SCIENCE

THE [YE]AR BOOK OF FACTS

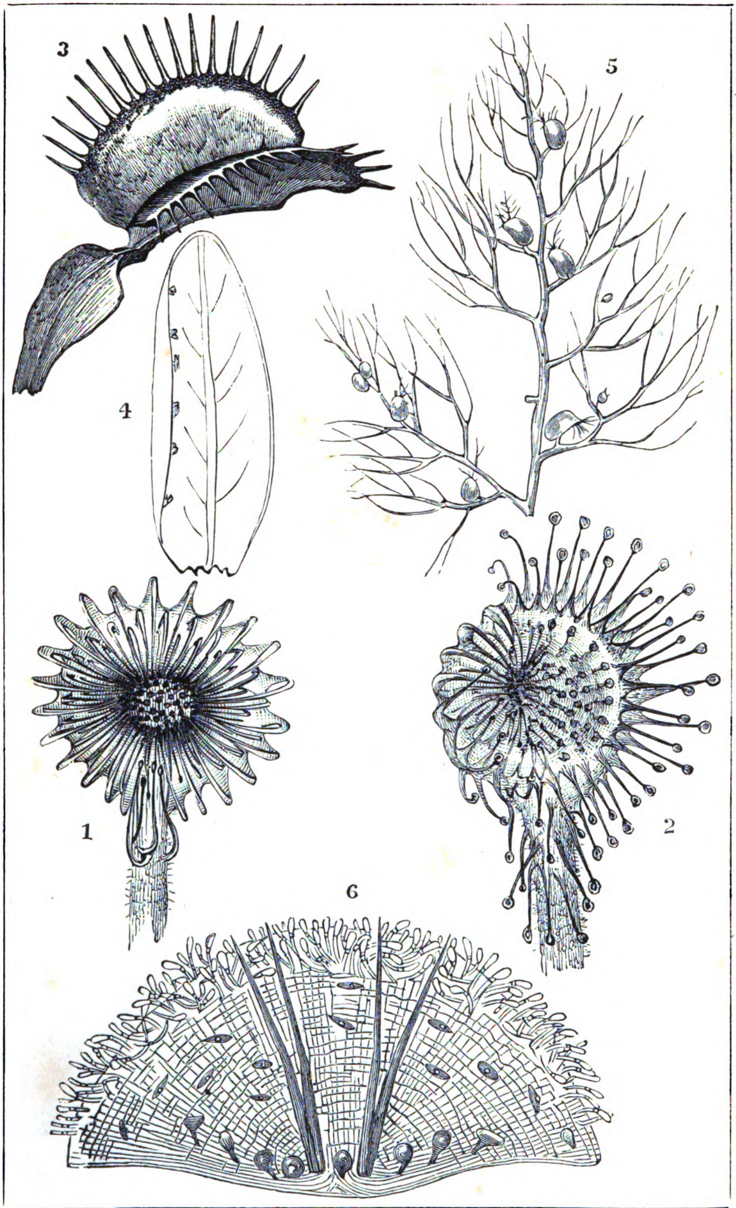
IN SCIENCE AND THE ARTS.

INVENTIONS IMPROVEMENTS

THE EIGHTY-ONE TON GUN.

EDITED BY CHAS. W. VINCENT.
F. C. S. LONDON AND BERLIN.

LONDON: WARD. LOCK. & TYLER.



INSECTIVOROUS PLANTS (CHARLES DARWIN, F.R.S.).

THE

YEAR-BOOK OF FACTS

IN

SCIENCE AND THE ARTS,

FOR

1875.

EDITED BY

CHARLES W. VINCENT, F.R.S.E.,
F.C.S. (LONDON AND BERLIN),
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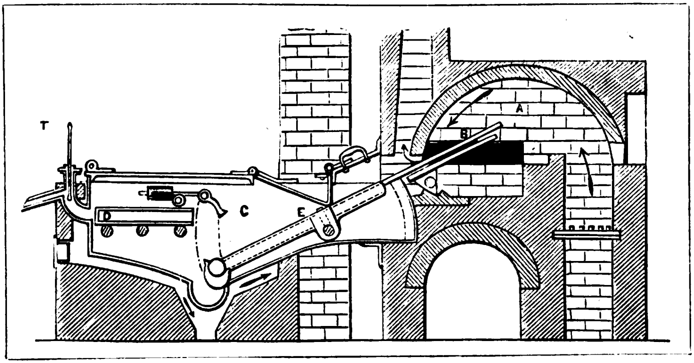

M. De la Bastie's Furnace for Tempering Glass.

LONDON: WARD, LOCK, AND TYLER,
WARWICK HOUSE, PATERNOSTER ROW.

MDCCCLXXVI.

PREFACE.

THIS volume is a record of scientific and mechanical progress during the past year.

Scientific societies and scientific journals are now so numerous that the workers themselves are well-nigh swamped with the flood of papers on all subjects pouring upon them from all quarters of the globe; and general readers have little chance of being able to keep at all near the surface of the stream. To them the Year-book of Facts, it is to be hoped, will render material assistance.

The subject-matter of those papers which open out fresh fields for investigation, or which more fully illustrate known facts, are here collected and classified, so that the value of the labours of investigators in each branch of science can be readily estimated. It is a matter of regret that those researches which merely extend the knowledge of details (though oftentimes most laborious and praiseworthy for the self-negation which is evidenced by undertaking such thankless work) have been necessarily either greatly condensed or altogether omitted.

The sketches of the means by which carnivorous plants capture their victims, forming the frontispiece, are copied by the kind permission of Mr. CHARLES DARWIN from his work on "Insectivorous Plants." To him and to many friends for much assistance I tender my sincere thanks.

CHARLES W. VINCENT.

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DISCOVERY OF A NEW METAL, "GALLIUM."

THE chief scientific event of 1875 was the discovery of a new element. On the 27th of August, M. Lecoq de Boisbaudran, whilst examining with the spectroscope a blende from Pierrefitte mine, in the valley of Argeles, Pyrenees, observed coloured bands which were not coincident with those of any of the elements: and chemical analysis led him to infer the existence of a new metal, to which he gave the name "Gallium." In December last he succeeded in obtaining gallium in the metallic state; and laid before the French Academy a specimen weighing 3·4 milligrams. The number of known elementary bodies thus becomes 64.

The oxide of gallium (perhaps a suboxide) is thrown down by metallic zinc in a solution containing chlorides and sulphates. Chlorides and sulphates are precipitated by a small quantity of ammonia; but the precipitates are in great part soluble in excess of ammonia or ammonium carbonate. If the portion insoluble in ammonia be redissolved in hydrochloric acid, and the operation repeated, all the gallium may easily be obtained in an ammoniacal solution. An ammoniacal solution of gallium sulphate or chloride is precipitated by excess of acetic acid, hot or cold: if ammonium acetate be used, the solution must be heated. Gallium salts are thrown down by ammonium sulphide, even in presence of ammonium acetate, or free acetic acid. The sulphide is insoluble in ammonium sulphide. In presence of zinc the gallium is concentrated in the first sulphides precipitated, but six successive precipitations do not entirely free it from zinc sulphide. The salts are not precipitated by sulphuretted hydrogen. Barium carbonate precipitates gallium carbonate from solutions of the sulphate or chloride, even in the cold.

Gallium sulphate, evaporated and dried till sulphuric acid vapour almost entirely ceases to be given off, is still soluble in cold water. Acid solution of gallium chloride is precipitated by potassium ferrocyanide.

M. Boisbaudran has obtained an ammonia alum of gallium.

This salt is soluble in cold water, but decomposes when the solution is heated, unless free acetic acid is added. It crystallizes in cubes and octrahedra, which present exactly the appearance of ordinary alum. A small crystal of gallium alum when placed in a saturated solution of ammonio-aluminium alum determined its crystallization. If there be no error concerning the nature of gallium alum, the existence of this salt fixes the atomicity of the new element, and places it among the triads. Its oxide will therefore be Ga_2O_3.

The electric spectrum of a slightly concentrated solution of gallium chloride is very brilliant. The spectrum consists of a narrow violet ray, situated at about 417 in the scale of wave lengths, and of a less intense ray at 404. The colour of the electric spark in gallium chloride is a fine light violet.

The metal was isolated by a voltaic current from an ammoniacal solution of gallium sulphate. Metallic gallium was deposited on the platinum plate forming the negative pole, whilst the positive pole was covered with a whitish pellicle, easily detached from the platinum, and which was insoluble in excess of ammonia.

Electrolytic gallium is hard, and can be polished, though with great difficulty, by an agate burnisher. The metal then acquires great brightness, and appears somewhat whiter than platinum. When the electric current and the size of the poles are properly adjusted a fine silvery deposit is obtained, which is found under the microscope to consist of brilliant crystals.

Gallium is not sensibly oxidized by boiling with water, nor when dried in the open air at 200° C. The polished surface, however, becomes more or less clouded after a few days' exposure to the air.

Gallium decomposes water acidulated with hydrochloric acid, hydrogen being given off.

The new metal has since been detected by M. Boisbaudran in other zinc ores, especially in a transparent blende from Santander; he believes it will be found in all blendes. The extreme sensibility of the spectral reaction caused him at first to overestimate the quantity of gallium present. The earliest experiment was made upon not more than the hundredth part of a milligram dissolved in a very small drop of liquid. The spectral examination of so small a quantity was rendered possible by the reduction of the size of the apparatus for obtaining electric spectra, and the adoption of very small sparks.

THE
YEAR-BOOK OF FACTS.

MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION, BRISTOL MEETING.

ADDRESS BY PROFESSOR BALFOUR STEWART.

(*Abstract.*)

SINCE the last meeting of the British Association, science has had to mourn the loss of one of its pioneers, in the death of the veteran astronomer, Schwabe, of Dessau.

It is now nearly fifty years since he first began to produce daily sketches of the spots that appeared upon the sun's surface. Every day on which the sun was visible for forty years, he made his sketch of the solar disc. At length his unexampled perseverance met with its reward in the discovery of the periodicity of sun-spots.

A priori we should not have expected such a phenomenon: for while all are ready to acknowledge periodicity as one of the natural conditions of terrestrial phenomena, yet everyone is inclined to ask what there can be to cause it in the behaviour of the sun himself. Manifestly it can only have two possible causes. It must either be the outcome of some strangely hidden periodical cause residing in the sun himself, or must be produced by external bodies, such as planets, acting somehow in their varied positions on the atmosphere of the sun. But whether the cause be internal or external, in either case we are completely ignorant of its nature.

If we look within, we are at a loss to account for the periodicity of solar disturbances; and if we look without, we are equally at a loss to account for their magnitude. Mr. Carrington was the next to enter the field of solar research. His aim was to obtain accurate records of the positions, the sizes, and the shapes of the sun-spots. Each sun-spot that made its appearance during the seven years extending from the beginning of 1854 to the end of 1860 was sketched with the greatest possible accuracy, and had also its heliographic position, that is to say, its solar latitude and longitude, accurately determined. He then discovered that sun-spots have a proper motion of their own—those nearer the solar equator moving faster than those more remote: and also that there were periodical changes affecting the disposition of spots in solar latitude.

Before Mr. Carrington had completed his labours, celestial photography had been introduced by Mr. Warren de la Rue. Under his superintendence in the year 1862, the first of a ten years' series of solar photographs was begun at Kew. Before this date, however, he had ascertained, by means of his photoheliograph, on the occasion of the total eclipse of 1860, that the red prominences surrounding the eclipsed sun, belong, without doubt, to our luminary himself.

From these observations several important conclusions have been obtained. In the first place these photographs confirm the theory of Wilson, that the dark portions of the sun-spots exist at a level considerably beneath the general surface of the sun; in other words, they are hollows, or pits, the interior of which is of course filled up with the solar atmosphere. The observers were led to associate the low temperature of the bottom of sun-spots with the downward carriage of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculæ or bright patches which almost invariably accompany spots. In the next place they discovered traces of the influence of the nearer planets upon the behaviour of sun-spots. This influence appears to be of such a nature, that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet—that is to say, into positions where the body of the sun is between them and the planet. There is also evidence of an excess of solar action when two influential planets come near together. But it ought to be borne in mind that the cause of the remarkable period of eleven years and a quarter, originally discovered by Schwabe, has not yet been properly explained. The Kew observers have likewise discovered traces of a peculiar oscillation of spots between the two hemispheres of the sun.

While the sun's surface was thus being examined, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes, that the vapour of sodium, at a comparatively low temperature, forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium vapour.

Kirchhoff soon found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapours.

The new method soon brought forth further fruit when applied in the hands of Huggins, Miller, Secchi, and others, to the more distant heavenly bodies. It was speedily found that the fixed stars had constitutions very similar to that of the sun. But a peculiar and unexpected success was attained when some of the nebulæ were examined spectroscopically. To-day it seems very much like recalling an old superstition, to remind you that until the advent of the spectroscope, the irresolvable nebulæ were considered to be gigantic and remote clusters of stars, the individual members of which were too distant to be separated from each other even with a telescope like that of Lord Rosse. But Mr. Huggins, by means of the spectroscope, soon found that this was not the case, and that most of the nebulæ which had defied the telescope gave indications of incandescent hydrogen gas. He also found that the proper motions of some of the fixed stars in a direction to or from the earth, might be detected by means of the displacement of their spectral lines.

Up to this time it had not been attempted to localise the use of the spectroscope so as to examine particular districts of the sun, as for instance a sun-spot, or the red flames. This application was first made by Mr. Lockyer, who in 1865 examined a sun-spot spectroscopically, and remarked the greater thickness of the lines in the spectrum of the darker portion of the spot. Dr. Frankland had previously found that thick spectral lines correspond to great pressure, and hence the inference, from the greater thickness of lines in the umbra of a spot, is that this umbra or dark portion is subject to a greater pressure; that is to say, it exists below a greater depth of the solar atmosphere than the general surface of the sun. Thus the results derived from the Kew photoheliograph, and those derived from the spectroscope were found to confirm each other.

The flames were analysed spectroscopically by Capt. Herschel, M. Janssen, and others, on the occasion of a total eclipse occurring in India, and were found to consist of incandescent gas, most probably hydrogen. In addition M. Janssen made the important observation that the bright lines in the spectrum of these flames remained visible even after the sun had reappeared, from which he argued that a solar eclipse is not necessary for the examination of this region.

Before information of this discovery had reached this country, a powerful instrument, constructed by Mr. Lockyer, with the hope that if the red flames consisted of ignited gas the spectroscope would disperse and thus dilute and destroy the glare which ordinarily prevents them from being seen, was completed; and he found that by its means he was able to analyse at leisure the composition of the red flames without the necessity of a total eclipse. An atmosphere of incandescent hydrogen was found to surround our luminary, into which, during the greater solar storms, sundry metallic vapours were injected, sodium, magnesium, and iron forming the three that most frequently made their appearance.

Here we come to an interesting chemical question.

It had been remarked by Maxwell and by Pierce, as the result of the molecular theory of gases, that the final distribution of any number of kinds of gas in a vertical direction under gravity is such, that the density of each gas at a given height is the same as if all the other gases had been removed, leaving it alone. In our own atmosphere the continual disturbances prevent this arrangement from taking place, but in the sun's enormously extended atmosphere (if indeed our luminary be not nearly all gaseous) it appears to hold, inasmuch as the upper portion of this atmosphere, dealing with known elements, apparently consists entirely of hydrogen. Various other vapours are, however, as we have seen, injected from below the photosphere into the solar atmosphere on the occasion of great disturbances, and Mr. Lockyer has asked the question—Whether we have not here a true indication of the relative densities of these various vapours derived from the relative heights to which they are injected on such occasions?

