he calls *Campione*, is placed between the king's knight and castle; the other, named *Centaur*, between the queen's knight and castle, has the move of the bishop and knight united. This invention, however, did not survive its author. In another of this kind, the two additional pieces are called the *centurion* and *decurion*; the former situated between the king and his bishop, in its move the same with that of the queen, but only for two squares; the latter moves as the bishop, but only one square at a time. This, like the former, died with its inventor. The chess-board of Tamerlane was a parallelogram, having 11 squares one way and 12 the other. In the Memoirs of the late Marshal Keith, we find it related, that he invented an amusement something similar to that of chess, with which the king of Prussia was highly entertained. Several thousand small statues were cast by a founder; and these were ranged opposite to each other as if they had been drawn up in an army; making the different movements with them as in real service in the field.

A very complicated kind of game at chess was invented by the late duke of Rutland. At this the board has 14 squares in breadth, and 10 in height, which make in all 140 houses; and there are 14 pawns on each side, which may move either on two, or three squares the first time. The other pieces were the king, queen, two bishops, two knights, a crowned castle uniting the move of the king and castle, and a common castle. On the other side of the king was a *concubine*, whose move united that of the castle and knight, two bishops, a single knight, a crowned castle, and a common one. In this game the pawns are of very little use; and by the extent of the board, the knights lose much of their value, which consequently renders the game more defective and less interesting than the common one.

There is an amusing variety at the game of chess, in which the king with eight pawns engages the whole set, by being allowed to make two moves for every one of his adversary. In this he is almost certain of coming off victorious; as he can make his first move into check, and the second out of it. Thus he can take the queen when she stands immediately before her king, and then retreat; for he cannot remain in check. He cannot be check-mated unless his adversary has preserved his queen and both castles.

Chess-trees, (*toquets d'anjure*); two pieces of wood bolted perpendicularly, one on the starboard, and another on the larboard side of the ship. They are used to confine the *clue*, or lower corners of the main-sail; for which purpose there is a hole in the upper part, through which the rope passes that usually extends the clue of the sail to windward. See Tack.

The chess-trees are commonly placed as far before the main-mast as the length of the main-beam.

CHEST, in commerce, a kind of measure, containing an uncertain quantity of several commodities.

A chest of sugar, *v. g.* contains from ten to fifteen hundred weight; a chest of glass, from two hundred to three hundred feet; of Castile soap, from two and a half to three hundred weight; of indigo, from one and a half to two hundred weight, five score to the hundred.

Chest, or *Thorax*. See Anatomy *Index*.

CHESTER, commonly called *West-Chester*, to distinguish it from many other Chesters in the kingdom; the capital of Cheshire in England. It is a very ancient city, supposed to have been founded by the Romans; and plainly appears to have been a Roman station by the many antiquities which have been and are still discovered in and about the town. It was among the last places the Romans quitted: and here the Britons maintained their liberty long after the Saxons had got possession of the rest of their country. At present it

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Chester, Chester-le-Street.

it is a large, well-built, wealthy city, and carries on a considerable trade. Mr Pennant calls it *a city without a parallel*, on account of the singular structure of the four principal streets. They are as if excavated out of the earth, and sunk many feet beneath the surface; the carriages drive far beneath the level of the kitchens on a line with ranges of shops. The houses are mostly of wood, with galleries, piazzas, and covered walls before them; by which not only the shops, but those who are walking about the town, are so hid, that one would imagine there were scarce any inhabitants in it. But though by this contrivance such as walk the streets are screened from rain, &c. yet the shops are thereby rendered dark and inconvenient. The back courts of all the houses are on a level with the ground; but to go into any of the four principal streets, it is necessary to descend a flight of several steps. It contained 17,472 inhabitants in 1811.

Chester is a bishop's see. It was anciently part of the diocese of Litchfield; one of whose bishops removing the seat of his see hither in the year 1075, occasioned his successors to be frequently styled *bishop of Chester*. But it was not erected into a distinct bishopric until the general dissolution of monasteries, when King Henry VIII. in the year 1541, raised it to this dignity, and allotted the church of the abbey of St Werburg for the cathedral, styling it the *cathedral church of Christ and the blessed Virgin*; adding the bishopric to the province of Canterbury: but soon after he disjoined it from Canterbury, and added it to the province of York. When this abbey was dissolved, its revenues were valued at 1003l. 5s. 11d. This diocese contains the entire counties of Chester and Lancaster, part of the counties of Westmoreland, Cumberland, and Yorkshire, two chapelries in Denbighshire, and five parishes in Flintshire; amounting in all to 256 parishes, of which 101 are impropriations. This bishopric is valued in the king's books at 420l. 1s. 8d. and is computed to be worth annually 2700l.; the clergy's tenth amounting to 435l. 12s. To this cathedral belong a dean, two archdeacons, a chancellor, a treasurer, six prebendaries, and other inferior officers and servants. W. Long. 3. 0. N. Lat. 53. 12.

Chester-le-Street, the *Cuneacestre* of the Saxons; a small thoroughfare town between Newcastle and Durham, with a good church and fine spire. In the Saxon times this place was greatly respected on account of the relics of St Cuthbert, deposited here by Bishop Eardulf, for fear of the Danes, who at that time (about 884) ravaged the country. His shrine became afterwards an object of great devotion. King Athelstan, on his expedition to Scotland, paid it a visit, to obtain, by intercession of the saint, success on his arms; bestowed a multitude of gifts on the church; and directed, in case he died in his enterprise, that his body should be interred there. At the same time that this place was honoured with the remains of St Cuthbert, the bishopric of Lindesfarn was removed here, and endowed with all the lands between the Tyne and the Were, the present county of Durham. It was styled *St Cuthbert's patrimony*. The inhabitants had great privileges, and always thought themselves exempt from all military duty, except that of defending the body of their saint. Chester-le-Street may be considered as the parent of the see of Durham: for when the relics were removed there, the see in 995 followed them. Tanner says, that probably a chapter of monks, or rather secular canons, attended the body at this place from its first arrival; but Bishop Beke, in 1286, in honour of the saint, made the church collegiate, and established here a dean and suitable ecclesiastics; and, among other privileges, gave the dean a right of fishing on the Were, and the tythe of fish.

Chester-le-Street ‖ Chevreau.

New-Chester, a town of Pennsylvania in America, and capital of a county of that name. It is seated on the Delaware: and has a fine capacious harbour, admitting vessels of any burden. W. Long. 74. 7. N. Lat. 40. 15.

CHESTERFIELD, a market-town of Derbyshire in England, pleasantly situated on a hill between two small rivers. It has the title of an earldom; and a considerable market for corn, lead, and other country commodities. The houses are for the most part built of rough stone, and covered with slate. Population 4476 in 1811. W. Long. 1. 25. N. Lat. 53. 20.

CHESTERFIELD, *Earl of*. See STANHOPE.

CHEVAL *de* FRISE, a large piece of timber pierced, and traversed with wooden pikes, armed or pointed with iron, five or six feet long. See Plate CXXXVII.

The term is French, and properly signifies a *Friseland horse*; as having been first invented in that country.—It is also called a *Turnpike* or *Turniquet*.

Its use is to defend a passage, stop a breach, or make an entrenchment to stop the cavalry. It is sometimes also mounted on wheels with artificial fires, to roll down in an assault. Errand observes, that the prince of Orange used to inclose his camp with *Chevaux de Frise*, placing them one over another.

CHEVALER, in the manege, is said of a horse, when in passing upon a walk or trot, his off fore-leg crosses or overlaps the near fore-leg every second motion.

CHEVALIER, a French term, ordinarily signifying a KNIGHT. The word is formed of the French *cheval* "horse," and the barbarous Latin *cavallus*.