It had already been observed by Kirchhoff that sometimes one or more of the spectral lines of an elementary vapour appeared to be reversed in the solar spectrum, while the other lines did not experience reversal. Mr. Lockyer succeeded in obtaining an explanation of this phenomenon.

Hitherto, when taking the spectrum of the electric spark between the two metallic poles of a coil, the arrangements were such as to give an average spectrum of the metal of these poles; but it was found that when the method of localisation was employed, different portions of the spark gave a different number of lines, the regions near the terminals being rich in lines, the midway regions comparatively poor.

If we imagine that in the midway regions the metallic vapour given off by the spark is in a rarer state than that near the poles, we are led to regard the short lines which cling to the poles as those which require a greater density of the vapour particles before they make their appearance; while on the other hand, those which extend all the way between the two poles come to be regarded as those which will continue to make their appearance in vapour of great tenuity.

Now these long lines are the very lines which are reversed in the atmosphere of the sun. Hence when we observe a single coincidence between a dark solar line and the bright line of any metal, we are led to inquire whether this bright line is one of the long lines which will continue to exist all the way between two terminals of that metal when the spark passes.

If this be the case, then we may argue that the metal in question really occurs in the solar atmosphere; but if the coincidence is merely between a solar dark line and a short bright one, then we are led to imagine that it is not a true coincidence, but something which will probably disappear on further examination. This method has afforded a means of determining the relative amount of the various metallic vapours in the sun's atmosphere. Thus, in some instances all lines are reversed, whereas in others the reversal extends only to a few of the longer lines.

Several new metals have thus been detected in the solar atmophere, and it is now certain that the vapours of hydrogen, potassium, sodium, rubidium, barium, strontium, calcium, magnesium, aluminium, iron, manganese, chromium, cobalt, nickel, titanium, lead, copper, cadmium, zinc, uranium, cerium, vanadium, and palladium occur in our luminary.

If we have learned to be independent of total eclipses as far as the lower portions of the solar atmosphere are concerned, it must be confessed that as yet the upper portions—the outworks of th sun—can only be successfully approached on these rare and precious occasions. Thanks to the various expeditions despatched, we are in the possession of definite information regarding the solar corona.

In the first place, we are now absolutely certain that a large part of this appendage unmistakably belongs to the sun, and in the next place, we know that it consists, in part at least, of an ignited gas giving a peculiar spectrum, which we have not yet been able to identify with that of any known element. The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

A peculiar physical structure of the corona has likewise been suspected.

If we now turn our attention to matters nearer home, we find that there is a difficulty in grasping the facts of terrestrial meteorology. These perplex us because we are so intimately mixed up with them in our daily lives and actions; because, in fact, the scale is so large and we are so near. The result has been that until quite recently our meteorological operations have been conducted by a band of isolated volunteers individually capable and skilful, but from their very isolation incapable of combining together with advantage to prosecute a scientific campaign. Of late, however, we have begun to perceive that if we are to make any advance in this very interesting and practical subject, a different method must be pursued, and we have already reaped the first fruits of a more enlightened policy; already we have gained some knowledge of the constitution and habits of our atmosphere.

There are strong grounds for supposing that the meteorology of the sun and that of the earth are intimately connected together. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation; five successive years' observations of the barometer at Singapore all giving the period 25·74 days. Baxendell, of Manchester, was, I believe, the first to show that the convection currents of the earth appear to be connected somehow with the state of the sun's surface as regards spots; and still more recently Meldrum, of the Mauritius Observatory, has shown that the cyclones in the Indian Ocean are most frequent in years when there are most sun-spots. He likewise affords us grounds for supposing that the rainfall, at least in the tropics, is greatest in years of maximum solar disturbance. Poey has found a similar connection in the case of the West Indian hurricanes; and finally, Piazzi, Smyth, Stone, Köppen and Blanford, have been able to bring to light a cycle of terrestrial temperature having apparent reference to the condition of the sun.

Thus, we have strong matter-of-fact grounds for presuming a connection between the meteorology of our luminary and that of our planet, even although we are in complete ignorance as to the exact nature of this bond.

If we turn to terrestrial magnetism the same connection becomes apparent.

Sir Edward Sabine was the first to show that the disturbances of the magnetism of the earth are most violent during years of maximum sun-spots. Broun has shown that there is likewise a reference in magnetic phenomena to the period of the sun's rotation about his axis, an observation confirmed by Hornstein; and still more recently Broun has pointed out that the moon has an action upon the earth's magnetism which depends, in part, at least, upon the relative position of the sun and moon.

We are all familiar with the generalisation of Hadley, that is to say, we know there are under-currents sweeping along the surface of the earth from the poles to the equator, and upper-currents sweeping back from the equator to the poles. We are likewise aware that these currents are caused by the unequal temperature of the earth; they are in truth convection-currents, and their course is determined by the positions of the hottest and coldest parts of the earth's surface. We may expect them, therefore, to have a reference not so much to the geographical equator and poles as to the hottest and coldest regions. In fact, we know that the equatorial regions into which the trade winds rush, and from which the anti-trades take their origin, have a certain annual oscillation depending upon the position of the sun, or in other words upon the season of the year. We may likewise imagine that the region into which the upper-currents pour themselves is not the geographical pole, but the pole of greatest cold.

In the next place we may imagine that these currents, as far as regards a particular place, have a daily oscillation. This has, I believe, been proved as regards the lower currents or trade-winds, which are more powerful during the day than during the night, and we may therefore expect it to hold good with regard to the upper-currents or anti-trades; in fact, we cannot go wrong in supposing that they also, as regards any particular place, exhibit a daily variation in the intensity with which they blow.

Again, we are aware that the earth is a magnet. We must bear in mind that rarefied air is a good conductor of electricity; indeed, according to recent experiments, an extremely good conductor. The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are therefore to be regarded in the light of good conductors crossing the lines of magnetic force; we may therefore expect them to be the vehicle of electric currents. Such electric currents will of course react on the magnetism of the earth. Now, since the velocity of these upper currents has a daily variation, their influence as exhibited at any place upon the magnetism of the earth may be expected to have a daily variation also.

The question thus arises, Have we possibly here a cause which may account for the well-known daily magnetic variation? Are the peculiarities of this variation such as to correspond to those which might be expected to belong to such electric currents? I think it may be said that as far as we can judge, there is a likeness of this kind between the peculiarities of these two things, but a more prolonged scrutiny will of course be essential before we can be absolutely certain that such currents are fitted to produce the daily variation of the earth's magnetism.

Besides the daily and yearly periodic changes in these upper convection currents, we should also expect occasional and abrupt changes forming the counterparts of those disturbances in the lower strata with which we are familiar. And these may be expected in like manner to produce non-periodic occasional disturbances of the magnetism of the earth. Now it is well known that such disturbances do occur, and further that they are most frequent in those years when cyclones are most frequent, that is to say, in years of maximum sun-spots. In one word it appears to be a tenable hypothesis to attribute at least the most prominent magnetic changes to atmospheric motions taking place in the upper regions of the atmosphere where each moving stratum of air becomes a conductor moving across lines of magnetic force.

It thus seems possible that the excessive magnetic disturbances which take place in years of maximum sun-spots may be due to the excessive meteorological disturbances which are likewise characteristic of such years. But on the other hand, the magnetic and meteorological influence which Broun has found to be connected with the sun's rotation, points to some unknown direct effect produced by our luminary, even if we imagine that the magnetic part of it is caused by the meteorological. Broun is of opinion that this effect of the sun does not depend upon the amount of spots on his surface.

In the next place, that influence of the sun in virtue of which we have most cyclones in the years of maximum spots cannot, I think, be attributed to a change in the heating power of the sun.

We are thus tempted to associate this cyclone producing influence with something different from his light and heat. As far, therefore, as we can judge, the sun produces three distinct effects upon our globe. In the first place, a magnetic and meteorological effect, depending somehow upon his rotation: secondly, a cyclonic effect depending somehow upon the disturbed state of his surface; and lastly, the well-known light and heat effect with which we all are familiar.

If we now turn to the sun we find that there are three distinct forms of motion which animate his surface particles. In the first place, each particle is carried round by the rotation of our luminary. Secondly, each particle is influenced by the gigantic meteorological disturbances of the surface, in virtue of which it may acquire a velocity ranging as high as 130 or 140 miles a second; and lastly, each particle, on account of its high temperature, is vibrating with extreme rapidity, producing light and heat.

Now, is it philosophical to suppose that it is only the last of these three motions that influences our earth, while the other two produce absolutely no effect? On the contrary, we are, I think, compelled by considerations connected with the theory of energy, to attribute an influence, whether great or small, to the first two as well as to the last.

We are thus led to suppose that the sun must influence the earth in three ways, one depending on his rotation, another on his meteorological disturbance, and a third by means of the vibrations of his surface particles.

But we have already seen that, as a matter of fact, the sun does appear to influence the earth in three distinct ways—one magnetically and meteorologically, depending apparently on his period of rotation; a second cyclonically, depending apparently on the meteorological conditions of his surface; and a third, by means of his light and heat.

Is this merely a coincidence, or has it a meaning of its own? We cannot tell; but I may venture to think that in the pursuit of this problem we ought to be prepared at least to admit the possibility of a three-fold influence of the sun.

Even from this very meagre sketch of one of the most interesting and important of physical problems, it cannot fail to appear, that while a good deal has already been done, its progress in the future will very greatly depend on the completeness of the method and continuity of the observations by which it is pursued. We have here a field which is of importance, not merely to one, or even to two, but almost to every conceivable branch of research.

In conclusion, it cannot be doubted that a great generalisation is looming in the distance—a mighty law, we cannot yet tell what, that will reach us, we cannot yet say when. It will involve facts hitherto inexplicable, facts that are scarcely received as such because they appear opposed to our present knowledge of their causes. It is not possible perhaps to hasten the arrival of this generalisation beyond a certain point; but we ought not to forget that we *can* hasten it, and that it is our duty to do so. It depends much on ourselves, our resolution, our earnestness; on the scientific policy we adopt, as well as on the power we may have to devote ourselves to special investigations, whether such an advent shall be realised in our day and generation, or whether it shall be indefinitely postponed.

Acoustic Reversibility.—By Professor Tyndall, D.C.L., LL.D. —On the 21st and 22nd of June, 1822, a Commission appointed by the Bureau of Longitudes of France executed a celebrated series of experiments on the velocity of sound. Two stations had been chosen, the one at Villejuif, the other at Montlhéry, both lying south of Paris, and 11·6 miles distant from each other. Prony, Mathieu, and Arago were the observers at Villejuif, while Humboldt, Bouvard, and Gay-Lussac were at Montlhéry. Guns, charged sometimes with 2 lb. and sometimes with 3 lb. of powder, were fired at both stations, and the velocity was deduced from the interval between the appearance of the flash and the arrival of the sound.

On this occasion an observation was made which, as far as I know, has remained a scientific enigma to the present hour. It was noticed that while every report of the cannon fired at Montlhéry was heard with the greatest distinctness at Villejuif, by far the greater number of the reports from Villejuif failed to reach Montlhéry. Had wind existed, and had it blown from Montlhéry to Villejuif, it would have been recognised as the cause of the observed difference; but the air at the time was calm, the slight movement actually existing being from Villejuif towards Montlhéry, or against the direction in which the sound was best heard.

So marked was the difference in transmissive power between the two directions, that on the 22nd of June, while every shot fired at Montlhéry was heard "à merveille" at Villejuif, but one shot out of twelve fired at Villejuif was heard, and that feebly, at the other station.

With the caution which characterised him on other occasions, and which has been referred to admiringly by Faraday, Arago made no attempt to explain this anomaly.

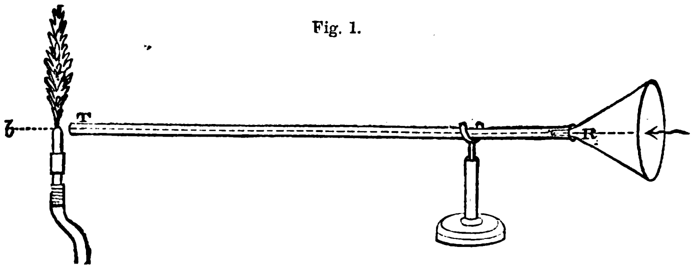
I have tried, after much perplexity of thought, to bring this subject within the range of experiment, and have now to submit a possible solution of the enigma. The first step was to ascertain whether the sensitive flame referred to in my recent paper in the "Philosophical Transactions," * could be safely employed in experiments on the mutual reversibility of a source of sound and an object on which the sound impinges. Now the sensitive flame usually employed by me measures from 18 to 24 inches in height, while the reed employed as a source of sound is less than a square quarter of an inch in area. If, therefore, the whole flame, or the pipe which fed it, were sensitive to sonorous vibrations, strict experiments on reversibility with the reed and flame might be difficult, if not impossible. Hence my desire to learn whether the seat of sensitiveness was so localised in the flame as to render the contemplated interchange of flame and reed permissible.

The flame being placed behind a cardboard screen, the shank of a funnel passed through a hole in the cardboard was directed upon the middle of the flame. The sound-waves issuing from the vibrating reed placed within the funnel produced no sensible effect upon the flame. Shifting the funnel so as to direct its shank upon the root of the flame, the action was violent.

To augment the precision of the experiment, the funnel was connected with a glass tube three feet long and half an inch in diameter, the object being to weaken by distance the effect of the waves diffracted round the edge of the funnel, and to permit those only which passed through the glass tube to act upon the flame.

Presenting the end of the tube (T) to the orifice of the burner (*b*, Fig. 1), or

Fig. 1.



the orifice to the end of the tube, the flame was violently agitated by the sounding-reed, R. On shifting the tube, or the burner, so as to concentrate the sound on a portion of the flame about half an inch above the orifice, the action was *nil*. Con

* Obtained by ignition of coal gas passing at a high pressure through a straight steatite burner of small orifice.

centrating the sound upon the burner itself about half an inch below its orifice, there was no action.

These experiments demonstrate the localisation of "the seat of sensitiveness," and they prove the flame to be an appropriate instrument for the contemplated experiments on reversibility.

The experiments proceeded thus: —The sensitive flame being placed close behind a screen of cardboard 18 inches high by 12 inches wide, a vibrating reed, standing at the same height as the root of the flame, was placed at a distance of six feet on the other side of the screen. The sound of the reed, in this position, produced a strong agitation of the flame.

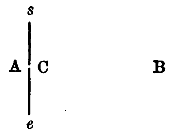
The whole upper half of the flame was here visible from the reed; hence the necessity of the foregoing experiments to prove the action of the sound on the upper portion of the flame to be *nil*, and that the waves had really to bend round the edge of the screen so as to reach the seat of sensitiveness in the neighbourhood of the orifice of the burner.

The positions of the flame and reed were reversed, the reed being now close behind the screen, and the flame at a distance of six feet from it. The sonorous vibrations were without sensible action upon the flame.

The experiment was repeated and varied in many ways. Screens of various sizes were employed; and instead of reversing the positions of the flame and reed, the screen was moved so as to bring, in some expements the flame, and in other experiments the reed, close behind it. Care was also taken that no reflected sound from the walls or ceiling of the laboratory, or from the body of the experimenter, should have anything to do with the effect. In all cases it was shown that the sound was effective when the reed was at a distance from the screen and the flame close behind it; while the action was insensible when these positions were reversed.

Thus, let *s e* be a vertical section of the screen. When the reed was

Fig. 2.



at A and the flame at B there was no action; when the reed was at B and the flame at A the action was decided. It may be added that the vibrations communicated to the screen itself, and from it to the air beyond it, were without effect; for when the reed, which at B is effectual, was shifted to C, where its action on the screen was greatly augmented, it ceased to have any action on the flame at A.

We are now, I think, prepared to consider the failure of reversibility in the larger experiments of 1822. Happily an incidental observation of great significance comes here to our aid. It was observed and recorded at the time, that while the reports of the guns at Villejuif were without echoes, a roll of echoes, lasting from 20 to 25 seconds, accompanied every shot at Montlhéry, being heard by the observers there. The report says that "tous les coups tirés à Montlhéry y étaient *accompagnés* d'un roulement semblable à celui du tonnerre." I have italicised a very significant word—a word which fairly applies to our experiments on gun-sounds at the South Foreland, where there was no sensible solution of continuity between explosion and echo, but which could hardly apply to echoes coming from the clouds. For supposing the cloud to have been only a mile distant, the sound and its echo would have been separated by an interval of nearly ten seconds. But there is no mention of any interval: and had such existed, surely the word "followed," instead of "accompanied," would have been the one employed. The echoes, moreover, appear to have been continuous, while the clouds observed seem to have been separate. But from separate clouds a continuous roll of echoes could hardly come. To this may be added the experimental fact that clouds far denser than any ever formed in the atmosphere are demonstrably incapable of sensibly reflecting sound, while cloudless air has been proved capable of powerfully reflecting it.

And considering the hundreds of shots fired at the South Foreland, with the attention specially directed to the aërial echoes, when no single case occurred in which echoes of measurable duration did not accompany the report of the gun, I think Arago's statement that at Villejuif no echoes were heard when the sky was clear, must simply mean that they vanished with great rapidity. Unless the attention were specially directed to the point, a slight prolongation of the cannon-sound might well escape observation; and it would be all the more likely to do so if the echoes were so loud and prompt as to form apparently part and parcel of the direct sound.

Turning now to the observations at Montlhéry, we are struck by the extraordinary duration of the echoes heard at that station. At the South Foreland the charge habitually fired was equal to the largest of those employed by the French philosophers; but on no occasion did the gun-sounds produce echoes approaching to 20 or 25 seconds' duration. The time rarely reached half this amount.

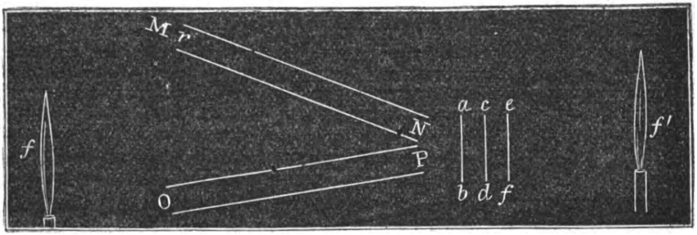
I have stated in another place that the duration of the air-echoes indicates "the atmospheric depths" from which they come. An optical analogy may help us here. Let light fall upon chalk, the light is wholly scattered by the superficial particles; let the chalk be powdered and mixed with water, light reaches the observer from a far greater depth of the turbid liquid. The solid chalk typifies the action of exceedingly dense acoustic clouds; the chalk and water that of clouds of moderate density. In the one case we have echoes of short, in the other echoes of long duration. These considerations prepare us for the inference that Montlhéry, on the occasion referred to, must have been surrounded by a highly diacoustic atmosphere; while the shortness of the echoes at Villejuif shows the atmosphere surrounding that station to have been acoustically opaque.

Have we any clue to the cause of the opacity? I think we have. Villejuif is close to Paris, and over it, with the observed light wind, was slowly wafted the air from the city. Thousands of chimneys to windward of Villejuif were discharging their heated currents; so that an atmosphere non-homogeneous in a high degree must have surrounded that station. At no great height in the atmosphere the equilibrium of temperature would be established. This non-homogeneous air, surrounding Villejuif, is experimentally typified by our screen with the source of sound close behind it, the upper edge of the screen representing the place where equilibrium of temperature was established in the atmosphere above the station. In virtue of its proximity to the screen, the echoes from our sounding-reed would, in the case here supposed, so blend with the direct sound as to be practically indistinguishable from it, as the echoes at Villejuif followed the direct sound so hotly, and vanished so rapidly, that they escaped observation. And as our sensitive flame, at a distance, failed to be affected by the sounding body placed close behind the cardboard screen, so, I take it, did the observers at Montlhéry fail to hear the sounds of the Villejuif gun.

Something further may be done towards the experimental elucidation of this subject. Sounds pass through textile fabrics with great facility, a layer of cambric or calico, or even of thick flannel or baize, being found competent to intercept but a small fraction of the sound from a vibrating reed. Such a layer of calico may be taken to represent a layer of air differentiated from its neighbours by temperature or moisture; while a succession of such sheets of calico may be taken to represent successive layers of non-homogeneous air.

Two tin tubes (M N and O P, fig. 3) with open ends were placed so as to form an acute angle with

Fig. 3.



each other. At the end of one was the vibrating reed *r*; opposite the end of the other, and in the prolongation of P O, the sensitive flame *f*, a second sensitive flame (*f′*) being placed in the continuation of the axis of M N. On sounding the reed, the direct sound through M N agitated the flame *f′*. Introducing the square of calico *a b* at the proper angle, a slight decrease of the action on *f′* was noticed, and the feeble echo from *a b* produced a barely perceptible agitation of the flame *f*. Adding another square *c d*, the sound transmitted by *a b* impinged on *c d*; it was partially echoed, returned through *a b*, passed along P O, and still further agitated the flame *f*. Adding a third square, *e f*, the reflected sound was still further augmented, every accession to the echo being accompanied by a corresponding withdrawal of the vibrations from *f′* and a consequent stilling of the flame.

With thinner calico or cambric, it would require a greater number of layers to intercept the entire sound; hence with such cambric we should have echoes returned from a greater distance, and therefore of greater duration. Eight layers of the calico employed in these experiments, stretched on a wire frame and placed close together as a kind of pad, may be taken to represent a dense acoustic cloud. Such a pad, placed at the proper angle beyond N, cuts off the sound, which in its absence reaches *f′*, to such an extent that the flame *f′*, when not too sensitive, is thereby stilled, while the flame *f* is far more powerfully agitated than by the reflection from a single layer. With the source of sound close at hand, the echoes from such a pad would be of insensible duration. Thus close at hand do I suppose the acoustic clouds surrounding Villejuif to have been, a similar shortness of echo being the consequence.*

* Since this was written I have sent the sound through fifteen layers of calico, and echoed it back through the same layers, in

A further step is here taken in the illustration of the analogy between light and sound. Our pad acts chiefly by internal reflection. The sound from the reed is a composite one, made up of partial sounds differing in pitch. If these sounds be ejected from the pad in their pristine proportions, the pad is acoustically *white;* if they return with their proportions altered, the pad is acoustically *coloured.*

In these experiments my assistant, Mr. Cottrell, has rendered me material assistance.

Application of Wind to String Instruments. By J. B. Hamilton.—The Æolian harp is an instrument played upon by the wind uncontrolled by human agency.

The well-known sounds thus produced, although useless for musical purposes, have long shown the capabilities of wind and strings, and have excited in many minds the desire to reduce these Æolian sounds to human control. In order to gain control the draught would be increased by a bellows or other artificial means, and concentrated upon the string by approximating the surfaces between which it lies until nothing was left but a narrow slit, corresponding to the string's dimensions. Power and control would certainly be gained, but the intermittent closing of the slit by the string would produce only a reedy effect, and the pleasing features of the Æolian tone would be lost. If, however, this slit was reduced to a small portion of the string's length, the remainder of the string would be free from this defect, and subject to control by the finger or other means. The portion on which the wind impinged would, moreover, be flattened so as to offer more resistance to the draught.

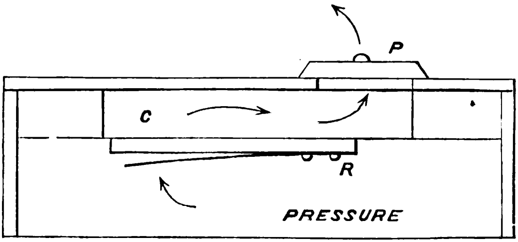
strength sufficient to agitate the flame. Thirty layers were here crossed by the sound. The sound was subsequently found able to penetrate two hundred layers of cotton net: a single layer of wetted calico being competent to stop it.

These have been the steps generally adopted by all those who have attempted to gain any musical results from wind and string, and the means employed by them may be described as a string excited by a current of air concentrated on a flattened portion of its length, generally at or near the end.

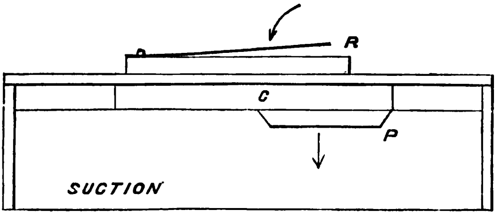
Many years ago, J. Farmer, organist at Harrow School, substituted the tongue of a harmonium reed for this flattened portion of the string, and showed that the remainder of this compound string could be played upon like the string of a violin.

The reed used in these experiments is a "free reed," such as is used in harmoniums and kindred instruments. It consists of a tongue of metal vibrating from a root, and having a definite pitch. It lies over a frame which leaves a hole corresponding to the surface of the tongue, the fixed end of the tongue being riveted to this frame. If this tongue be plucked it affords a note of a certain pitch. This note is sustained in reed instruments by a draught of air; but in order that the draught may allow the vibration of the reed tongue it is necessary to create true suction upon it by allowing some tube or channel to follow the reed-tongue. The mere frame of the reed acts as a rudimentary channel; and it will be seen on blowing a reed with the lips, that the draught must always tend *towards* the frame, unless indeed the reed be preceded by some tube or cavity which allows of its vibration. But, as a rule, it is found more convenient to allow true suction to be formed by a channel *following* the reed. Accordingly, in harmoniums where pressure is employed, the air escapes from a common chest past the reed, and then through a channel. But when suction is employed, as in American organs, the air *enters* past the reed and its rudimentary channel into the general cavity. In both cases the pallet or valve succeeds the reed (fig. 4).

Fig. 4.



Harmonium where pressure is used.
R, reed *C*, channel. P, pallet.

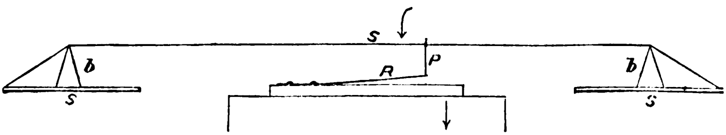


American Organ.

The mode of connecting together the reed and string is by a rigid pin passing from the free end of the reed-tongue to the string. The reed and string may thus be on different levels, and enjoy the conditions which suit them best respectively.

The following diagrams show the arrangements necessitated by this mode of connection.

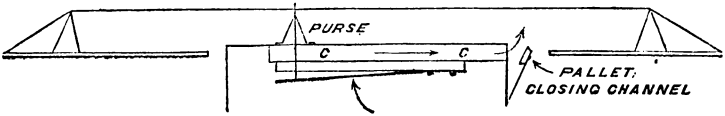
Fig. 5.



These drawings are only diagrammatic.
s, string. *b*, bridge. *S*, soundboard, *P*, connecting-pin. *R*, reed.
The arrows indicate the direction of the draught.

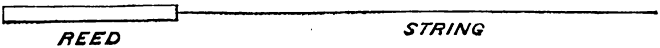
In the case of suction instruments (fig. 5) no new arrangements are necessitated as regards the reed in order to allow its connection with the string. But in the case of pressure instruments (fig. 6), a channel *intervenes* between reed and string, accordingly the pin passes *through* this channel, which is preserved air-tight by a "purse," which allows the required movement of the pin which it surrounds.

Fig. 6.



The original mode of connection may be thus represented, and illustrates most conveniently the way in which the reed enters into the constitution of the string so as to alter the intervals obtainable from it.

Fig. 7.



Unlike a bow, whose weight does not affect the intervals of the string which it moves, the reed forms part of the string which it excites, and if a string were set at the same length and tension in conjunction with a succession of reeds, the proportional lengths corresponding to given intervals would alter with every reed applied.

	The Third.	The Fourth.	The Fifth.	The Octave.
	in.	in.	in.	in.
A string giving at 64 inches the 16 feet C when connected with a reed of same pitch gave when shortened to . . .	51	48	40	23
Similarly connected reed and string produced 16 feet E . .	50½	47½	41	26
Ditto, ditto, 8 feet G♯ .	51	47	40½	22

Taking strings of different calibre and with uniform tension upon them, each string being sixty-four inches in length, the relations of lengths to musical intervals as in a free string plucked, are not maintained. And when under slackened tension the string divides into two segments, the free segment is always of greater length than the segment connected with the reed. In the instances above, the measurements respectively were:

The free segment.	as against reed segment.
34 inches	30 inches
35 „	29 „
34½ „	29½ „

Every combination of reed and string having variable ratios according as the power of one or the other preponderates.

Musicians will recognise these divisions as different from those of free strings. There is a point, however, more interesting than intervals, and that is, the qualities of tone resulting from this combination of reed and string. It is hardly necessary to speak of the numerous varieties of tone obtainable from either of these sources separately. The stops of harmoniums and reed organs show how many varieties of tone may be obtained from reeds with the most rudimentary channels and appliances; and the varied qualities of strings are equally remarkable according to their calibre, soundboard, and mode of excitation. But it might be supposed that the tones afforded by their combination must be either that of a string or reed, according as either element predominated. A single experiment will remove any such impression. A very large reed combined with a very small and short string, gives a pure clean tone indistinguishable from that of an organ pipe (an open metal diapason), whilst a small reed with a very long string, in spite of the predominance of the string, gives a comparatively coarse and reedy effect. The real varieties of tone and their causes are due mainly to the following simple facts, which may be expressed almost in a tabular form:

In free reeds, as a general rule, large excursions of the tongue tend to produce reedy, coarse, and striking tones; small excursions, more pure and soft and massive.

In strings, flexibility promotes large excursions, — rigidity, small excursions; the flexibility or rigidity of the string being determined by its relative length, tension, or calibre. If a given reed were connected with a flexible string, and then with a rigid one, the result of the first combination would be a tone of the nature of a reed-pipe, and the second of a flute-pipe in an organ.

This is of course a very general description, for the gradations of flexibility of strings and of tones in these two great classes of organ pipes are in both cases very numerous.

But the main results may be illustrated by the following experiment: Take two reeds affording by themselves a note of the same pitch. These are then to be attached to two different kinds of strings. The first to a thin wire a foot long, at a moderate tension, so that it comes under the head of flexible strings. The result will be a note somewhat of the trumpet character, loud, brilliant, and reedy. The other and similar reed is to be attached to a wire at the same tension, which, however, is three feet long, and six times the calibre of the other. Though this is also a flexible string, the result will be different, for the weight of the string seems to regulate the vibrations of the reed very much according to its own natural movement; consequently the excursions of the reed are in no way exaggerated, and the result will be a decided string tone, free from all reedy character. Again, take two strings affording a similar pitch, both a foot long, and of the calibre of a pianoforte string about the middle of the scale. Subject both to a somewhat high tension. To the first attach a large reed of a very low pitch, many octaves below the note of the string. The result will be a combined tone of a soft massive character, such as characterises the flute-pipes of an organ. In this case the naturally large and powerful vibrations of the reed are simply confined and transmitted to the soundboard by the small rigid string. The tone of the reed is thus completely purified, and the displacement of air which its naturally large excursions would have caused, is far more than replaced by the action of the soundboard.