It is used, in heraldry, to signify any *cavalier* or horseman armed at all points; by the Romans called *cataphractus eques*: now out of use, and only to be seen in coat-armour.

CHEVAUX *de* FRISE. See *Cheval de Frise*.

CHEVIN, a name used in some parts of England for the CHUB.

CHEVIOT, or (TIVIOT) HILLS, run from north to south through Northumberland and Cumberland; and were formerly the borders or boundaries between England and Scotland, where many a bloody battle has been fought between the two nations; one of which is recorded in the ballad of Chevy-chase. These hills are the first land discovered by sailors in coming from the east into Scotland.

CHEVISANCE, in *Law*, denotes an agreement or composition, as an end or order set down between a creditor and his debtor, &c. In the statutes, this word is most commonly used for an unlawful bargain or contract.

CHEVREAU, URBAN, a learned writer, born at Loudun in 1613. He distinguished himself in his youth by his knowledge of the belles lettres; and became se-

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cretary of state to Queen Christina of Sweden. Several German princes invited him to their courts; and Charles Lewis, the elector palatine, retained him under the title of counsellor. After the death of that prince, he returned to France, and became preceptor to the duke of Maine. At length retiring to Lundun, he died there in 1701, aged 88. He was the author of several books, and amongst others of an Universal History, which has been often reprinted.

CHEVRON, or CHEVERON, in *Heraldry*. See HERALDRY.

CHEWING-BALLS, a kind of balls made of asafœtida, liver of antimony, bay-wood, juniper-wood, and pellitory of Spain; which being dried in the sun, and wrapped in a linen cloth, are tied to the bit of the bridle for the horse to chew; they create an appetite; and it is said, that balls of Venice treacle may be used in the same manner with good success.

CHEYKS. See BENGAL, No. 17.

CHEYNE, DR GEORGE, a physician of great learning and abilities, born in Scotland in 1671, and educated at Edinburgh under the great Dr Pitcairn. He passed his youth in close study, and with great temperance; but coming to settle at London, when about 30, and finding the younger gentry and free-livers to be the most easy of access and most susceptible of friendship, he changed on a sudden his former manner of living, in order to force a trade, having observed this method to succeed with many others. The consequence was, that he grew daily in bulk, and in intimacy with his gay acquaintance; swelling to such an enormous size, that he exceeded 32 stone weight; and he was forced to have the whole side of his chariot made open to receive him into it; he grew short-breathed, lethargic, nervous, and scorbutic; so that his life became an intolerable burden. In this deplorable condition, after having tried all the power of medicine in vain, he resolved to try a milk and vegetable diet; the good effects of which quickly appeared. His size was reduced almost a third: and he recovered his strength, activity, and cheerfulness, with the perfect use of all his faculties. In short, by a regular adherence to this regimen, he lived to a mature period, dying at Bath in 1742, aged 72. He wrote several treatises that were well received; particularly "An Essay on Health and Long Life;" and "The English Malady, or a Treatise of Nervous Diseases;" both the result of his own experience. In short, he had great reputation in his own time, both as a practitioner and as a writer; and most of his pieces passed through several editions. He is to be ranked among those physicians who have accounted for the operations of medicines and the morbid alterations which take place in the human body, upon mechanical principles. A spirit of piety and of benevolence, and an ardent zeal for the interests of virtue, are predominant throughout his writings. An amiable candour and ingenuousness are also discernible; and which led him to retract with readiness whatever appeared to him to be censurable in what he had formerly advanced. Some of the metaphysical notions which he had introduced into his books may perhaps justly be thought fanciful and ill-grounded; but there is an agreeable vivacity in his productions, together with much openness and frankness, and in general great perspicuity.

CHIABRERA, GABRIEL, esteemed the Pindar of Italy, was born at Savona in 1552, and went to study at Rome. The Italian princes, and Urban VIII. gave him public marks of their esteem. He wrote a great number of poems; but his lyric verses are most admired. He died at Savona, in 1638, aged 86.

CHIAN EARTH, in *Pharmacy*, one of the medicinal earths of the ancients, the name of which is preserved in the catalogues of the materia medica, but of which nothing more than the name has been known for many ages in the shops.

It is a very dense and compact earth; and is sent hither in small flat pieces from the island of Chios, in which it is found in great plenty at this time. It stands recommended to us as an astringent. They tell us, it is the greatest of all cosmetics; and that it gives a whiteness and smoothness to the skin, and prevents wrinkles, beyond any of the other substances that have been celebrated for the same purposes.

CHIAOUS, a word in the original Turkish, signifying "envoys," are officers to the number of five or six hundred in the grand signior's court, under the command of a chiaous baschi. They frequently meet in the grand vizir's palace, that they may be in readiness to execute his orders, and carry his dispatches into all the provinces of the empire. The chiaous baschi assists at the divan, and introduces those who have business there.

CHIAPA, the capital of a province of the same name in Mexico, situated about 300 miles east of Acapulco. W. Long. 98. 0. N. Lat. 16. 30.

CHIAPA el Real, a town of Mexico, in a province of the same name, with a bishop's see. Its principal trade consists in chocolate-nuts, cotton, and sugar. W. Long. 98. 35. N. Lat. 16. 20.

CHIAPA de los Indos, a large and rich town of North America, in Mexico, and in a province of the same name. The governor and most of the inhabitants are originally Americans. W. Long. 98. 5. N. Lat. 15. 6.

CHIARI, JOSEPH, a celebrated Italian painter, was the disciple of Carlo Maratti; and adorned the churches and palaces of Rome with a great number of fine paintings. He died of an apoplexy in 1727, aged 73.

CHIARI, a town of Italy, in the province of Brescia, and in the Austro-Venetian territories, 7 miles west of Brescia, and 27 east of Milan. Here the Imperialists gained a victory over the French in 1701. E. Long. 18. 18. N. Lat. 45. 30.

CHIARO SCURO. See *CLARO Obscuro*.

CHIAVENNA, a handsome, populous, and large town of Swisserland, in the county of the Grisons. It is a trading place, especially in wine and delicate fruits. The governor's palace and the churches are very magnificent, and the inhabitants are Roman Catholics. It was at one period, during the late contest with France, the scene of much carnage and bloodshed. It is seated near the lake Como. E. Long. 9. 29. N. Lat. 46. 15.

CHIAUSI, among the Turks, officers employed in executing the vizirs, bashaws, and other great men: the orders for doing this, the grand signior sends them wrapped up in a black cloth; on the reception of which they immediately perform their office.

CHICANE, or CHICANERY, in *Law*, an abuse of judiciary

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judiciary proceeding, tending to delay the cause, to puzzle the judge, or impose upon the parties.

Chicane, in the schools, is applied to vain sophisms, distinctions, and subtleties, which protract disputes, and obscure the truth.