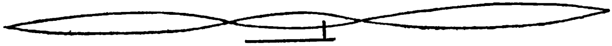
To the other similar string attach a reed far nearer to its own pitch, whose tone it purifies and intensifies in the same way. But as there is a more perfect sympathy existing between their natural note of vibration, the result is a note equally pure, but more rich and cloying, differing from the other as the note of a French horn differs from that of a stopped flute-pipe. On these simple causes four main sources of variety of tone depend.

All these experiments are made under the same conditions of reed, channel, and soundboard. But when it is remembered that any one of them can be modified as it stands, by the simple treatment which affects reeds, and the arrangement of soundboard which affects strings, it will be seen that any one of them can be multiplied by the causes that affect either reeds or strings so as to afford distinctive qualities, and that these qualities may be further combined and merged into each, so as to afford all the gradations between trumpet and horn, and flute, and voice, and string.

In all these experiments, and in the wind violin, the string combined with the reed vibrates in a single segment. But if the string were prolonged on either side, it would resolve itself into three segments. The sweetness and intensity of the tone would be much increased.

The two terminal segments are in this case equal, whilst that to which the reed is attached is shorter. (Fg. 8.)

Fig. 8.



Before explaining the musical results obtainable from reed and string instruments, it may be as well to deal with some difficulties which may have been anticipated (fig. 8).

When used as a wind violin, no difficulties present themselves except that of arranging the strings and intervals so as best to suit the performer. But when used in a rigid instrument, two difficulties at once suggest themselves: 1st, the notes might not respond to the touch; 2nd, they might go out of tune.

As regards the first difficulty, it may seem remarkable that the most rigid strings ensure as a rule the most perfect promptness, and the better the note the quicker its speech, any delay being due to a want of that sympathy between string and reed, which necessarily requires long study to establish.

But it might naturally appear that an instrument partially composed of strings might share their liability to alter in pitch. As a matter of fact, the strings used are so short, the framework so compact, and the tension on the whole series so low, that structural displacement need no longer be considered. Next, strings may be affected by temperature; but there are metals and alloys which are practically unaffected. And although these could not be hitherto used in pianofortes and instruments which depend on the free string for their sound, yet, in this case, the substance of the metal wire which conveys the reed's vibrations is immaterial.

Another source of derangement in string instruments hitherto, has been the gradual exhaustion of the string's retractile power by its own constant vibration, and especially by the shock conveyed in causing it so to vibrate.

Now when a reed is the motive power, there is no such shock; and as has been already shown, the amplitude of excursion is reduced to a minimum. Moreover, the reed is capable of holding its own against the string, as much as the string of influencing the reed. Supposing a reed and string in combination to afford notes of varied quality, prompt in speech, easy to control, and simple in arrangement, what form will musical instruments so constructed assume, and what position will they occupy in music?

When it is desired to gain the same control over a string worked by a reed as the violinist gains over a string worked by a bow, the strings are set before the performer, at a convenient level, and subject to the control of both hands, as in a zither. Wind is supplied to the reeds by a small feeder, as in a harmonium. It is admitted to each reed by a valve, which is opened by the same pressure of the hand which controls the string thus sounded. For a strip of wood which opens the valve by a "roller action" may run parallel to each string in the position naturally occupied by the thumb of the hand which controls it. The "feet" thus supply the place of the "bow," both hands being left free to control the strings. The quality of the sound can be any of the numerous ones which string and reed can supply; and Mr. Farmer has shown that the "glide" and expression and control of the string, which can only be obtained from the violin by long practice, are here within the reach of the most unpractised hand. But when these sounds are controlled by a "key" we should consider rather the application of strings to wind instruments, and the application of wind to strings.

The introduction of the "free reed" into Europe has brought within everyone's reach wind instruments deficient only in these very respects, in which string and reed instruments excel.

Any one who examines a harmonium or reed organ will see that all that is unsatisfactory in them is due to the want of a real reinforcement to each note. All that the most costly arrangement of tubes or resonators can supply is effected the moment that a reed is connected with a string, which not only entirely purifies its sound by confining its vibrations, but transmits those vibrations to a soundboard, and thus reproduces the work of the reed in a form which is pure, massive, and voluminous, and eminently suited to support the human voice, as is the case with all sounds due to the action of a string and soundboard. As the space occupied by each string need not exceed the scale of each note on keyboard or pedals, it is hardly necessary to point out the economy of this system. A "stop," or series of such notes of a certain quality, naturally assumes a somewhat harp-like form. The wind is admitted to the reed of each string by a tracker or rod connected with its key.—*Royal Institution Proceedings.*

Baillie Hamilton's String Organ. — A short paper on the mathematical theory of this instrument is given by Mr. R. H. M. Bosanquet, in the February number of the *Philosophical Magazine.* Following the method of investigation employed by the late Professor Donkin (Donkin's *Acoustics*, p. 139), Mr. Bosanquet is led to a general equation, the solution of which determines what segment-length of the string employed would, when vibrating alone, yield the same note as is actually sounded under the conditions of the instrument, *i.e.*, when the string is attached at some point of its length to the tongue of a reed which is set in vibration by a stream of air. The solution of this equation in the general case, presents great difficulty, but is effected in certain particular cases: *e.g.* (1) When the point of attachment of the reed is a node; (2) When the note sounded is that of the reed alone; (3) When the point of attachment is the middle of the string. Experimental observations appear to correspond roughly with theory, certain assumptions being made respecting the relations of the elements in the problem.—*Academy.*

Hermann Smith (in *Nature*) says —Mathematicians decide that the problem of the instrument is that of a loaded string. This appears to me a one-sided view, taken under limited experiments. Practically, some details of their conclusions are not corroborated; there are several elements entering into the composition not heeded, and a wider experience would show that the problem is equally that of a loaded reed. Here is an instance. I have in action a reed with pin attached; it sounds C sharp: and a string which, independently sounding, gives the F below. These, when conjoined, produce the G between. The note of the string is thus raised a whole tone; consequently the weight of the oscillating string is a load on the reed.

Lord Rayleigh, also in (*Nature*), does not think Bosanquet has touched upon the real points of interest in the string organ. He says —The origin of the instrument has led to considerable misconception as to its real acoustical character. The object of Hamilton and his predecessors was to combine the musical qualities of a string with the sustained sound of the organ and harmonium. Musically, the result appears to be a success, but is, I think, acoustically considered, something very different from what was originally intended. I believe that the instrument ought to be regarded rather as a modified reed instrument, than as a modified string instrument.

The string and reed together form a system capable of vibrating in a number theoretically infinite, of independent fundamental modes, whose periods are calculated by Bosanquet. The corresponding series of tones could only by accident belong to a harmonic scale, and certainly cannot coexist in the normal working of Hamilton's instrument, one of whose characteristics is great sweetness and smoothness of sound. I conceive that the vibration of the system is simple harmonic, and that accordingly the sound emitted directly from the reed, or string, or from the resonance-board in connection with the string, is simply harmonic. On the other hand, it is certain that the note actually heard is compound, and capable of being resolved into several components with the aid of resonators.

The explanation of this apparent contradiction is very simple. Exactly as in the case of the ordinary free reed, whose motion is rigorously simple harmonic, the intermittent stream of air, which does not take its motion from the reed, gives rise to a highly compound musical note, whose gravest element is the same as that of the pure tone given by the string and resonance-board. One effect of the string, therefore, is to intensify the gravest tone of the compound note given by the intermittent stream of air.

The fact that the pitch of the system is mainly dependent upon the string, seems to have distracted attention from the important part played by the stream of air. I may mention, however, that I have noticed on one or two occasions an immediate falling off in the sound when the wind was cut off, although the string and reed remained in vibration for a second or two longer. A resonator tuned to one of the principal overtones was without effect when held to the string, but produced a very marked alteration in the character of the sound when held to the reed.

It will be seen that according to my explanation the principal acoustical characteristic of the string—

that its tones form a harmonic scale—does not come into play, the office of the string being mainly to convey the vibration of the reed itself (as distinguished from the wind) to the resonance-board, and thence through the air to the ear of the observer. A second advantage due to the string appears to be a limitation of the excursion of the reed, whereby the peculiar roughness of an ordinary reed is in great measure avoided.

Wind Instruments.—By W. H. Stone, M.D.—There are some discrepancies to be noted in the behaviour of air issuing from the side orifices of wind instruments in vibration which deserve attention, and may be accounted for by the laws of efflux. The stream from the side hole of a clarionet, when sounding, is sufficient to extinguish a candle, though the musical vibration is obviously in the main tube. The usual mode of tuning these instruments is by introducing a resinous cement into the hole, so as to diminish its calibre. But after a certain point, the rounded surface thus obtained ceases to produce an effect, though a note will still be produced by introducing a cylindrical tube of the same diameter, and this additional tube exercises greater influence than the rounded edge. Dr. Stone was thus led to inquire whether the theorem of D. Bernoulli, or the particular case of it named after Torricelli, could be brought to bear on the question. The Vena Contracta, which, in fluid, reduces the efflux to ·62 of the calculated amount, is also to be noticed in gases, the flow of which from orifices is affected by three conditions:—1. The thinness of the wall in which the orifice is made; 2. The shape of the nozzle; 3. Friction in a long pipe. The vibration in a musical tube must also exercise sensible influence. There are, however, two junctions of a side orifice in an instrument: the first to cut off a portion of the tube, and so raise the pitch; the second, and most usual, to establish a point of non-resistance in the wall of the tube, and thus to act by influencing the longitudinal vibrations. In the organ, peculiar qualities of tone are obtained by these side holes, as in the "viol di gamba" and "keraulophon" stops. In flutes, oboes, clarionets, and others, great part of the tone comes from the bell, even when side holes are open. In instruments where the holes are long, as in the bassoon, the hole itself becomes a separate vibrating tube. This may be shown by introducing tubes of different and increasing lengths into an orifice in the side of an organ reed-pipe. The friction at last becomes so great, and the secondary wave so strong, that the pipe returns to its old pitch. When a reed is applied to a cylindrical tube, and a sharp-edged orifice opened at its middle, the production of any note whatever is prevented, but on a cylindrical nozzle being introduced, the octave is sounded freely; nor is it altered by increasing the length of the nozzle to several inches, though there is then very little efflux through it. The general results deduced by the author are that the function of holes is double; that the pitch of the note emitted varies with their size, shape, and even more with their length; and that the actual severing of continuity in the principal tube is a comparatively minor point. Three tubes, varying in length from two to six inches, were inserted in a cylindrical tube, like that of a clarionet, at right angles to its length, the longest being placed at the centre of the instrument, and the shortest at one-eighth from the mouth-piece. The same note was produced when each tube was used singly and when the three were employed. The author hopes that a series of experiments may render it possible to develop curves in which the co-ordinates will be the lengths of the additional tubes and their positions in the instrument, and also that a new instrument may be produced, in which the side orifices shall act purely as nodal points by the assistance of friction and contracted vein.—*Physical Society.*

Just and Tempered Intonation.—By A. G. Ellis (a paper read before the Musical Association).—By "intonation" we understand the selection of a set of musical sounds on fixed principles. "Just intonation" is where we select such sounds only as form perfect consonances. "Tempered intonation" is where the selected sounds are modified in some way, so that they are rendered more manageable for practical applications.

No two simple tones produce beats in the ear unless they lie within a certain interval, which varies from nearly a major third in the lower to about a tone in the higher part of the scale.

When two tones sound together a resultant tone is heard, whose vibration number is the difference of those of the primaries. The observation that, if the two tones were within beating distance the beats are heard also as a separate effect, disposes of the old theory of Young.

Musical notes are heard in the ear as if they consisted of all the tones whose vibration numbers are as successive integers. That the note of a tuning fork is composite may be shown by presenting it successively to resonators tuned to the fundamental and octave, both of which will be sounded by it. Any simple tones which belong to the harmonic series may be added to a note, and will produce only a change in the quality of tone without disturbance or beats. When composite notes are added instead, there is a difference which is inappreciable so long as the tuning is perfect. If the notes thus introduced do not belong to the harmonic series, there will be pairs of tones here and there within beating distance, and beats will arise. By using notes deprived of their fifth partials, a major third can be formed quite out of tune, which yet gives no beats.

The principal temperaments are the equal temperament, the mean tone, the Greek, and the Arabic; this last is derived from the Greek by substituting D♭ for C♯ in the chord of A.

"Wolf" in the Violoncello.—By W. T. Kingsley.—The "wolf" occurs somewhere about the low E or E flat, and may be attributed to the finger-board having the same pitch, so that the finger-board becomes as it were a portion of the string stopped down on it and vibrates with it: if this is the true cause, the "wolf" cannot be got rid of, but may be placed at such a pitch between E and E flat as to occur on a note rarely used; also by thickening the neck of the finger-board, the extent of the discursion in the vibration may be made less.—A different explanation of the phenomenon was given by M. Savart, which was to this effect. The old Italian makers constructed the violoncello of such dimensions that the mass of air included within the instrument resonates to a note making 85·33 vibrations in a second, a number which then represented the lowest F on the C string, but which now, owing to the rise of pitch since the beginning of the eighteenth century, nearly represents the note E immediately below it. Savart's theory was that notes half a tone above or below this E will cause beats between the vibrations of the string and those of the mass of included air. It seemed quite possible that the mass of air contained in the instrument should be capable of controlling the vibrations of the whole instrument, but not that the vibrations of the finger-board alone could do this. For the sound, technically called the "wolf," is an actual check to the whole vibration of the violoncello, producing not merely beats, but a baying sound, destitute of the freedom of vibration which characterises other notes. But a great objection to the above explanation is this experiment. On an Italian instrument, the upper D on the fourth or lowest string is the imperfect note. But when the same note is elicited from the third string, the note is perfectly resonant. This peculiar effect seems then to depend upon the point of the finger-board which is pressed. It is also well known that the "wolf" can be modified by an alteration of the position of the sound-post. As an explanation, we may conceive that the whole framework of the violoncello vibrates like a stretched string, producing its fundamental, with a series of overtones, and that a nodal line passes through the point of the finger-board, pressure upon which produces the "wolf," and that thus, all vibrations being destroyed except those which have a node at the point of pressure, this peculiar tone is elicited.—*Cambridge Philosophical Society.*

Alteration of the Note of Railway Whistles in Trains meeting each other.—By W. Pole (*Nature*).—If two railway trains meet and pass each other at tolerable speed, and the driver of one of them is sounding his whistle, any person in the other train accustomed to music will notice that the moment the whistle passes him its note will be lowered in pitch in a marked degree.

It was at first supposed that at, the time of passing, the driver lowered his whistle intentionally, as a salute to the other train (like "dipping the ensign" at sea), but this was found not to be the fact, the driver himself being unconscious of any change.

Every musical note propagates aërial waves succeeding each other with a known rapidity, corresponding to the pitch of the note; the higher the pitch the greater the rapidity of succession of the waves, and *vice versâ*. Now, when a person advances to meet these waves, more of them will pass him in a given time than if he stood still, thus the apparently increased rapidity of the waves will give him the impression of a sharper note.

On the other hand, when the trains have passed each other, the listener will be moving in the same direction as the sound-waves, and consequently a less number will pass him in a given time, causing the note to appear flatter.

The sum of these effects will be the sudden drop of the pitch of the note at the moment the listener passes the whistle.

We may reduce the effect to numerical calculation.

Taking 1,120 feet per second as the velocity of sound for ordinary conditions, the following table shows the value of the drop for different speeds :—

Conjoint speed of the two meeting trains.		Corresponding drop of the note of the whistle.
Miles per hour	Feet per second.	
24	34	A semitone $\left(\frac{16}{15}\right)$
45	66	A whole tone. $\left(\frac{9}{8}\right)$
70	102	A minor third $\left(\frac{6}{5}\right)$
85	125	A major third. $\left(\frac{5}{4}\right)$
108	160	A fourth $\left(\frac{4}{3}\right)$
152	224	A fifth $\left(\frac{3}{2}\right)$

I have made observations whenever I have had the opportunity, and find the results corroborate the deductions of theory. The most common interval observed in ordinary travelling is about a third, major or minor, corresponding to a speed of between thirty-five and forty miles per hour for each train.

Refraction of Sound.—By Professor Osborne Reynolds (British Association).—The author remarked that in previous papers he had pointed out that the upward diminution of temperature in the atmosphere must refract and give an upward direction to the rays of sound which would otherwise proceed horizontally, and suggested that this might be the cause of the observed difference of the distinctness with which similar sounds were heard on different occasions, particularly of the very marked advantage that the night has over the day in this respect. On this subject he had made a series of experiments. He mentioned a case in which at sea, when leaving a yacht in a small boat, for the purpose of making experiments on sound, those in the yacht and the boat were able to call to one another, and be heard at a distance of three-and-a-half miles, and that the hiss and report of a rocket sent up from the yacht, was heard at a distance of five miles. Also on the same occasion the barking of a dog on shore, which was eight miles distant, was heard, and the paddles of a steamer which must have been fifteen miles off were distinctly audible. The distinctness with which sounds of such comparatively low intensity could be heard was perhaps beyond anything definitely on record. As the result of a series of experiments made by means of an electric bell, it was found that when the sky was cloudy and there was no dew, the sound could invariably be heard much further with than against the wind; but when the sky was clear, and there was a heavy dew, the sound could be heard as far against a light wind as with it. On one occasion in which the wind was very light and the thermometer showed 39° Fahr. at one foot above the grass, and 47° Fahr. at eight feet, the sound was heard 440 yards against the wind and only 270 yards with it.

Tone in Music.—Helmholtz.—A little attention will lead anyone possessing an ordinarily susceptible ear to the perception that a musical sound has three properties. These are: (1) its pitch, or its degree of acuteness or gravity in the musical scale; (2) its strength, or degree of loudness or softness; (3) the quality or character of tone.

The *pitch* of a musical sound depends on the rapidity of the vibrations which cause it.

The strength, or degree of loudness or softness of a musical sound, depends on the amplitude or extent of the vibrations, a larger amplitude giving a louder sound, and *vice versâ*.

The third property of musical sounds is their quality or peculiar character of tone. A violin, for example, gives a tone of a different quality from that of a clarionet, an oboe, a flute, or a trumpet, which all again differ from each other. These varieties of quality of tone are almost infinite.

The tone of a particular violin, or of a particular violin player, can be identified by a connoisseur among a hundred, and we all know that the varieties of quality of the human voice, even in the same register, are as easily recognised by the ear as the varieties of physiognomy are by the eye.

The nature of this property of sounds has hitherto been very obscure.

To put the problem clearly, suppose we have two musical sounds of the same pitch and the same degree of loudness, but of different qualities. To what physical cause is the difference in quality due? We know that the rapidity and the amplitude of the vibrations is the same in both cases; what other element of variation can enter into the phenomenon? Helmholtz is the first who has given a complete answer to the question.

It very seldom happens that a musical sound consists of one simple note; it is generally a compound of many notes combined together. To illustrate this by a simple example, suppose a stretched string, such as a violin string or pianoforte wire, sounds any particular note. This note, which is called the fundamental one, will be due to the vibrations of the string as a whole, and if we could prevent any other kind of vibration this sound would be a simple one. But the string has a natural tendency to take upon itself other partial vibrations, and thereby to complicate the effect produced. It will divide itself spontaneously into two, three, four, five, six, or more aliquot parts, and each of these parts will set up an independent vibration of its own, giving a new note corresponding to its length. All these will sound together, and thus by the vibration of the string we get not only the fundamental note (which is usually the loudest and most prominent), but its octave, its twelfth, its double octave, its seventeenth, nineteenth, and so on, all heard in addition, and giving a sound which is a compound of them all. All the additional notes above the fundamental have been usually called in England harmonics; Helmholtz calls them overtones (obertöne).

A compound sound, so far as its effect on the ear is concerned, is due to a particular form of air-wave, produced in the instance given by the superposition of different sets of vibrations of the sounding body; and such a form of wave may be equally well produced by other means, such as a reed; or it may originate in the air itself, as in a flute. In every case where a given fundamental note is found, there is the same tendency for it to be accompanied by subsidiary fractional vibrations, producing corresponding overtones.

Helmholtz shows that the senses are apt, in the presence of prominent facts, to ignore others which may be less prominent but equally real; and he reasons that as the fundamental note is almost always stronger than any of the others, the ear is inclined to refer the whole combination to that one note, and refuses to take the trouble of separating and identifying the various elements of the sound.

By a little practice the ear may be educated to distinguish and separate the various notes which make up a compound sound, and when the habit of doing this is acquired, the illusion disappears. But that no proof may be wanting of this important principle, Helmholtz has contrived certain instruments called resonators, each of which will test the presence of a particular overtone, and by submitting these in succession to the vibrating influence of the compound tone, they at once show whether the sounds they are tuned to are present or absent therein.

The explanation he uses as the basis for most of his researches, namely, the compound nature of musical sounds.

Among the many novel uses Helmholtz makes of this fact, the most important, physically, is the way in which he deduces from it the explanation of the third property of musical sounds, namely, their quality or character of tone.

Helmholtz has shown, by the most conclusive investigations, that the quality of a musical tone depends chiefly on the number and on the comparative strength of the various harmonical notes of which the tone is compounded

The overtones accompanying a fundamental note may be present in greater or less number, and they may vary considerably in comparative loudness or softness, and it is on the combination of these sources of variation that the quality of the tone will depend—or, to put the explanation in another and more scientific shape; as the pitch of a sound depends on the length or the frequency of recurrence of the air-wave, and the loudness on the degree of disturbance of the particles of the air therein; the quality of tone depends on what is called its internal form, or on the varieties of arrangement of expansion and compression of the air contained within one complete periodic cycle of oscillation.

Some modification in effect is often produced by a sound being accompanied by unmusical noises, such as the escaping of imperfectly used wind in a pipe, the unskilful scratching of the bow on a violin, the beating of reeds, and so on; but these are rather impurities than varieties of tone, and may be excluded from consideration.

There are very few natural sounds which are entirely simple, consisting of the fundamental note only. The nearest approach to them may be found in the larger stopped wood pipes of an organ, an old-fashioned (not a modern) flute, and a tuning-fork after the sharp ring has subsided. The vocal sound of the Italian U (our oo) is also nearly a simple one. These examples will give the idea that simple tones are soft, dull, and entirely devoid of what is called brilliancy.

The addition of overtones gives this brilliancy and at the same time adds life, richness, and variety. It is to them that we owe entirely the agreeableness and pleasurable effect of musical tones. In proportion as the higher overtones predominate, so will the sound be bright and sparkling, or if in great predominance it will become metallic, thin, and wiry. If, on the other hand, the upper tones are weakened and the lower strengthened, the tone becomes more full, rich, and mellow. All the qualities of tone most esteemed and most useful in music are rich in overtones.—*Nature.*

Specific Heat of Carbon.—(*Academy*).—The law enunciated by Dulong and Petit, that the product of the specific heat into the atomic weight of a solid elementary body is a constant quantity, was shown by Regnault to be of very general applicability, the numerical value of the constant (the atomic heat) being about 6·3. For three solid elements, however—silicon, boron, and carbon—considerably smaller atomic heats were obtained, viz., 4·8 for silicon, 2·7 for crystallised boron, and 1·8 crystallised carbon. Examining in succession the various allotropic modifications of carbon, Regnault found the specific heats to vary between 0·1429 (for diamond) and 0·2608 (for animal charcoal). Contemporaneously with Regnault, De la Rive and Marcet found much smaller numbers for the specific heat of carbon. Again, Kopp and Wüllner obtained numbers differing from each other as well as from those of Regnault and De la Rive. The differences in the individual results are so great as to preclude the belief that they are due to errors in the methods of experiment or to impurities in the substances themselves. Dr. H. F. Weber (*Phil. Mag.*), attributes these differences to the widely differing ranges of temperature between which the specific heats were estimated. His elaborate researches show that the specific heats of these bodies increase very rapidly with the temperature. In the case of diamond, for instance, he found the specific heat at -50° C. to be 0·0635; at 247° it was 0·3026, and at 986°, 0·4622. From low temperatures the specific heat rises steadily, till a certain point is reached, after which, with further rise of temperature, it remains constant. This point for carbon and boron is about 600° C., for silicum about 200° C. The specific heat of carbon is increased seven times, that of boron, 2½ times, in raising the temperature from 50° to 600° C.

Thermal Conductivity of Rocks.—Professor Herschel and Mr. Lebtour find that quartz offers the least resistance to the passage of heat. Slate in the direction of the cleavage they found to have a greater resistance than across it. Sandstone, brick, and plaster-of-Paris conduct heat better when wet than when dry.

Thermal Conductivity of Mercury. — Herman Herwig. — (*Phil. Mag.*)—According to Wiedemann and Franz, the metals have equal conducting power for heat and electricity, and since we know from numerous experiments that for electric conductivity a very marked variability with the temperature takes place, it follows, if the statement of Wiedemann and Franz be true, that there will be found for the thermal conductivity of most metals a variability with temperature in about the same degree. On the other hand, Lorenz has asserted the independence of temperature of the heat-conductivity of pure metals which remain homogeneous, and accounted for the observed variations by assuming the development of thermo-electric currents in consequence of unequal heating of the metals. To decide this question it was necessary to employ a pure metal which remains homogeneous, and mercury was accordingly selected as being the only known metal satisfying the condition. Herwig's experiments show that between 40° and 160° C. the heat-conducting power of pure mercury is perfectly constant, and so far confirm the results of Lorenz.—*Academy.*

Thermal Conductivity of Liquids.—Dr. Winkelmann in *Poggendorff's Annalen*, gives an account of his investigations on the thermal conductivity of water, solutions of sodium chloride, alcohol, carbon bisulphide, and glycerine. His mode of experimenting was as follows:—He employed two brass cylinders, the smaller, which served as an air thermometer, being so fixed within the larger that the perpendicular distance between the surfaces of the two was the same at all points. The space between the cylinders he filled with the liquid under examination. Into a hole in the top of the inner cylinder was cemented a glass tube, which, passing through the upper surface of the outer cylinder, was bent twice at right angles, and dipped into a cup of mercury. The apparatus, after having been allowed to assume a uniform temperature, was placed in a mixture of ice and water. The mercury rose in the glass tube, consequent upon the contraction of the air in the air thermometer, and the position of the top of the column was observed at fixed intervals of time by means of a kathetometer. From the experimental data thus obtained, the velocity of cooling was calculated, and thence the coefficients of thermal conductivity. To secure equality of temperature on the surface of the outer cylinder the author used an annular stirrer, the inner edge of which was armed with fine brushes. It is assumed that in consequence of the equal cooling of the outer vessel at all points of its surface, no convection currents arise to interfere with the conduction-passage of heat. The following numbers represent the coefficients of thermal conductivity for the corresponding liquids, a centimètre and a second being the units of length and time:—

Water . . .	0·001540
Sodium chloride (20 per cent. of salt) .	0·001912
Sodium chloride (33·3 per cent. of salt) .	0·002675
Alcohol . . .	0·001506
Carbon bisulphide .	0·002003
Glycerine . .	0·000748

It appears from the above that solutions of sodium chloride conduct heat better than pure water, and better as the per centage of salt is greater, a result which agrees with those obtained by Dr. Guthrie. According to Lundquist and Paalzow, however, the heat-conductivity of water is not improved by the presence of salts in solution—*Academy.*

Thermal Conductivity of Ice.—By Dr. Pfaff (*Sitzungsberichte der Phys. Med. Soc. Erlangen*).—Comparing the conducting power of ice with that of iron, the author finds that ice is far from being a bad conductor of heat. In fact, taking Despretz's figures, which represent the conductivity of gold by 1,000, platinum 981, silver 973, iron 374, and tin 303, the conductivity of ice may be represented by 314.—*Athenæum.*

Ice under Pressure.—Dr. Pfaff, of Erlangen, has lately made a series of experiments to know, with reference to glacier motion, what is the minimum of pressure at which ice yields to pressure. It was found that even the smallest pressure was sufficient to dislocate ice-particles if it acted continuously, and if the temperature of the ice and its surroundings was near the melting-point. At a pressure of two atmospheres ice showed itself so yielding, that a hollow iron cylinder of 11·5 mm. diameter and 1·7 mm. thickness of side entered 3 mm. deep into the ice within two hours and at a temperature of between − 1° and + 0·5°C. The following will show the influence of temperature. The same iron cylinder under the same pressure entered 1·25 mm. deep into the ice in twelve hours at a temperature of between − 1° and − 4° C.; while at a temperature varying between − 6° and 12° C. it only entered 1 mm. deep in five days, at a pressure of five atmospheres, or only 0·1 mm. in twelve hours. If the temperature of the surroundings rises beyond the melting-point the ice becomes so soft that in one hour the same iron cylinder under the same low pressure entered 3 cm. deep into the ice, although it was completely surrounded by snow in order to prevent the temperature of the cylinder itself rising beyond 0°. In these experiments a lever was used to regulate the pressure; it consisted of a steel rod of 86 cm. length, which had a boring at its end, and was fastened to a steel plug round which it could easily be turned. By this simple contrivance any desired pressure could be maintained for any length of time. Herr Pfaff is of opinion that at this temperature the plasticity of the ice only becomes *nil* when the pressure itself is *nil*, but that it decreases very quickly as the temperature gets lower.

The opinion is widely spread, based upon the experiments of Tyndall, that ice is not in the least flexible or ductile. Herr Pfaff experimented with a parallelopiped of ice of 52 cm. length, 2·5 cm. breadth, and 1·3 cm. thickness. This was placed with its two ends on wooden supports, so that on each side 5 mm. were resting on wood. From Feb. 8th to Feb. 15th, when the temperature remained between − 12° and − 3·5 C., the middle sunk very little, on the average 2 or 3 mm. in twenty-four hours, so that on Feb. 15th the total bend amounted to 11·5 mm. Then the temperature rose but still remained under − 0° C.; yet this rise caused a great increase in the bending, as it reached the value of

9 mm. in twenty-four hours (therefore 20·5 in all). Nowhere could any crack or tear in the ice be seen; the lower surface was examined with particular care, and did not show the trace of a crack!