CHICHESTER, the capital city of the county of Sussex, was built by Cissa, the second king of the South Saxons, and by him called *Cissan Cæster*. It is surrounded with a wall, which has four gates answering to the four cardinal points; from which run two streets, that cross one another in the middle and form a square, where the market is kept, and where there is a fine stone piazza built by Bishop Read. The space between the west and south gates is taken up with the cathedral church and the bishop's palace. It has five parish-churches; and is seated on the little river Lavant, which washes it on all sides except the north. This city would have been in a much more flourishing condition if it had been built by the sea side; however, the inhabitants have endeavoured to supply this defect in some measure, by cutting a canal from the city down to the bay. The principal manufactures of the town are malt and needles. The market of Chichester is noted for fish, wheat, barley, malt, and oats; the finest lobsters in England are bred in the Lavant; and it is observable, that this river, unlike most others, is very low in winter, but in summer often overflows its banks. Chichester is a city and county of itself; it is governed by a mayor, recorder, aldermen, common-council without limitation, and four justices of the peace chosen out of the aldermen; and it sends two members to parliament. It is a bishop's see. The cathedral church was anciently dedicated to St Peter. It was new built by Radulph, the twenty-fifth bishop; but being destroyed by fire, it was again built by Seffridus II. the twenty-ninth bishop. This see hath yielded to the church two saints, and to the nation three lord chancellors, two almoners, and one chancellor to the university of Oxford. Anciently the bishops of Chichester were confessors to the queens of England. This diocese contains the whole of the county of Sussex (excepting 22 parishes, peculiars of the archbishop of Canterbury), wherein are 250 parishes, whereof 112 are impropriated. It hath two archdeacons, viz. of Chichester and Lewes; is valued in the king's books at 667l. 1s. 3d. and is computed to be worth annually 2600l. The tenths of the whole clergy are 287l. 2s. 0½d. To the cathedral belong a bishop, a dean, two archdeacons, a treasurer, a chancellor, thirty-two prebendaries, a chanter, twelve vicars-choral, and other officers. Population 6425 in 1811. W. Long. 50. N. Lat. 50. 50.

CHICK, or Chicken, in *Zoology*, denotes the young of the gallinaceous order of birds, especially the common hen. See Phasianus, Ornithology *Index*.

Chick-Weed. See Alsine, Botany *Index*.

Chicken-Pox. See Medicine *Index*.

CHICKLING-pea, a name given to the Lathyrus. See Botany *Index*.

CHICUITOS, a province of South America, in the government of Santa Cruz de la Sierra. The chief riches consist of honey and wax; and the original inhabitants are very voluptuous, yet very warlike. They maintained bloody wars with the Spaniards till 1690; since which, some of them have become Christians. It is bounded by La Plata on the north-east, and by Chili on the west.

CHIDLEY, or Chimley, a market town of Devonshire, situated in W. Long. 4. 0. N. Lat. 51. 0.

CHIEF, a term signifying the head or principal part of a thing or person. Thus we say, the chief of a party, the chief of a family, &c. The word is formed of the French *chef*, "head;" of the Greek κεφαλη, *caput*, "head;" though Menage derives it from the Italian *capo*, formed of the Latin, *caput*.

Chief, in *Heraldry*, is that which takes up all the upper part of the escutcheon from side to side, and represents a man's head. *In chief*, imports something borne in the chief part or top of the escutcheon.

CHIEFTAIN, denotes the captain or chief of any class, family, or body of men. Thus the chieftains or chiefs of the Highland clans, were the principal noblemen or gentlemen of their respective clans. See Clans.

CHIELEFA, a strong town of Turkey in Europe, in the Morea. It was taken by the Venetians in 1685; but after that the Turks retook it, with all the Morea. E. Long. 22. 21. N. Lat. 26. 50.

CHIGI, Fabio, or Pope Alexander VII. was born at Sienna in 1599. His family, finding him a hopeful youth, sent him early to Rome, where he soon engaged in a friendship with the marquis Pallavicini, who recommended him so effectually to Pope Urban VIII. that he procured him the post of inquisitor at Malta. He was sent vice-legate to Ferrara, and afterward nuncio into Germany: there he had an opportunity of displaying his intriguing genius; for he was mediator at Munster, in the long conference held to conclude a peace with Spain. Cardinal Mazarin had some resentment against Chigi, who was soon after made a cardinal and secretary of state by Innocent X. but his resentment was sacrificed to political views. In 1665, when a pope was to be chosen, Cardinal Sacchetti, Mazarin's great friend, finding it was impossible for him to be raised into St Peter's chair, because of the powerful opposition made by the Spanish faction, desired Cardinal Mazarin to consent to Chigi's exaltation. His request was granted, and he was elected pope by the votes of all the 64 cardinals who were in the conclave: an unanimity of which there are but few instances in the election of popes. He showed uncommon humility at his election, and at first forbade all his relations to come to Rome without his leave; but he soon became more favourable to his nephews, and loaded them with favours. It is asserted that he had once a mind to turn Protestant. The newspapers in Holland bestowed great encomiums upon him; and acquainted the world that he did not approve of the cruel persecutions of the Waldenses in Piedmont. There is a volume of his poems extant. He loved the *Belles-Lettres*, and the conversation of learned men. He was extremely fond of stately buildings: the grand plan of the college *Della Sapienza*, which he finished, and adorned with a fine library, remains a proof of his taste in architecture. He died in 1667.

CHILBLAIN (*pernio*), in *Medicine*, a tumor affecting the feet and hands; accompanied with an inflammation, pains, and sometimes an ulcer or solution of

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Chilblains | Children.

of continuity; in which case it takes the denomination of *chaps* on the hands, and of *kibes* on the heels. Chilblain is compounded of *chill* and *blain; q. d.* a blain or sore contracted by cold. *Pernio* is the Latin name adopted by physicians; and is derived by Vossius from *perna*, "a gammon of bacon," on account of some resemblance. *Chap* alludes to *gape*, both in sound and appearance. *Kibes*, in Welch *kibws*, may be derived from the German *kerben*, "to cut;" the skin, when broke, appearing like a cut.

Chilblains are occasioned by excessive cold stopping the motion of the blood in the capillary arteries. See the article PERNIO.

CHILD, a term of relation to *parent*. See PARENT and CHILDREN.

Bartholine, Parè, Licetus, and many other writers, give an account of a petrified child, which has seemed wholly incredible to some people. The child, however, which they describe, is still in being; and is kept as a great rarity in the king of Denmark's museum at Copenhagen. The woman who was big with this, lived at Sens in Champagne in the year 1582; it was cut out of her belly, and was universally supposed to have lain there about 20 years. That it is a real human fœtus, and not artificial, is evident to the eyes of any observer; and the upper part of it, when examined, is found to be of a substance resembling the gypsum or stone whereof they made the plaster of Paris; the lower part is much harder, the thighs and buttocks being a perfect stone of a reddish colour, and as hard as common quarry stone; the grain and surface of this part appear exactly like that of the calculi or stones taken out of human bladders; and the whole substance, examined ever so nearly, and felt ever so carefully, appears to be absolute stone. It was carried from Sens to Paris, and there purchased by a goldsmith of Venice; and Frederic III. king of Denmark purchased it of this man at Venice for a very large sum, and added it to his collection of rarities.

CHILD-Bed. } See MIDWIFERY.
CHILD-Birth. }

CHILD-Wit, a power to take a fine of a bond-woman unlawfully gotten with child, that is, without consent of her lord. Every reputed father of a base child got within the manor of Writtel in Essex, pays to the lord a fine of 3s. 4d.; where, it seems, child-wit extends to free as well as bond-women.

CHILDERMAS-DAY, or *INNOCENTS Day*, an anniversary held by the church of England on the 28th of December, in commemoration of the children of Bethlehem massacred by order of Herod.

CHILDREN, the plural of CHILD.

Mr Derham computes, that marriages, one with another, produce four children not only in England, but in other parts also.

In the genealogical history of Tuscany, written by Gamarini, mention is made of a nobleman of Sienna, named Pichi, who of three wives had 150 *children;* and that, being sent ambassador to the pope and the emperor, he had 48 of his sons in his retinue. In a monument in the church-yard of St Innocent, at Paris, erected to a woman who died at 88 years of age; it is recorded, that she might have seen 268 *children* directly issued from her. This exceeds what Hakewell relates of Mrs Honeywood, a gentlewoman of Kent, born in the year 1527, and married at 16 to her only husband R. Honeywood of Charing, Esq. and died in her 93d year. She had 16 *children* of her own body; of which three died young, and a fourth had no issue; yet her *grandchildren*, in the second generation, amounted to 114; in the third, to 228; though in the fourth they fell to 9. The whole number she might have seen in her lifetime, being 367. 16+114+228+9=367. So that she could say the same as the distich does of one Dalburgh's family at Basil:

1 2 3 4
Mater ait natæ, dic natæ filia natam,
5 6
Ut moneat, natæ plangere, filiolam.