This behaviour of ice towards pressure at different temperatures throws a new light upon the fact that the velocity in the motion of glaciers increases with temperature. As the glacier ice and the air over it possess a temperature, in the summer months at least, which lies very near the freezing point, it is evident that a very small pressure suffices to cause the glaciers to move.—*Nature.*

Salt Solutions and Attached Water. — By Professor Guthrie (*Phil. Mag.*)—When ordinary brine is sufficiently reduced in temperature, ice is separated, while the brine becomes richer in salt. But if the solution be saturated, crystals of a bihydrate of chloride of sodium are formed, and their separation necessarily impoverishes the brine. Now, Professor Guthrie finds that when this impoverished brine is further cooled, by contact with solid carbonic acid and ether, the whole solidifies, the water and salt forming a homogeneous crystalline mass of definite composition, which is probably a hydrate containing ten molecules of water. The term Cryohydrates is provisionally proposed for the newly-discovered class of bodies, of which this compound is a type: a class of bodies, in fact, which contains water combined with various salts, and which solidify below the freezing-point of water. In the freezing of sea-water ice is first formed; but it is probable that the remaining brine may be so enriched as to throw out, on continued cooling, some of these cryohydrates. Professor Guthrie concludes that the degree of saltness of an ice-floe will depend not only on its age, as Dr. Rae had already observed, but also on the rapidity with which it is first formed, and on the lowest temperature to which it has afterwards been submitted.

Salt Solutions and Attached Water.—Professor Guthrie (*Physical Society*).—Continuing the direction of research previously indicated, the author described the following facts: Contrary to the generally received opinion, the minimum temperature attainable by mixing ice with a salt is very independent of the ratio of the two and of their temperature and of the state of division of the ice. The temperature of a mixture of ice and a salt is as constant and precise as the melting points of ice. The nine salts resulting from the union of potassium, sodium, and ammonium on the one hand, and chlorine, bromine, and iodine on the other, were examined in reference to their cryohydrates, the temperatures of the formation of which range from -28° to -11° C. For the same halogen, sodium salts assume less water than ammonium, and ammonium less than potassium. For the same metal, iodine salts assume less water than bromine, and bromine salts less than chlorine. The result of the examination of thirty-five salts establishes the identity of the temperature at which the cryohydrate is formed with the temperature got by mixing the salt with ice. Only two apparent exceptions to this identity have been as yet observed. The temperature at which a cryohydrate is formed, is, with similar salts, lower according as it assumes a less molecular ratio of water. There appear to be no exceptions to the rule, that the lower the temperature got by mixing the salt with ice, the lower the molecular ratio of water. The temperature of incipient solidification of spirits of wine of different strengths was also examined. It was found that from spirits containing more water than the four molecule hydrate pure ice was separated, and that the temperature gradually sank to $-34°$ C., when the ratio of the four molecule hydrate was reached; thence the temperature remained constant and the whole solidified into a hard mass. When a spirit richer than this cryohydrate is cooled, the cryohydrate separates, and stronger and stronger spirit is left which ultimately defies the source of cold to solidify it. Prof. A. Dupré's experiments regarding the maximum temperature produced on diluting alcohol are singularly confirmed. For this experimenter showed that this very four molecule ratio produced the greatest heat in its formation. Ethylic ether, which dissolves water and is dissolved by it, seems to form a definite cryohydrate. Water saturated with ether solidifies at $-2°$ C. without separation of ether. The icy mass so got, when ignited, burns with a colourless flame, the heat of which just suffices to melt the ice.

Dissipation of Energy.—Lord Rayleigh (*Royal Institution*).—The second law of thermodynamics, and the theory of dissipation founded upon it, has been for some years a favourite subject with mathematical physicists, but has not hitherto received full recognition from engineers and chemists, nor from the scientific public.

A heat engine is an apparatus capable of doing work by means of heat supplied to it at a high temperature and abstracted at a lower, and thermodynamics shows that the fraction of the heat supplied capable of conversion into work depends on the limits of temperature between which the machine operates. A non-condensing steam engine is not, properly speaking, a heat engine at all, inasmuch as it requires to be supplied with water as well as heat, but it may be treated correctly as a heat engine giving up heat at 212° Fahr. This is the lower point of temperature. The higher is that at which the water boils in the boiler, perhaps 363° Fahr. The range of temperature available in a non-condensing steam engine is therefore small at best, and the importance of working at a high pressure is very apparent. In a condensing engine the heat may be delivered up at 80° Fahr.

It is a radical defect in the steam engine that the range of temperature between the furnace and the boiler is not utilised, and it is impossible to raise the temperature in the boiler to any great extent, in consequence of the tremendous pressure that would then be developed. There seems no escape from this difficulty but in the use of some other fluid, such as a hydrocarbon oil, of much higher boiling point. The engine would then consist of two parts—an oil engine taking in heat at a high temperature, and doing work by means of the fall of heat down to the point at which a steam engine becomes available, and secondly a steam engine receiving the heat given out by the oil engine and working down to the ordinary atmospheric temperature.

Heat engines may be worked backwards, so as by means of work to raise heat from a colder to a hotter body. This is the principle of the air or ether freezing machines now coming into extensive use.

When heat passes from a hotter to a colder body without producing work, or some equivalent effect such as raising other heat from a colder to a hotter body, energy is said to be dissipated, and an opportunity of doing work has been lost never to return. If on the other hand the fall of heat is fully utilised, there is no dissipation, as the original condition of things might be restored at pleasure; but in practice the full amount of work can never be obtained, in consequence of friction and the other imperfections of our machines.

The prevention of unnecessary dissipation is the guide to economy of fuel in industrial operations. Of this a good example is afforded by the regenerating furnaces of Mr.

Siemens, in which the burnt gases are passed through a passage stacked with fire-bricks and are not allowed to escape until their temperature is reduced to a very moderate point. After a time the products of combustion are passed into another passage, and the unburnt gaseous fuel and air are introduced through that which has previously been heated.

The chemical bearings of the theory of dissipation are very important. A chemical transformation is impossible, if its occurrence would involve the opposite of dissipation (for which there is no convenient word); but it is not true, on the other hand, that a transformation which would involve dissipation must necessarily take place. Otherwise the existence of explosives like gunpowder would be impossible. It is often stated that the development of heat is the criterion of the possibility of a proposed transformation, though exceptions to this rule are extremely well-known. It is sufficient to mention the solution of a salt in water. This operation involves dissipation, or it would not occur, and it is not difficult to see how work might have been obtained in the process. The water may be placed under a piston in a cylinder maintained at a rigorously constant temperature, and the piston slowly raised until all the water is evaporated, and its tension reduced to the point at which the salt would begin to absorb it at the temperature in question. After the salt and vapour are in contact the piston is made to descend until the solution is effected. In this process work is gained, since the pressure under the piston during the expansion is greater than at the corresponding stage of the contraction. If the salt is dissolved in the ordinary way energy is dissipated, an opportunity of doing work at the expense of low temperature heat has been missed and will not return.

The difficulty in applying thermodynamical principles to chemistry arises from the fact that chemical transformations cannot generally be supposed to take place in a reversible manner, even although unlimited time be allowed.

The possibility of chemical action must often depend on the density of the reacting substances. A mixture of oxygen and hydrogen in the proper proportions may be exploded by an electric spark at the atmospheric pressure, and energy will be dissipated. In this operation the spark itself need not be considered, as a given spark is capable of exploding any quantity of gas. Suppose, now, that previously to explosion the gas is expanded at constant temperature, and then after explosion brought back to the former volume. Since in the combination there is a condensation to two-thirds, the pressure required to compress the aqueous vapour is less than that exercised at the same volume by the uncombined gases, and accordingly work is gained on the whole. Hence the explosion in the expanded state involves less dissipation than in the condensed state, and the amount of the difference may be increased without limit by carrying the expansion far enough. It follows that beyond a certain point of rarity the explosion cannot be made, as it could not then involve any dissipation. But although the tendency to combine diminishes as the gas becomes rarer, the heat developed during the combination remains approximately constant.

It must be remembered that the heat of combination is generally developed at a high temperature, and that therefore work may be done during the cooling of the products of combustion. If, therefore, it is a necessity of the case that the act of combustion should take place at a high temperature, the possibility of explosion will cease at an earlier point of rarefaction than would otherwise have been the case.

It may probably be found that many mixtures which show no tendency to explode under ordinary conditions will become explosive when sufficiently condensed.

Effects of Heat on the Structure of Steel.—By Professor Barrett (British Association). — The author finds that if steel wire be heated by any means, at a certain temperature it ceases to expand, although the heat be continuously poured in. During this period also the wire does not increase in temperature. The length of time during which this abnormal condition lasts varies with the thickness of the wire and the rapidity with which it can be heated through. It ceases to expand, and no further change takes place till the heat is cut off. When this is done the wire begins to cool down regularly till it has reached the critical point at which the change took place on heating. Here a second and reverse change occurs. At the moment that the expansion occurs, an actual increase in temperature takes place sufficiently large to cause the wire to glow again with a red-hot heat. It is curious that this after-glow had not been noticed long ago, for it is a very conspicuous object in steel wires that have been raised to a white heat and allowed to cool.

The Force caused by the communication of Heat between a Surface and a Gas.—Professor Osborne Reynolds.—Mr. Crookes has discovered that, under certain conditions, discs of pith suspended in a very perfect vacuum, and at the end of arms free to rotate, spin round when light or radiant heat falls upon them. Prof. Reynolds disputes Crookes' view that radiant heat is attended by a force which produces this effect. When a candle is presented the disc tends to run away, and when a piece of ice is presented it tends to follow; this shows that the force is not a radiative one, and he considers that, except as regarded the raising of the temperature of the body, radiant heat has nothing to do with the motions. The suspended body may give up its heat to the ether or to the surrounding gas, and thus propel itself, for the communication of this heat to the surrounding medium must be accompanied by a reaction. It has been said that Mr. Crookes uses a perfect vacuum, so that there can be no gaseous reaction; but it remains to be proved that he uses a vacuum so absolutely perfect. The greater the perfection of the vacuum the less is the resistance, and that is why the body appears under such circumstances to be driven by a greater force. He had not witnessed the experiments with light, made by Mr. Crookes, but he thought that the results were probably due to the conversion of light into heat. Professor Balfour Stewart, the president, remarked that, as had been said by Professor Stokes, it was doubtful whether Professor Reynolds' explanation covered the whole ground. There was something else besides residual gas in the bulbs, viz., ether, and the particles of the radiometer might communicate more force to the ether when moving in one direction than when falling back again; consequently, motion might be given to the whole body to restore the balance. At all events Mr. Crookes's experiments were among the most interesting in the range of physical science.—*British Association* (*Nature*).

Thermo-diffusion.—M. Merget (French Association, Nantes).—A thermo-diffuser is generally a porous vessel, filled with an inert powder, in the middle of which is a glass tube or a metallic tube riddled with holes. On heating such an apparatus, after having moistened it, steam is disengaged in abundance through the porous substance, while dry air traverses the apparatus in an inverse direction, and escapes by the tube. If this escape be prevented, there is produced a pressure which reached three atmospheres at a dull red heat. If the pulverulent mass or the porous body ceases to be moist, no gas escapes. The author is convinced that there is here a thermo-dynamic phenomenon. Thermo-diffusion must play an important part in the gaseous exchanges of vegetable life; he showed this by taking a leaf of Nelubium as a thermo-diffuser.

Underground Temperatures.—By Sir William Thompson (Geological Soc., Glasgow).—These observations are difficult to make, on account of the change of temperature caused by the opening of the ground to place the thermometers. The best form of thermometer is that having a long-shaped bulb.

Experiments were made at Edinburg by Fourier, upon various kinds of rock, those experimented upon being sandstone, trap, and sand, and the depths from the surface were 3, 6, 12, and 24 feet (the foot here used is the French foot = 1·066 English). It was ascertained that the range of temperature on each side of a mean varied from 7·19° Fahr. at 3 feet, to ·63° Fahr. at 24 feet. It also appeared, from an inspection of the curves laid down from these observations, that there was a retardation of phase, the periods of maxima and minima at the different depths arriving later, so that when there was winter temperature at 3 feet from the surface, there was summer temperature at 24 feet from the surface.

It was found that, generally speaking, the temperature of the earth increased by 1° Fahr. for every 50 feet of depth.

Oceanic Circulation.—Dr. W. B. Carpenter (*British Association*).—After expounding with great completeness the theory, which he has for some time advocated, of a general circulation of the waters of the ocean, due to the cooling and sinking of polar waters and the indraught of warmer surface water to supply their place, the speaker laid before the Section some of the facts recently obtained by the *Challenger* Expedition and by Capt. Belknap, of the United States frigate *Tuscarora.* The point chiefly dwelt upon related to the surface-drift of equatorial water to the South Pole. The speaker admitted that there was no deep upper stratum of warm water setting to the south to correspond with that which we are familiar in the North Atlantic; but he put forth in explanation of this that the North Atlantic basin narrowed rapidly from the tropics northward, whilst the South Atlantic broadened out even in greater degree; thus the warm stratum would thicken in travelling north, and, on the contrary, thin out in its course southward. In the Antarctic Sea a thin stratum of water of warmer temperature (36° Fahr.) was indubitably proved to exist by the *Challenger* observations, but, in that icy sea, it was overlaid by a colder surface stratum, the product of melted (chiefly fresh water) ice, which, by its lesser specific gravity, floated above the denser saline warm substratum. The atmosphere being never warm enough to heat the antarctic water to the temperature (36° Fahr.) possessed by the substratum, there could not be the shadow of a doubt that the latter was derived from equatorial sources. The temperature soundings of the *Tuscarora* had thrown great light on the oceanic circulation of the North Pacific. Amongst the surprising facts supplied was that of the exceedingly low temperature of the water at moderate depths; thus, near the coasts of Japan, the water was found to be at 35° Fahr. at the depth of thirty fathoms. The Pacific being closed by the shallow sea south of Behring Straits against a bottom flow of Polar water from the north, the cold lower stratum of the North Pacific must be derived from antarctic sources.

Absorption of Light and Heat by the Solar Atmosphere.—Professor S. P. Langley, of Alleghany Observatory, at the last meeting of the American Association detailed some of the conclusions at which he had arrived after years of study of the solar surface. He first showed by comparative experiments that an absorptive atmosphere surrounds the sun. The earlier efforts to tabulate its absorptive power, produced with different observers, though men of eminence, strangely discordant results. Their methods and deductions were given in detail. Secchi's results, making the neighbourhood of the edge of the sun about half the brightness of the centre, are probably near the fact. The author applied well-known photometric methods to the problem. By attaching a circle of cardboard to the equatorial telescope, a solar image is received on the board, plainly showing spots, penumbræ, &c., if the image be one foot in diameter. From holes in this cardboard pencils of rays issue, which, being caught on a screen, give a second series of images. If these images are caught upon separate mirrors, instead of a screen, their relative light can be made the subject of comparison with that of a disc of flame from Bunsen's apparatus, and thereby their relative intensity determined. Between each aperture and its respective mirror a lens was interposed, which concentrated the pencil of rays. By suitable additions this apparatus can be converted to a Rumford photometer. The blackest umbra, the author finds, is between 5,000 and 10,000 times as bright as the full moon. The light of the sun is absorbed by its atmosphere not in the same, but in a greater proportion than its heat. A long series of experiments shows that not much more or less than one-half of the radiant heat of the sun is absorbed or suffers internal reflection by the atmosphere of the sun itself. Observations indicate that this atmosphere is (speaking comparatively) extremely thin: Professor Langley is inclined to regard it as identical with the "reversing layer" observed by Dr. Young of Dartmouth, at the base of the chromosphere, though the chromospheric shadow should perhaps be taken into the account. The importance of a study of this absorbent atmosphere becomes evident if we admit that the temperature of the temperate zone is principally due to the sun's radiation. To this atmosphere new matter is constantly being added and taken away by the continual changes of the interior surface. Any alteration in the capacity for absorption—say a difference of 25 per cent., which could hardly be recognised by observation—would alter the temperature of our globe by 100° C. The existence of life on the earth is clearly dependent on the constancy of the depth and absorption of this solar envelope. Hitherto we have chiefly confined calculations to the diminution of solar heat by contraction of the sun's mass—an operation likely to go on with great uniformity. But here is an element of far more rapid variation. If changes in the depth of this solar envelope are cyclical, they would be accompanied by cyclical alterations of the earth's temperature. This may serve alike to explain the characteristics of variable stars and the vast secular changes on earth indicated by geology. If the law of alterations in that envelope can be ascertained, new light may be shed on the history of the globe and the near future of life upon it.

New Method of obtaining Isothermals on the Solar Disc.

—Alfred M. Mayer.—In the American Journal, July, 1872, I showed how one can, with great precision, trace the progress and determine the boundary of a wave of conducted heat in crystals, by coating sections of these bodies with Meusel's double iodide of copper and mercury, and observing the blackening of the iodide where the wave of conducted heat reaches 70° C. If we cause the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of the iodide, we may work on the solar disc as we formerly did on the crystal sections.

The method of proceeding is as follows: beginning with an aperture of object-glass which does not give sufficient heat in any part of the solar image to blacken the iodide, I gradually increase the aperture until I have obtained that area of blackened iodide which is the smallest that can be produced with a well-defined contour. This surface of blackened iodide I call the area of blackened temperature. On exposing more aperture of object-glass, the surface of blackened iodide extends, and a new area is formed bounded by a well-defined isothermal line. On again increasing the aperture another increase of blackened surface is produced with another isothermal contour; and on continuing this process I have obtained maps of the isothermals of the solar image. By exposing for about twenty minutes the surface of iodide to the action of the heat inclosed in an isothermal, I have obtained thermographs of the above areas, which are sufficiently permanent to allow one to trace accurately their isothermal contours. There are other substances, however, which are more suitable than the iodide for the production of permanent thermographs.

The contours of the successively blackened areas on the iodide are isothermals, whose successive thermometric values are inversely as the successively increasing areas of aperture of object-glass which respectively produced them.

As far as the few observations have any weight, the following appear to be the discoveries already made of this new method. (1) There exists on the solar image an area of sensibly uniform temperature and of maximum intensity. (2) This area of maximum temperature is of variable size. (3) This area of maximum temperature has a motion on the solar image. (4) The area of maximum temperature is surrounded by well-defined isothermals marking successive gradations of temperature. (5) The general motions of translation and of rotation of these isothermals appear to follow the motions of the area of maximum temperature which they inclose; but both central area and isothermals have independent motions of their own.

On projecting the enlarged image of a sun-spot on the blackened surface, and then bringing a hot-water box, coated with lamp-black, near the other side of the paper, one may develop the image of the spot in red on a dark ground. A similar method probably may serve to develop the athermic lines in the ultra-red region of the solar and other spectra. —*Silliman's American Journal.*

Intensity of Solar Radiation. —M. Soret.—If we look at an ordinary flame, such as that from a gas-burner, through plates of glass coloured blue with cobalt, we observe that with a certain thickness of glass the flame presents a purple colour, since the glass transmits the extreme red rays and the highly refrangible blue and violet rays, while it intercepts the rays of intermediate refrangibility. If the source of light have a high temperature, and therefore emits highly refrangible rays, the flame appears blue, and it requires a number of superposed plates in order to develop the purple tint. Thus M. Soret found, in a certain case, that at the temperature at which platinum fuses, two plates would give a purple colour; at the fusion of iridium three plates were required, and on observing the sun the purple colour was not developed even with half-a-dozen plates.

Absorption of the Sun's Heat-Rays by the Vapour of the Atmosphere.—Rev. J. W. Stow (Meteorological Soc.).—The author finds that the drier the air the greater is the amount of radiation, and therefore northerly winds show a greater effect than southerly; but, *e.g.*, at Whitby northerly winds, being sea winds, are not dry, so that the maximum radiation is exhibited by N.W. winds. Similarly, N.E. winds favour radiation in spring, owing to their low temperature and dryness, but not so in summer and autumn, when they are warm winds. The author next instituted a set of observations in order to gain an insight into the seasonal change of radiation, by finding the corrections for the figures for each month for the varying altitude of the sun. He found the amount of radiation corresponding to different altitudes of the sun on a cloudless day, when vapour was nearly constant, and compared the figures thus obtained with those found in cloudless weather at all seasons, and with variable amounts of vapour tension. The final result is that in this climate, in clear weather, the amount of solar radiation, which would be intercepted by the atmosphere if the sun were vertical rarely exceeds 13° out of a possible maximum of 69°, or about 19 per cent.; 10 or 12 per cent. appears to be approximately the winter minimum, and 20 per cent. the summer maximum of absorption, for a vertical sun, when the sky is clear.

Condensation of Vapour by Expansion.—M. Mascart (French Association), Nantes, 1875.—If a little water is placed in the bottom of a perfectly clean flask, closed by a glass tube terminated by an india-rubber syphon bag, we have a closed space, which soon becomes saturated with moisture. By pressing on the bag the temperature rises, and there can be no condensation. But by allowing the bag to resume, by its elasticity, its original form, the air expands, is consequently cooled, but yet no condensation takes place. To produce the condensation ordinarily observed, it is necessary to introduce into the flask some unfiltered air, for filtered air produces no effect. In the same way very beautiful clouds are obtained by introducing a little tobacco smoke, or gases resulting from any kind of combustion. These experiments may be of some use in explaining the formation of clouds.

Method of obtaining a Constant Temperature.—Professor Cooke (*Chem. News*), to obtain a constant temperature of 100° C. employs an electric regulator of very simple construction. The current is made or broken by a very slight rise or fall of mercury in a U-tube connected with a glass bulb within the air-bath. By means of a pressure-tap, which closes an open L of the connecting tube, the air within the bulb may be confined as soon as the bath reaches the required temperature. After this a very slight increase of temperature raises the mercury column sufficiently to close the electric circuit, and then the current shuts the cock which regulates the supply of gas to the burner under the bath. This stop-cock consists of an ordinary chloride of calcium tube placed horizontally, and closed at the larger end by a rubber stopper, which allows a considerable freedom of motion to a smaller glass tube passing through it; by this the illuminating gas enters the chloride of calcium tube, from which it passes to the burner. When the current is closed, an electro-magnet acting on an armature attached to the outer end of the small tube plunges the curved inner end beneath the surface of some mercury in the bulb of the chloride of calcium tube, and thus shuts off the main supply of gas; although a small orifice in the side of the inner tube allows a sufficient flow to keep the flame under the air-bath alive. The variation of the temperature of the air-bath does not ordinarily exceed one or two degrees during periods of fifteen to twenty hours, even under great variations of pressure in gas mains.

Self-Registering Thermometer.—H. H. Cripps.—The instrument is divided into two portions:—First, the thermometer, which marks the degrees; secondly, the clockwork, which indicates the hours and minutes. The thermometer consists of a glass bulb, rather more than an inch in diameter, ending in a glass tube 12 inches long, having a bore of $\frac{1}{8}$ inch. This tube is coiled round the bulb in such a manner as to form a complete circle 4 inches in diameter, the bulb being in the centre of this circle. Fixed to opposite poles of the bulb, exactly at right angles to the encircling tube, are two needle-pointed pivots. These pivots work in minute metal depressions fixed to the sides of two parallel uprights. The bulb with its glass tube will thus rotate freely between the uprights, and the pivots are the centre of a circle, the circumference of which is formed by the glass tube. The bulb is filled with spirit in such quantity that at 60° Fahr. it fills not only the bulb, but about 4 inches of the tube. Mercury is then passed into the tube till it comes into contact with the spirit, so as to fill up about 3 inches of the remaining portion of the tube. The spirit is now heated to 120° Fahr., and as it expands forces the column of mercury in front of it till the mercury comes within $\frac{1}{4}$ inch of the end of the tube. The tube is then hermetically sealed, enclosing a small quantity of air. If the thermometer be now arranged with its needle-points between the uprights, it will be observed that, as the spirit contracts on cooling, it draws the column of mercury with it. This immediately alters the centre of gravity, and the bulb and tube begin to revolve in a direction opposite to that of the receding mercury. On again applying heat, and the mercury passing forwards, the bulb regains its original position. By this simple arrangement, the two forces, heat and gravity, acting in contrary directions, generate a beautifully steady rotatory movement.

A grooved wheel, 2 inches in diameter, is fixed to one of the central pivots, therefore revolving with the bulb. Directly above, and at a distance of 7 inches from this wheel, is fixed between needle-points another wheel of exactly similar size. Around and between these two wheels passes a minute endless chain. To the chain is fixed a tiny pencil, which can be carried backwards and forwards between the wheels in a perpendicular line. This constitutes the register worked by the thermometer. The clockwork portion of the machine is so arranged that it causes a vertical cylinder, round which a ruled paper is coiled, to revolve once in twenty-four hours. The cylinder is so placed that as it revolves the surface of the paper is $\frac{1}{10}$th of an inch away from the point of the pencil register moving at right angles to its surface. A small striker is connected with the clockwork in such a manner that every five minutes (or oftener if required) it gives the pencil a gentle tap, thus striking its point against the paper. By this means all friction of the moving pencil against the paper is avoided, and the index is marked by a series of dots.—*Royal Society.*

Velocity of Light.—Professor Cornu (Royal Institution). — Two methods of determination are in use. Rœmer, a Danish astronomer, after having computed from some old observations the eclipse times of Jupiter's satellites, found great discrepancies between the calculated and observed times: the eclipses appear too soon when Jupiter approaches the earth, and too late when it goes away. Rœmer ascribed these differences to the time necessary for the propagation of light, and concluded from his observations that light requires about eight minutes to come from the sun to the earth.

Bradley, one of the most illustrious English astronomers, seeking to put in evidence certain small annual motions of the stars caused by the displacement of the earth in space (annual parallax), found such a motion, but quite different from the expected one. The apparent deflection of the direction of a star —for instance, γ Draconis, near the pole of the ecliptic—instead of being at every moment directed, as expected, towards the centre of the terrestrial orbit (the sun), is directed at a right angle. The greatest elongation (called aberration) rises to 40·7″ from six to six months. Bradley, after many attempts, ascribed this effect to the composition of the velocity of light with the velocity of the elliptic motion of the earth (1728).

From those observations, and from the approximate knowledge of the distance from the sun to the earth, the velocity of light was found equal to about 200,000 English miles in a second, in other terms, one million times the velocity of sound.

Direct determinations of the velocity of light were for a long time considered impossible, owing to the enormous value of this velocity. The first solution was given by M. Fizeau (1849) by means of a toothed wheel.

A beam of light passes through the interval between two teeth of a rotative toothed wheel: this beam is reflected on a mirror fixed some miles distant, comes back exactly on the same line, and passes again through the same interval as before. An observer can perceive this beam: he will see a luminous point, a luminous echo, through each hollow between two teeth: if the wheel revolves with an increasing speed the luminous impression will first become continuous. The wheel will soon revolve with sufficient rapidity to turn a small angle during the time necessary for the beam of light to go and come back again. The angular velocity can be so regulated that the solid part of a tooth is substituted for the hollow part during this time; then, on coming back, the beam will be obstructed by the wheel. The same obstruction will take place at each tooth, and the luminons echo will disappear.

If the velocity of the wheel be doubled, the luminous point will appear again, because the reflected beams will meet with the following hollow and pass through. With a triple velocity a new extinction will take place, as before.

The following apparatus is necessary to produce the exact reflection of the beam:—At each station a telescope is directed to aim at the centre of the object-glass of the opposite station. The beam of light is sent through the first telescope: the pencil of rays, rendered nearly parallel, is received by the second and concentrated in its focus, and there reflected by a small mirror. After reflection, the rays follow exactly the same path, and come back at the very point they start from. The observer can receive these return rays without being blinded by the source of light, by interposition of a piece of transparent glass, which reflects a good part of the return rays.

M. Fizeau's experiment was made between Suresne and Montmartre. The distance of the stations was about 5½ English miles. The number found by M. Fizeau agreed sufficiently with the astronomical result to give the greatest confidence in the exactness of the method, when applied under fair conditions.

Professor Cornu's first experiments were made between the Polytechnic School in Paris and Mont Valerien. (Distance, about 6½ English miles.)

His researches were conducted with a view to improve the method of the toothed wheel. The chief difficulty is to measure the angular motion or velocity of the wheel, to which the velocity of light is directly compared. The simplest means would have been to give an uniform motion to the wheel, but this is practically impossible. The principle of M. Cornu's improvement is the use of an electrical registering apparatus, to register the continuous increase of motion of the wheel. With this arrangement an exact uniform motion is no longer necessary, the observer being able by signal to point out the instant at which the right velocity is obtained.

His second improvement is the substitution of a pair of observations of the return rays, when reduced to a determined feeble intensity, for the single observation of a total extinction.

These improvements, experimentally tried in 1872, gave the velocity of light as 298,000 kilometres per second. The probable error does not rise to 1 per cent.

Professor Cornu's latest determination was made between the Paris Observatory and the tower of Montlhéry. (Distance, about 14½ English miles.)

A direct determination of the velocity of light was ordered at the beginning of 1874 by the Council of the Paris Observatory. The best conditions were chosen for the optical and mechanical apparatus, and the stations were placed at an increased distance. One was erected upon the higher terrace of the Observatory, and supplied with a telescope of 0·38^{m} (1½ foot) aperture, and 9^{m} (30 feet) focal length. The telescope and the remainder of the apparatus (toothed wheel, registering cylinder, clocks, &c.) were sheltered under a large cabin constructed on purpose. The opposite station was erected on the top of the tower of Montlhéry; it contains only a reflection telescope sheltered by a cast-iron tube.

The experiments were made in the summer of 1874. The average of 508 pairs of observations gave the velocity as 300,400 kilometres (186,663 English miles) in a second of mean time. The probable error appears not to exceed one-thousandth.

The importance of the result is perhaps greater for those physicists who occupy themselves with electricity than for those who work on optics. The experiments and theories of Prof. Maxwell, Sir William Thomson, &c., have shown that the velocity of light is a coefficient common to the undulatory waves, and to the mode of motion which is called electricity. Several determinations, but purely electrical ones, have been made in England of that coefficient, and the results agree with the above-given value.

The numbers measuring the phenomena discovered by Rœmer and Bradley, combined with the approached distance of the sun to the earth, a hundred and fifty years ago furnished an approximate value of the velocity of light. Now the exact value of the velocity of light permits, by the inverted calculus, the computation of the mean distance of the sun or the sun's parallax, that is to say, the same element which is directly given by the transit of Venus. Professor Cornu's last result, combined with Delambre's equation of light (deduced from more than a thousand observations of eclipses of Jupiter's satellites) or of Bradley's aberration value, which seems one of the best determined number, agree exactly with the result obtained by M. Le Verrier in his researches on planetary perturbations, and with the already known results of the last transit of Venus observations.