Management of CHILDREN. See INFANT.

Overlaying of CHILDREN, is a misfortune that frequently happens; to prevent which, the Florentines have contrived an instrument called *arcuccio*. See ARCUCCIO.

CHILDREN are, in *Law*, a man's issue begotten on his wife. As to *illegitimate children*, see BASTARD.

For the legal duties of parents to their children, see the articles PARENT and BASTARD.

As to the duties of children to their parents, they arise from a principle of natural justice and retribution. For to those who gave us existence, we naturally owe subjection and obedience during our minority, and honour and reverence ever after; they who protected the weakness of our infancy are entitled to our protection in the infirmity of their age; they who by sustenance and education have enabled their offspring to prosper, ought, in return, to be supported by that offspring, in case they stand in need of assistance. Upon this principle proceed all the duties of children to their parents, which are enjoined by positive laws. And the Athenian laws carried this principle into practice with a scrupulous kind of nicety, obliging all children to provide for their father when fallen into poverty; with an exception to spurious children, to those whose chastity had been prostituted with consent of their father, and to those whom he had not put in any way of gaining a livelihood. The legislature, says Baron Montesquieu, considered, that, in the first case, the father, being uncertain, had rendered the natural obligation precarious; that, in the second case, he had sullied the life he had given, and done his children the greatest of injuries, in depriving them of their reputation; and that, in the third case, he had rendered their life (so far as in him lay) an insupportable burden, by furnishing them with no means of subsistence.

Our laws agree with those of Athens, with regard to the first only of these particulars, the case of spurious issue. In the other cases, the law does not hold the tie of nature to be dissolved by any misbehaviour of the parent; and, therefore, a child is equally justifiable in defending the person, or maintaining the cause or suit, of a bad parent as of a good one; and is equally compellable, if of sufficient ability, to maintain and provide for a wicked and unnatural progenitor, as for one who has shown the greatest tenderness and parental piety. See further the article *FILIAL Affection*.

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Chili.

CHILI, a province of South America, bounded by Peru on the north, by the province of La Plata on the east, by Patagonia on the south, and by the Pacific ocean on the west, lying between 75 and 85 degrees of west longitude; and between 25 and 45 of south latitude; though some comprehend in this province Patagonia and Terra del Fuego.

The first attempt of the Spaniards upon this country was made by Almagro in the year 1535, after he and Pizarro had completed the conquest of Peru. He set out on his expedition to Chili with a considerable body of Spaniards and auxiliary Indians. For 200 leagues he was well accommodated with every necessary by the Indians, who had been subjects of the emperors of Peru: but reaching the barren country of Charcas, his troops became discontented through the hardships they suffered; which determined Almagro to climb the mountains called *Cordilleras*, in order to get the sooner into Chili; being ignorant of the invaluable mines of Potosi, contained in the province of Charcas, where he then was. At that time the Cordilleras were covered with snow, the depth of which obliged him to dig his way through it. The cold made such an impression on his naked Indians, that it is computed no less than 10,000 of them perished on these dreadful mountains, 150 of the Spaniards sharing the same fate; while many of the survivers lost their fingers and toes through the excess of cold. At last, after encountering incredible difficulties, Almagro reached a fine, temperate, and fertile plain, on the opposite side of the Cordilleras, where he was received with the greatest kindness by the natives. These poor savages taking the Spaniards for deputies of their god Virachoca, immediately collected for them an offering of gold and silver worth 290,000 ducats; and soon after brought a present to Almagro worth 300,000 more. These offerings only determined him to conquer the whole country as soon as possible. The Indians among whom he now was had acknowledged the authority of the Peruvian incas, or emperors, and consequently gave Almagro no trouble. He therefore marched immediately against those who had never been conquered by the Peruvians, and inhabited the southern parts of Chili. These savages fought with great resolution, and disputed every inch of ground; but in five months time the Spaniards had made such progress, that they must infallibly have reduced the whole province in a very short time, had not Almagro returned to Peru, in consequence of a commission sent him from Spain.

In 1540, Pizarro having overcome and put Almagro to death, sent into Chili, Baldivia or Valdivia, who had learned the rudiments of war in Italy, and was reckoned one of the best officers in the Spanish service. As he penetrated southwards, however, he met with much opposition; the confederated caziques frequently gave him battle, and displayed great courage and resolution; but could not prevent him from penetrating to the valley of Masiocho, which he found incredibly fertile and populous. Here he founded the city of St Jago; and, finding gold mines in the neighbourhood, forced the Indians to work in them; at the same time building a castle for the safety and protection of his new colony. The natives, exasperated at this slavery, immediately took up arms, attacked the fort, and though defeated and repulsed, set fire to the outworks, which contained all the provisions of the Spaniards. Nor were they discouraged by this and many other defeats, but still continued to carry on the war with vigour. At last, Valdivia, having overcome them in many battles, forced the inhabitants of the vale to submit; upon which he immediately set them to work in the mines of Quilotta. This indignity offered to their countrymen redoubled the fury of those who remained at liberty. Their utmost efforts, however, were as yet unable to stop Valdivia's progress. Having crossed the large rivers Maulle and Hata, he traversed a vast tract of country, and founded the city of La Conception on the South-sea coast. He erected fortresses in several parts of the country, in order to keep the natives in awe; and built the city called *Imperial*, about 40 leagues to the southward of Conception. The Spanish writers say, that the neighbouring valley contained 80,000 inhabitants of a peaceable disposition; and who were even so tame as to suffer Valdivia to parcel out their lands among his followers, while they themselves remained in a state of inactivity. About 16 leagues to the eastward of Imperial, the Spanish general laid the foundation of the city *Villa Rica*, so called on account of the rich gold mines he found there. But his ambition and avarice had now involved him in difficulties from which he could never be extricated: He had extended his conquests beyond what his strength was capable of maintaining. The Chilesians were still as desirous as ever of recovering their liberties. The horses, fire-arms, and armour of the Spaniards, indeed, appeared dreadful to them; but thoughts of endless slavery were still more so. In the course of the war they had discovered that the Spaniards were vulnerable and mortal men like themselves; they hoped, therefore, by dint of their superiority in numbers, to be able to expel the tyrannical usurpers. Had all the nations joined in this resolution, the Spaniards had certainly been exterminated; but some of them were of a pacific and fearful disposition, while others considered servitude as the greatest of all possible calamities. Of this last opinion were the Araceans, the most intrepid people in Chili, and who had given Valdivia the greatest trouble. They all rose to a man, and chose Capaulican, a renowned hero among them, for their leader. Valdivia however received notice of their revolt sooner than they intended he should, and returned with all expedition to the vale of Araccea; but before he arrived 14,000 of the Chilesians were there assembled under the conduct of Capaulican. He attacked them with his cavalry, and forced them to retreat into the woods; but could not obtain a complete victory, as they kept continually sallying out and harassing his men. At last Capaulican, having observed that fighting with such a number of undisciplined troops only served to contribute to the defeat and confusion of the whole, divided his forces into bodies of 1000 each. These he directed to attack the enemy by turns; and, though he did not expect that a single thousand would put them to flight, he directed them to make as long a stand as they could; when they were to be relieved and supported by another body; and thus the Spaniards would be at last wearied out and overcome. The event fully answered his expectations. The Chilesians maintained a fight

for

for seven or eight hours, until the Spaniards, growing faint for want of refreshment, retired precipitately. Valdivia ordered them to possess a pass at some distance from the field, to stop the pursuit; but this design being discovered to the Chilesians by the treachery of his page, who was a native of that country, the Spaniards were surrounded on all sides, and cut in pieces by the Indians. The general was taken and put to death; some say with the tortures usually inflicted by those savages on their prisoners; others that he had melted gold poured down his throat; but all agree, that the Indians made flutes and other instruments of his bones, and preserved his skull as a monument of their victory, which they celebrated by an annual festival. After this victory the Chilesians had another engagement with their enemies; in which also they proved victorious, defeating the Spaniards with the loss of near 3000 men; and upon this they bent their whole force against the colonies. The city of Conception, being abandoned by the Spaniards, was taken and destroyed: but the Indians were forced to raise the siege of Imperial; and their progress was at last stopped by Garcia de Mendoza, who defeated Capaulican, took him prisoner, and put him to death. No defeats, however, could dispirit the Chilesians. They continued the war for 50 years; and to this day they remain unconquered, and give the Spaniards more trouble than any other American nation. Their most irreconcilable enemies are the inhabitants of Araccea and Tucapel, those to the south of the river Bobia, or whose country extends towards the Cordilleras.—The manners of these people greatly resemble those of North America, which we have already described under the article AMERICA; but they seem to have a more warlike disposition. It is a constant rule with the Chilesians never to sue for peace. The Spaniards are obliged not only to make the first overtures, but to purchase it by presents. They have at last been obliged to abandon all thoughts of extending their conquests, and reduced to cover their frontiers by erecting forts at proper distances.

The Spanish colonies in Chili are dispersed on the borders of the South-sea. They are parted from Peru by a desert of 80 leagues in breadth; and bounded by the island of Chiloe, at the extremity next the straits of Magellan. There are no settlements on the coast, except those of Baldivia, Conception island, Valparaiso, and Coquimbo or La Serena, which are all seaports. In the inland country is St Jago, the capital of the colony. There is no culture nor habitation at any distance from these towns. The buildings in the whole province are low, made of unburnt brick; and mostly thatched. This practice is observed on account of the frequent earthquakes; and is properly adapted to the nature of the climate, as well as the indolence of the inhabitants.

The climate of Chili is one of the most wholesome in the whole world. The vicinity of the Cordilleras gives it such a delightful temperature as could not otherwise be expected in that latitude. Though gold mines are found in it, their richness has been too much extolled; their produce never exceeds 218,750l. The soil is prodigiously fertile. All the European fruits have improved in that happy climate. The wine would be excellent if nature were properly assisted by art; and the corn-harvest is reckoned a bad one when it does not yield a hundred fold. With all these advantages, Chili has no direct intercourse with the mother-country. Their trade is confined to Peru, Paraguay, and the savages on their frontiers. With these last they exchange their less valuable commodities, for oxen, horses, and their own children, whom they are ready to part with for the most trifling things. This province supplies Peru with great plenty of hides, dried fruit, copper, salt-meat, horses, hemp, lard, wheat, and gold. In exchange it receives tobacco, sugar, cacao, earthen-ware, woollen cloth, linen, hats, made at Quito, and every article of luxury brought from Europe. The ships sent from Callao on this traffic were formerly bound to Conception Bay, but now come to Valparaiso. The commerce between this province and Paraguay is carried on by land, though it is journey of 300 leagues, 40 of which lie through the snows and precipices of the Cordilleras: but if it was carried on by sea, they must either pass the straits of Magellan or double Cape Horn, which the Spaniards always avoid as much as possible. To Paraguay are sent some woollen stuffs called *ponchos*, which are used for cloaks; also wines, brandy, oil, and chiefly gold. In return they receive wax, a kind of tallow fit to make soap, European goods, and negroes.

Chili is governed by a chief, who is absolute in all civil, political, and military affairs, and is also independent of the viceroy. The latter has no authority except when a governor dies; in which case he may appoint one in his room for a time, till the mother-country names a successor. If, on some occasions, the viceroy has interfered in the government of Chili, it was when he has been either authorized by a particular trust reposed in him by the court, or by the deference paid to the eminence of his office: or when he has been actuated by his own ambition to extend his authority. In the whole province of Chili it was formerly computed there were not 20,000 white men, and not more than 60,000 negroes, or Indians, able to bear arms. Since 1810 this province has been the theatre of some revolutionary movements, which are not yet brought to a termination. See CHILI, SUPPLEMENT.

CHILIAD, an assemblage of several things ranged by thousands. The word is formed of the Greek χιλιας, *mille*, "a thousand."

CHILIAGON, in *Geometry*, a regular plane figure of 100 sides and angles. Though the imagination cannot form the idea of such a figure, yet we may have a very clear notion of it in the mind, and can easily demonstrate that the sum of all its angles is equal to 1996 right ones: for the internal angles of every plane figure are equal to twice as many right ones as the figure hath sides, except those four which are about the centre of the figure, from whence it may be resolved into as many triangles as it has sides. The author of *l'Art de Penser*, p. 44. has brought this instance to show the distinction between imagination and conceiving.

CHILIARCHA, or CHILIARCHUS, an officer in the armies of the ancients, who had the command of a thousand men.

CHILIASTS, in church-history. See MILLENARIANS.

CHILLINGWORTH, WILLIAM, an eminent divine

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vine of the church of England, was born at Oxford in 1602, and bred there. He made early great proficiency in his studies, being of a very quick genius. He was an expert mathematician, as well as an able divine, and a very good poet. Study and conversation at the university turning upon the controversy between the church of England and that of Rome, on account of the king's marriage with Henrietta daughter to Henry IV. king of France, Mr Chillingworth forsook the church of England and embraced the Romish religion. Dr Laud, then bishop of London, hearing of this, and being greatly concerned at it, wrote Mr Chillingworth; who expressing a great deal of candour and impartiality, that prelate continued to correspond with him. This set Mr Chillingworth on a new inquiry; and at last determined him to return to his former religion. In 1634 he wrote a confutation of the arguments which had induced him to go over to the church of Rome. He spoke freely to his friends of all the difficulties that occurred to him; which gave occasion to a groundless report, that he had turned Papist a second time, and then Protestant again. His return to the communion of the church of England made a great noise, and engaged him in several disputes with those of the Romish persuasion. But in 1635 he engaged in a work which gave him a far greater opportunity to confute the principles of the church of Rome, and to vindicate the Protestant religion, under the title of "The religion of Protestants a safe Way to Salvation." Sir Thomas Coventry, lord keeper of the great seal, offering him preferment, Mr Chillingworth refused to accept it on account of his scruples with regard to the subscription of the 39 articles. However, he at last surmounted these scruples; and being promoted to the chancellorship of the church of Sarum, with the prebend of Brixworth in Northamptonshire annexed to it, he complied with the usual subscription. Mr Chillingworth was zealously attached to the royal party; and, in August 1643, was present in King Charles I.'s army at the siege of Gloucester, where he advised and directed the making certain engines for assaulting the town. Soon after, having accompanied the Lord Hopton, general of the king's forces in the west, to Arundel castle in Sussex, he was there taken prisoner by the parliamentary forces under the command of Sir William Waller, who obliged the castle to surrender. But his illness increasing, he obtained leave to be conveyed to Chichester, where he was lodged at the bishop's palace; and, after a short sickness, died in 1644. He hath left several excellent works behind him.

CHILMINAR. See PERSEPOLIS.

CHILO, one of the seven sages of Greece, and of the ephori of Sparta the place of his birth, flourished about 556 years before Christ. He was accustomed to say that there were three things very difficult: "To keep a secret; to know how best to employ our time; and to suffer injuries without murmuring." According to Pliny, it was he who caused the short sentence *Know thyself*, to be written in letters of gold in the temple of Delphos. It is said that he died of joy, while embracing his son, who had been crowned at the Olympic games.

CHILOE, an island lying near the coast of Chili in South America, under the 43d degree of south latitude. It is the chief of an archipelago of 40 islands, and its principal town is Castro. It rains here almost all the year, insomuch that nothing but Indian corn, or some such grain, that requires but little heat to ripen it, can ever come to perfection. They have excellent shell-fish, very good wild-fowl, hogs, sheep, and beeves; as also a great deal of honey and wax. They carry on a trade with Peru and Chili; whither they send boards of cedar, of which they have vast forests.

CHILTENHAM, a town in Gloucestershire, six miles from Gloucester; noted for its purgative chalybeate spring, which has rendered it of late years a place of fashionable resort. This water, which operates with great ease, is deemed excellent in scorbutic complaints, and has been used with success in the gravel.

CHILTERN, a chain of chalky hills forming the southern part of Buckinghamshire, the northern part of the county being distinguished by the name of the *Vale*. The air on these heights is extremely healthful: The soil, though stony, produces good crops of wheat and barley; and in many places it is covered with thick woods, among which are great quantities of beech.—*Chiltern* is also applied to the hilly parts of Berkshire, and it is believed has the same meaning in some other counties. Hence the HUNDREDS lying in those parts are called the *Chiltern Hundreds*.

CHILTERN Hundreds, Stewards of. Of the hundreds into which many of the English counties were divided by King Alfred for the better government, the jurisdiction was originally vested in peculiar courts; but came afterwards to be devolved to the county courts, and so remains at present; excepting with regard to some, as the *chilterns*, which have been by privilege annexed to the crown. These having still their own courts, a *steward* of those courts is appointed by the chancellor of the exchequer, with a salary of 20s. and all fees, &c. belonging to the office: and this is deemed an appointment of such profit, as to vacate a seat in parliament.

CHIMÆRA, a port town of Turkey in Europe, situated at the entrance of the gulf of Venice, in the province of Epirus, about 32 miles north of the city of Corfu, near which are the mountains of Chimæra, which divide Epirus from Thessaly. E. Long. 20. 40. N. Lat. 40. 20.

CHIMÆRA, in fabulous history, a celebrated monster, sprung from Echidna and Typhon. It had three heads; that of a lion, a goat, and a dragon; and continually vomited flames. The fore parts of its body were those of a lion, the middle was that of a goat, and the hinder parts were those of a dragon. It generally lived in Lycia, about the reign of Jobates, by whose orders Bellerophon, mounted on the horse Pegasus, overcame it. This fabulous tradition is explained by the recollection that there was a burning mountain in Lycia, whose top was the resort of lions on account of its desolate wilderness; the middle, which was fruitful, was covered with goats; and at the bottom the marshy ground abounded with serpents. Bellerophon is said to have conquered the Chimæra, because he destroyed the wild beasts on that mountain, and rendered it habitable. Plutarch says that it was the captain of some pirates who adorned their ships with the images of a lion, a goat, and a dragon.

By a *chimæra* among the philosophers, is understood

Chimera, Chimes.

stood a mere creature of the imagination, composed of such contradictions and absurdities as cannot possibly anywhere exist but in thought.

CHIMES of a CLOCK, a kind of periodical music, produced at equal intervals of time, by means of a particular apparatus, added to a clock.

In order to calculate numbers for the chimes, and adapt the chime-barrel, it must be observed, that the barrel must turn round in the same time that the tune it is to play requires in singing. As for the chime-barrel, it may be made up of certain bars that run athwart it, with a convenient number of holes punched in them to put in the pins that are to draw each hammer; and these pins, in order to play the time of the tune rightly, must stand uprightly or hang down from the bar, some more, some less. To place the pins rightly, you may proceed by the way of changes on bells; viz. 1, 2, 3, 4; or rather make use of the musical notes. Observe what is the compass of your tune, and divide the barrel accordingly from end to end.

Thus, in the examples on Plate CXLIV. each of the tunes is eight notes in compass; and accordingly the barrel is divided into eight parts. These divisions are struck round the barrel; opposite to which are the hammer-tails.

We speak here as if there were only one hammer to each bell, that it may be more clearly apprehended; but when two notes of the same sound come together in a tune, there must be two hammers to the bell to strike it; so that if in all the tunes you intend to chime of eight notes compass, there should happen to be such double notes on every bell, instead of eight you must have sixteen hammers; and accordingly you must divide the barrel, and strike sixteen strokes round it, opposite to each hammer tail; then you are to divide it round about into as many divisions as there are musical bars, semibreves, minims, &c. in the tune.

Thus the hundredth-psalm tune has 20 semibreves, and each division of it is a semibreve; the first note of it also is a semibreve; and, therefore, on the chime-barrel must be a whole division, from five to five; as you may understand plainly, if you conceive the surface of a chime-barrel to be represented by the above figures, as if the cylindrical superficies of the barrel were stretched out at length, or extended on a plane; and then such a table, so divided, if it were to be wrapped round the barrel, would show the places where all the pins are to stand in the barrel; for the dots running about the table are the places of the pins that play the tune.

Indeed, if the chimes are to be complete, you ought to have a set of bells to the gamut notes; so as that each bell having the true sound of *sol*, *la*, *mi*, *fa*, you may play any tune with its flats and sharps; nay, you may by this means play both the base and treble with one barrel; and by setting the names of your bells at the head of any tune, that tune may easily be transferred to the chime-barrel, without any skill in music; but it must be observed, that each line in the music is three notes distant; that is, there is a note between each line, as well as upon it.

Chimes, Chimney.

CHIMNEY, in *Architecture*, a particular part of a house, where the fire is made, having a tube or funnel to carry off the smoke. The word *chimney* comes from the French *cheminée*; and that from the Latin *caminata*, "a chamber wherein is a chimney;" *caminata*, again, comes from *caminus*; and that from the Greek καμινος, "chimney;" of καιω, uro, "I burn."

Chimneys are usually supposed a modern invention, the ancients only making use of stoves; but Octavio Ferrari endeavours to prove chimneys in use among the ancients. To this end, he cites the authority of Virgil,

Et jam summa procul villarum culmina fumant:

and that of Appian, who says, "That of those persons proscribed by the triumvirate, some hid themselves in wells and common sewers, and some on the tops of houses and chimneys;" for so he understands καπνοδοις υπωροφιοις, *fumaria sub tecto posita*. Add, that Aristophanes, in one of his comedies, introduces his old man, Polycleon, shut up in a chamber, whence he endeavours to make his escape by the *chimney*.

Chimneys, in Professor Beckmann's opinion, are comparatively of modern invention. We shall lay before our readers some observations from his elaborate dissertation on this subject. He thus explains the above passage of Virgil.

"When the triumviri, says Appian *, caused those who had been proscribed by them to be sought for by the military, some of them, to avoid the bloody hands of their persecutors, hid themselves in wells, and others, as Ferrarius translates the words, *in fumaria sub tecto, qua scilicet fumus è tecto evolvitur* (A). The true translation, however (says Mr Beckmann), is *fumosa cœnacula*. The principal persons of Rome endeavoured to conceal themselves in the smoky apartments of the upper story under the roof, which, in general, were inhabited only by poor people; and this seems to be confirmed by what Juvenal † expressly says, *Rarus venit in cœnacula miles*.

"Those passages of the ancients which speak of smoke rising up from houses, have with equal impropriety been supposed to allude to chimneys, as if the smoke could not make its way through doors and windows. Seneca ‡ writes, 'Last evening I had some friends with me, and on that account a stronger smoke was raised; not such a smoke, however, as bursts forth from the kitchens of the great, and which alarms the watchmen, but such a one as signifies that guests are arrived.' Those whose judgments are not already warped by prejudice, will undoubtedly find the true sense of these words to be, that the smoke forced its way through the kitchen windows. Had the houses been built with chimney funnels, one cannot conceive why the watchmen should have been alarmed when they observed a stronger smoke than usual arising from them; but as the kitchens had no convenience of that nature, an apprehension of fire, when extraordinary entertainments

* De bellis civil. lib. iv. p. 961. edit. Tolii.

† Sat. 1. ver. 17.

‡ Epist. 64.

(A) Ες καπνοδους υπωροφιους, ή που τεγων ταις κεραμεσι βυθισθεντες.

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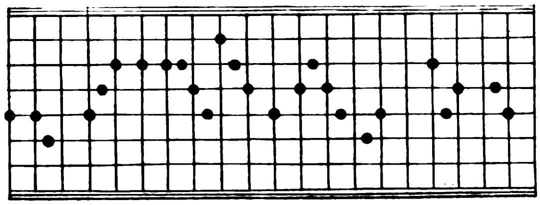
Fig. 1.

The Notes of the 100 Psalm tune

Fig. 2.

A Table for dividing the Chime barrel of the 100 Psalm tune.



CIPHER

Fig. 3.

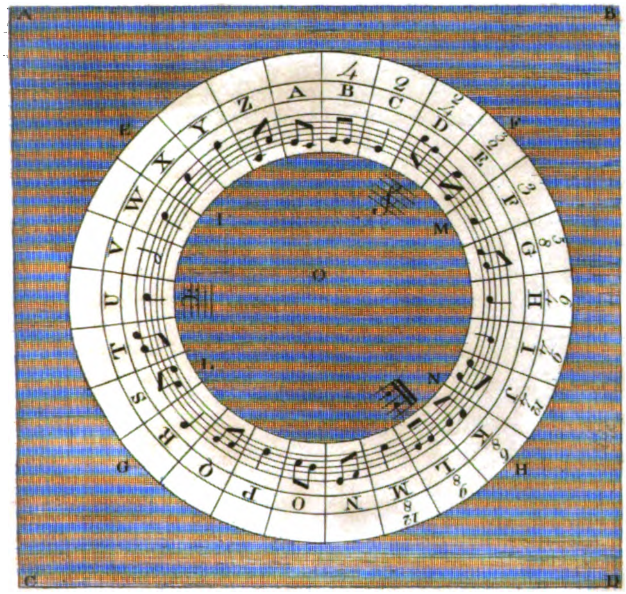


Fig. 4.

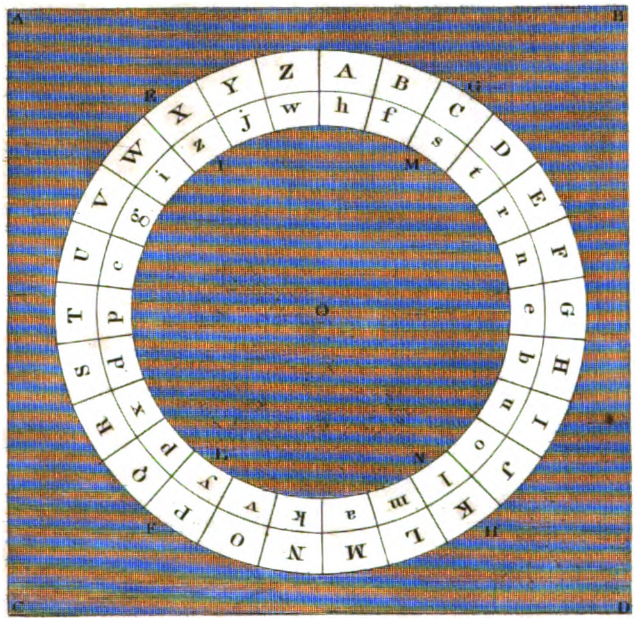


Fig. 5.

Fig. 6.

Ma un jvc uumm svar
vgnx qv ed jvc dlhmm
lhqr h yrkduvk hkt —
jvc ahj dqumm ahlr
h dlha vyyrduqurk —

Fig. 7.

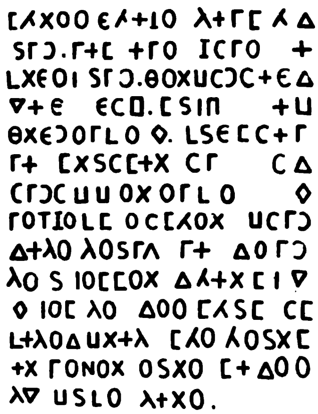


Fig. 8.

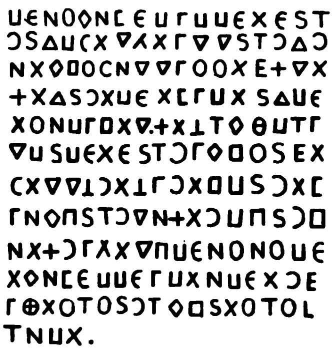
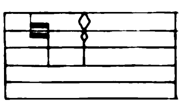


Fig. 9.

CLEFT

N°. 1.



N°. 2.

N°. 3.

E. Mitchell sculp.

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Chimney.

ments were to be provided in the houses of the rich for large companies, seems to have been well founded; and on such occasions people appointed for that purpose were stationed in the neighbourhood to be constantly on the watch, and to be ready to extinguish the flames in case a fire should happen. There are many other passages to be found in Roman authors of the like kind, which it is hardly necessary to mention; such as that of Virgil *,

Et jam summa procul villarum culmina fumant.

and the following words of Plautus †, descriptive of a miser:

Quin divum atque hominum clamat continuo fidem,
Suam rem periisse, seque eradicarier,
De suo tigillo fumus si qua exit foras.

" The passage of Aristophanes above alluded to, however (says the professor), which, according to the usual translation, seems to allude to a common chimney, can, in my opinion, especially when we consider the illustration of the scholiasts, be explained also by a simple hole in the roof, as Reiske has determined; and indeed this appears to be more probable, as we find mention made of a top or covering (πηλια) with which the hole was closed."

It has been said that the instances of chimneys remaining among the ruins of ancient buildings are few, and the rules given by Vitruvius for building them are obscure; but it appears that there exists *no* remains of ancient chimneys; and that Vitruvius gives *no* rules, either obscure or perspicuous, for building what, in the modern acceptation of the word, deserves the name of a chimney.

" The ancient mason-work still to be found in Italy does not determine the question. Of the walls of towns, temples, amphitheatres, baths, aqueducts, and bridges, there are some though very imperfect remains, in which chimneys cannot be expected; but of common dwelling houses none are to be seen, except at Herculaneum, and there no traces of chimneys have been discovered. The paintings and pieces of sculpture which are preserved, afford us as little information; for nothing can be perceived in them that bears the smallest resemblance to a modern chimney.

" If there were no funnels in the houses of the ancients to carry off the smoke, the directions given by Columella, to make kitchens so high that the roof should not catch fire, was of the utmost importance. An accident of the kind, which the author seems to have apprehended, had almost happened at Beneventum, when the landlord who entertained Mæcenas and his company was making a strong fire in order to get some birds sooner roasted.

——————— *ubi sedulus hospes*
Pæne arsit, macros dum turdos versat in igne;
Nam vaga per veterem dilapso flamma culinam
Vulcano summum properabat lambere tectum ‡.

Had there been chimneys in the Roman houses, Vitruvius certainly would not have failed to describe their construction, which is sometimes attended with considerable difficulties, and which is intimately connected with the regulation of the plan of the whole edifice. He does not, however, say a word on the subject; neither does Julius Pollux, who has collected with great care the Greek names of every part of a dwelling-house; and Grapaldus, who in later times made a collection of the Latin terms, has not given a Latin word expressive of a modern chimney *."

" *Camenis* signified, as far as I have been able to learn, first a chemical or metallurgic furnace, in which a crucible was placed for melting and refining metals; secondly, a smith's forge; and, thirdly, a hearth on which portable stoves or fire-pans were placed for warming the apartment. In all these, however, there appears no trace of a chimney." Herodotus relates (lib. viii. c. 137.), that a king of Libya, when one of his servants asked for his wages, offered him in jest the sun, which at that time shone into the house through an opening in the roof, under which the fire was perhaps made in the middle of the edifice. If such a hole must be called a chimney, our author admits that chimneys were in use among the ancients, especially in their kitchens; but it is obvious that such chimneys bore no resemblance to ours, through which the sun could not dart his rays upon the floor of any apartment.

However imperfect may be the information which can be collected from the Greek and Roman authors respecting the manner in which the ancients warmed their apartments, it nevertheless shews that they commonly used for that purpose a large fire-pan or portable stove, in which they kindled wood, and, when the wood was well lighted, carried it into the room, or which they filled with burning coals. When Alexander the Great was entertained by a friend in winter, as the weather was cold and raw, a small fire bason was brought into the apartment to warm it. The prince, observing the size of the vessel, and that it contained only a few coals, desired his host, in a jeering manner, to bring more wood or frankincense; giving him thus to understand that the fire was fitter for burning perfumes than to produce heat. Anacharsis, the Scythian philosopher, though displeased with many of the Grecian customs, praised the Greeks, however, because they shut out the smoke and brought only fire into their houses †. We are informed by Lampridius, that the extravagant Heliogabalus caused to be burned in these stoves, instead of wood, Indian spiceries, and costly perfumes ‡. It is also worthy of notice, that coals were found in some of the apartments of Herculaneum, as we are told by Winkelmann, but neither stoves nor chimneys.

It is well known to every scholar, that the useful arts of life were invented in the east, and that the customs, manners, and furniture of eastern nations, have remained from time immemorial almost unchanged. In Persia, which the late Sir William Jones seems to have considered as the original country of mankind, the methods employed by the inhabitants, for warming themselves, have a great resemblance to those employed by the ancient Greeks and Romans for the same purpose. According to De la Valle, the Persians make fires in their apartments, not in chimneys as we do, but in stoves in the earth, which they call *tennor*. " These stoves consist of a square or round hole, two spans or a little more in depth, and in shape not unlike an Italian cask. That this hole may throw out heat sooner, and with more strength, there is placed in it an iron vessel of the same size, which is either filled with burning coals,

* Eclog. i. ver. 23.

† Aulular. act. ii. sc. 4.

‡ Horat. lib. i. sat 5.

* Francisci Marii Grapaldi de partibus ædium libri.

† Plutarch, Sympos. lib. vi. 7. p 692.

‡ Æl. Lamprid. Vita Heliogab. cap. 31.

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Chimney. coals, or a fire of wood and other inflammable substances is made in it. When this is done, they place over the hole or stove a wooden top, like a small low table, and spread above it a large coverlet quilted with cotton, which hangs down on all sides to the floor. This covering condenses the heat, and causes it to warm the whole apartment. The people who eat or converse there, and some who sleep in it, lie down on the floor above the carpet, and lean, with their shoulders against the wall, on square cushions, upon which they sometimes also sit; for the *tennor* is constructed in a place equally distant from the walls on both sides. Those who are not very cold only put their feet under the table or covering; but those who require more heat can put their hands under it, or creep under it altogether. By these means the stone diffuses over the whole body, without causing uneasiness to the head, so penetrating and agreeable a warmth, that I never in winter experienced any thing more pleasant. Those, however, who require less heat, let the coverlet hang down on their side to the floor, and enjoy without any inconvenience from the stove the moderately heated air of the apartment. They have a method also of stirring up or blowing the fire when necessary, by means of a small pipe united with the tennor or stove under the earth, and made to project above the floor as high as one chooses; so that the wind, when a person blows into it, because it has no other vent, acts immediately upon the fire like a pair of bellows. When there is no longer occasion to use this stove, both holes are closed up, that is to say, the mouth of the stove and that of the pipe which conveys the air to it, by a flat stone made for that purpose. Scarcely any appearance of them is then to be perceived, nor do they occasion inconvenience, especially in a country where it is always customary to cover the floor with a carpet, and where the walls are plastered. In many parts these ovens are used to cook victuals, by placing kettles over them. They are employed also to bake bread; and for this purpose they are covered with a large broad metal plate, on which the cake is laid; but if the bread is thick and requires more heat, it is put into the stove itself *."

* *Hist. of Invent.* ii. 88.

The professor farther observes, the oldest account of them which he finds is an inscription at Venice, which relates, that in the year 1347 a great many chimneys were thrown down by an earthquake. It would appear, however, that in some places they had been in use for a considerable time before that period; for De Gataris, in his history of Padua, relates, that Francesco de Carraro, lord of Padua, came to Rome in 1368, and finding no chimneys in the inn where he lodged, because at that time fire was kindled in a hall in the middle of the floor, he caused two chimneys like those which had *long* been used at Padua to be constructed by masons and carpenters, whom he had brought along with him. Over these chimneys, the first ever seen at Rome, he affixed his arms, which were still remaining in the time of De Gataris, who died of the plague in 1405.

Method of Building CHIMNEYS *that will not smoke.* Workmen have different methods of drawing up the funnels of chimneys, generally according to their own fancies and judgments, and sometimes according to the customs of places. They are seldom directed by sound and rational principles. It will be found, for the most part, that the smoking of chimneys is owing to their being carried up narrower near the top than below, or zig-zag, all in angles; in some cases, indeed, it is owing to accidental causes; but, for the most part, to those two above mentioned. Where they are carried up in the pyramid or tapering form, especially if the house be of a considerable height, it is ten to one but they sometimes smoke. The air in the rooms, being rarefied, is forced into the funnel of the chimney, and receives from the fire an additional force to carry up the smoke. Now it is evident, that the further up the smoke flies, the less is the force that drives it, the slower it must move, and consequently the more room in proportion it should have to move in; whereas in the usual way it has less, by the sides of the chimney being gathered closer and closer together.

Chimney | Chimpanzee.

The method here proposed of carrying up chimneys will be objected to by some, thus: The wider a chimney is at the top, say they, the more liberty has the wind to blow down. Very true; but is it not resisted in going down, both by the form of the chimney and other evident causes, so that it must return again? In the other way, when the wind blows down, the resistance being less, the wind and smoke are, if we may use the expression, imprisoned, and make the smoke puff out below. This method has proved effectual after all others had failed; and that in a house placed in the worst situation possible, namely, under a high mountain to the southward, from which strong blasts blow down upon it. A vent was carried up without angles, as perpendicular as possible; and was made about three or four inches wider at top than at the bottom: the funnel was gathered in a throat directly above the fire-place, and so widening upwards. Since that time the house has not only ceased to smoke, but when the doors stand open, the draught is so strong, that it will carry a piece of paper out at the chimney head. See more on this subject, and the improvements by Count Rumford, under the article SMOKE.

CHIMNEY-*Money*, otherwise called *Hearth-money*, a duty to the crown on houses. By stat. 14. Char. II. cap. 2. every fire-hearth and stove of every dwelling or other house, within England and Wales (except such as pay not to church and poor), was chargeable with 2s. per annum, payable at Michaelmas and Lady-day to the king and his heirs and successors, &c.; which payment was commonly called *chimney-money*. This tax, being much complained of as burdensome to the people, has been since taken off, and others imposed in its stead; among which that on windows has by some been esteemed almost equally grievous.

CHIMPANZEE, in *Natural History*. See SIMIA.

END OF THE FIFTH VOLUME.

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