Increase of Actinism with increase of Motive Power in the Magneto-Electric Light.—Capt. Abney (British Association).—Six magneto-electric machines were examined, each of which was driven by a ten-horse power engine. Several were driven at varying speeds, that the difference in the light caused by the variation might be tested.

The method adopted for registering the actinic power of the light, was by exposing uniformly sensitive chloride of silver paper to the action of its rays. Two registrations were carried out with each light: first, paper was exposed to the naked light at a fixed distance from the carbon points for three minutes; and second, a strip of the same paper was exposed beneath black wedges of slight taper for sixteen minutes. Between ten and twenty observations were taken for each light at the beginning, middle, and end of each trial. Diagrams of the steam pressure were taken in the usual manner, and diagrams were also taken of the steam pressure when driving the machine without exciting a current, at the same speed as that at which the light was produced. They were also taken in many cases when the machines were what may be called short circuited. The data were thus obtained for calculating the power necessary to produce a light of a certain value.

Diagrams were drawn showing the mean of the results of a series of experiments with one instrument; one curve, deduced from eighty readings, giving what may be called the optical value; another, deduced from 450 readings, giving the actinic value; whilst a third showed the ratio of the actinic to the optic value—the abscissæ being in all these cases measures of the horse power. The curves are interesting as showing the rapid decrease of the optical value, and still more of the actinic value, of the light when worked with a low motive power. They also show that each machine has a point beyond which the increase in motive power is not compensated for by increase in light, the curves apparently becoming asymptotic.

Mirage at Sea.—Dr. Jansen, (British Association), stated that he had paid great attention to this phenomena in all his journeys since 1868, and had observed some very curious facts relating to it, chiefly at sunrise and sunset. He found that (1) the mirage was almost constant at the surface of the sea; (2) that the appearances were explained by admitting the existence of a plane of total reflection at a certain height above the sea; (3) that the phenomena are due to a thermic and hygrometric action of the sea on the neighbouring atmospheric strata; (4) that there exist at sea direct, inverse, lateral, and other mirages; (5) that the phenomena have a very general influence on the apparent height of the sea horizon, which is sometimes diminished, sometimes increased. This variation of the apparent horizon it is very important to take into account, if we remember the use made of the horizon in nautical astronomy.

Defects of the Human Eye as regards Achromatism.—Professor H. M'Leod (Physical

Society).—The eye has been considered to be achromatic because it practically is so; but it is easy to offer abundant evidence of the defects of the organ in this respect. For instance, to short-sighted persons the moon appears to have a blue fringe. In using the spectroscope, the red and blue ends of the spectrum cannot be seen with equal distinctness without adjusting the focussing glass. A black patch of paper on a blue ground appears to have a fringed edge if viewed from even a short distance, while a black patch on a red ground, when observed under similar conditions, has a perfectly distinct margin. In the author's opinion it is the overlapping of images in the eye which produce the mental impression that there is no want of achromatism. It is interesting to note that Wollaston considered that the coloured bands of the spectrum were really divided by the black (Fraunhofer) lines, and his statement that the red end of the spectrum does not appear to have a boundary line, "because the eye is not competent to converge the red rays properly," shows that he had very nearly, if not quite, discovered the achromatic defects of the eye. Dr. Young ascribes to Wollaston the merit of having observed that when a luminous point is viewed through a prism, the blue end appears to be wider than the red, the eye being incapable of recognising that the spectrum has the same width throughout its entire length. The relative distinctness of a dark line on grounds of various colours, can be shown by the following experiment. A string or wire is arranged that its shadow traverses the entire length of a spectrum thrown on a screen by an electric lamp. When viewed from a short distance the edges of the shadow appear to be sharp at the red end, but gradually became less distinct, until at the blue end nothing but a blurred line remains.

The Centre of Motion of the Eye.—Professor Clerk Maxwell (Philosophical Society, Cambridge).—The series of positions which the eye assumes as it is rolled horizontally have been investigated by Donders, and recently by J. L. Tupper. The chief difficulty in the investigation consists in fixing the head while the eyeball moves. The only satisfactory method of obtaining a system of co-ordinates fixed with reference to the skull is that adopted by Helmholtz. A piece of wood, part of the upper surface of which is covered with warm sealing-wax, is placed between the teeth and bitten hard till the sealing-wax sets and forms a cast of the upper teeth. By inserting the teeth into their proper holes in the sealing-wax, the piece of wood may at any time be placed in a determinate position relatively to the skull. By this device the experimenter is free to move his head as he likes, provided he keeps the piece of wood between his teeth. If we now adjust another piece of wood, so that it shall always have a determinate position with respect to the eyeball, we may study the motion of the one piece of wood with respect to the other as the eye moves about. For this purpose a small mirror is fixed to a board, and a dot is marked on the mirror. If the eye, looking straight at the image of its own pupil in the mirror, sees the dot in the centre of the pupil, the normal to the mirror through the dot is the visual axis of the eye—a determinate line. A right-angled prism is fixed to the board near the eye in such a position that the eye sees the image of its own cornea in profile by reflection, first at the prism, and then at the mirror. A vertical line is drawn with black sealing-wax on the surface of the prism next the eye, and the board is moved towards or from the eye till this line appears as a tangent to the front of the cornea, while the dot still is seen to cover the centre of the image of the pupil. The only way in which the position of the board can now vary with respect to the eye, is by turning round the line of vision as an axis, and this is prevented by the board being laid on a horizontal platform carried by the teeth. If now the eye is brought into two different positions, and the board moved on the platform, so as to be always in the same position relative to the eye, we have to find the centre about which the board might have turned so as to get from one position to the other. For this purpose two holes are made in the platform, and a needle thrust through the holes is made to prick a card fastened to the upper board. We thus obtain two pairs of points, A B for the first position, and a b for the second. The ordinary rule for determining the centre of motion is to draw lines bisecting A a and B b at right angles. The intersection of these is the centre of motion. This construction fails when the centre of motion is in or near the line A B, for then the two lines coincide. In this case we may produce A B and a b till they meet, and draw a line bisecting the angle externally. This line will pass through the centre of motion as well as the other two, and when they coincide it intersects them at right angles.

Contest between the Retinae.—Schön and Mosso.—If one eye be closed, while the other is directed, without fixation, towards a surface of uniform tint (such as the open sky or a blank wall), a temporary dimness seems to invade a part of the visual field of the uncovered eye. This obscuration is intermittent, taking place from five to twelve times in a minute; the number being tolerably constant for the individual observer. The duration of the dimness varies inversely as its frequency. It may be of a greenish-yellow or bluish tint, or it may not exhibit any definite colour. The phenomenon is explained by supposing that our attention is directed to each retina in turn, that there is a contest between them; about seven-tenths of our time being given to the retina of the uncovered eye, while three-tenths are diverted to that of the closed one. This explanation is supported by the following facts. The phenomenon only occurs during monocular vision, and is unknown to the one-eyed. It is limited to that part of the visual field which is common to both eyes. When the attention is concentrated on the uncovered eye by setting it some task, such as that of counting spots on the wall, the dimness does not occur. Lastly, when the eyes are unequal in power, and one eye is habitually used while the images formed on the retina of the other are as habitually suppressed (as in some cases of squint), the phenomenon cannot be produced. Whether the obscuration depend on a momentary blending of the two fields, or on a total diversion of the attention to the closed eye, it is not easy to decide. The circumstance that the outer region of the field remains distinct would seem to indicate that the former view is the correct one, since impressions on the independent region of the uncovered retina continue to be transmitted to the sensorium.—*Academy.*

Revolving Polariscope.—By W. Spottiswoode, LL.D. (Physical Society). A luminous beam passes from a small circular hole in a diaphragm through a polariscope, the analyser of which is a double image prism, the size of the hole being so arranged that the two luminous discs shall be clear of each other. If the prism be made to revolve rapidly (eight or ten revolutions per second), one of the discs revolves round the other and is merged into a ring of light, which is interrupted at opposite sides by a dark shaded band, the position of which depends upon the position of the original plane of polarisation. The discs may be coloured by inserting a selenite plate, and the rapid revolution of the analyser then gives alternating segments of complementary colours; or, if a quartz plate be used, the rotating disc passes successively twice in a revolution through all the colours of the spectrum, and when the revolution is rapid, merges into a prismatic ring.

Optical Properties of Titano-Silicic Glass.—Prof. G. C. Stokes and Dr. J. Hopkinson (British Association).—One object of the researches, of which this is the last, was to obtain two glasses which should achromatize each other without leaving a secondary spectrum, or a glass which should form with two others a triple combination; an objective composed of which should be free from defects of irrationality without requiring undue curvature in the individual lenses. The best solution of this problem was offered by glasses in which a portion of the phosphoric was replaced by titanic acid. It was found, in fact, that the substitution of titanic for phosphoric acid, while raising, it is true, the dispersive power, at the same time produced a separation of the colours at the blue, as compared with those at the red end of the spectrum, which ordinarily belongs only to glasses of a much higher dispersive power.

Several considerations seemed to make it probable that the substitution of titanic acid for a portion of the silica, in an ordinary crown glass, would have an effect similar to that which had been observed in the phosphatic series of glasses. Phosphatic-glasses are too soft for convenient employment in optical instruments, but should titano-silicic glasses prove to be to silicic what titano-phosphatic glasses have been found to be to phosphatic, it would be possible, without encountering any extravagant curvatures, to construct perfectly accurate combinations out of glasses having the hardness and permanence of silicic glasses; in fact, the chief obstacle at present existing to the perfection of the achromatic telescope would be removed. After some preliminary trials, a piece of glass free from striæ was prepared of titanate of potash mixed with the ordinary ingredients of a crown glass. Rutile fused with carbonate of potash was used as titanate of potash. The glass contained about seven per cent. of rutile, and as none was lost, the percentage of titanic acid cannot have been much less. The glass was somewhat greenish from iron contained in the rutile; but this did not affect the observations.

Out of this glass two prisms were cut. One of these was examined as to irrationality by Prof. Stokes, by his method of compensating prisms; the other by Mr. Hopkinson, by accurate measures of the refractive indices for several definite points in the spectrum. These two perfectly distinct methods led to the same result, viz., that this glass spaces out the more, as compared with the less refrangible part of the spectrum, no more than an ordinary glass of similar dispersive power. As in the phosphatic series, the titanium asserts its presence by a considerable increase of dispersive power; but, unlike what was observed in that series, it produces no sensible effect on the irrationality. The hopes therefore that had been entertained of its utility in silicic glasses prepared for optical purposes appear doomed to disappointment.

Hardened Glass. Its Opti-

cal Properties.—H. Pocklington. —A small cube of De la Bastie's hardened glass is mounted between strips of blackened cork, and examined in the usual way by means of Nicol's prisms, glass plates, or other appropriate polariscope. The beautiful chromatic phenomena brought out, at once indicate that amongst the causes which operate to produce the hardness of the glass, powerful compression of the interior by the contracting exterior must be one. The phenomena are, in fact, essentially those of compressed glass, and the curves of colour, or black and yellow, seen when the glass is examined by white or monochromatic light, indicate successive curves of tension, balance and no-tension. In a carefully prepared glass rod of half-inch length these curves are rings traversed by a well-marked black cross. In an oval the rings assume the character of those seen in biaxial crystals. When plates are examined, the light being transmitted from back to front, they appear to act essentially as bi-refracting plates, but with crosses and bands somewhat irregularly distributed, and capable of being referred to the angles of the plates or to centres of unequal heating.

I find this glass to be nearly twice as hard as ordinary glass, which it scratches with ease. It can be cut with a good file and can be ground on a stone with sand. One piece, which manifested when under the polariscope evidences of ill-balanced tension, the neutral line lying near one surface, submitted to transverse grooving, but disintegrated on being ground on one surface as soon as the outer surface had been ground away to near the neutral line. There appears to be an easily reached limit beyond which the surfaces must not be unequally removed, but there is practically no limit beyond which both surfaces may not be simultaneously removed. This result, foretold by me from polariscopical analysis, Mr. Fairley has shown by dissolving the opposing surfaces away by hydrofluoric acid. The least hard portions dissolved much more readily than the thoroughly hardened, and the etched surfaces show wavy lines closely following the tension lines shown by the polariscope. There is further this remarkable feature, that the inner portion of the glass proves to be essentially common glass, which fractures in the ordinary way.

Optical Properties of Collodion Plates.—M. E. Gripon.—The film formed by pouring collodion on clean glass and allowing it to dry, reflects light like glass, and polarises it both by reflection and transmission. Its index of refraction is $n = 1{\cdot}5108$, a little less than that of crown glass. It transmits a very large proportion of radiant heat, but less for low temperature than for high.—*Comptes Rendus.*

Electrical Resistance of Selenium.—J. E. H. Gordon.—The writer has tried the following interesting experiment with a selenium bar belonging to the Cavendish Laboratory. Its length is 50 mm., breadth 8 mm., thickness about 1 mm.; platinum wires are soldered to its ends, and it has a hard metallic surface. Its electrical resistance is enormous. In the dark it is just over 100 megohms. (100,000,000 B.A.U.) When, however, the light of the paraffin lamp of the galvanometer was allowed to fall on it from the distance of about a foot, the resistance decreased between 20 and 30 per cent. The experiment was repeated many times, with current sent sometimes one way, sometimes another, and with different sides and edges of the bar turned to the light, but always with the same result, namely, that the effect of letting in the light was to decrease the resistance.

A second set of experiments were

made with a selenium medal struck by Berzelius soon after the discovery of the metal in 1818. This medal was of oval shape, about 40 millims. long by 30 broad. Owing to the difference of form between the two specimens, their specific resistances could not be accurately compared; that of the medal was, however, not more than about $\frac{1}{40}$ of that of the bar. The medal was exactly like black lead both to touch and sight, and quite different in appearance to the bar. The resistance of the medal was sensibly the same, both in the dark and in the light; no difference could be detected.

These experiments seem to show that the physical form of the metal has a great deal to do with its behaviour when carrying an electric current and exposed to light.—*Nature.*

Properties of Selenium.—R. J. Moss observes with reference to the above note that he, in company with Mr. H. Draper, has already shown that the electrical properties of selenium are very variable. There is a granular variety of the element which is, at ordinary temperatures, apparently as good a non-conductor as the vitreous variety. Unlike the latter, however, it cannot be rendered electrical by friction. Another granular modification of the element was found to conduct electricity comparatively well in darkness, and scarcely any better under the influence of light; while there is an intermediate state of the element which appears to possess a molecular structure so susceptible of change, that light is capable of converting it temporarily into the form which conducts comparatively well. Some bars which we prepared of this sensitive variety exhibited an increased conductivity of 100 per cent. under the influence of sun-light. In appearance there is not the slightest difference between this and the non-conducting granular variety, both exhibiting a gray granular fracture resembling that of the metal cobalt. Thin plates are generally more sensitive to light than cylindrical bars. So far as the effect of heat on electrical resistance is concerned, some forms of granular selenium conform to the metallic type. This was demonstrated by placing a plate of selenium inside a spiral of platinum, at a distance of about 4 mm. from the wire. The usual decrease of resistance took place when the plate was exposed to light; but on heating the surrounding platinum wire by passing a current of electricity through it, the resistance of the selenium increased considerably. The effect of light is therefore partially counterbalanced by the effect of the heat which usually accompanies it. This partly explains the increase of resistance that is known to follow prolonged exposure to light. A portion of this increase being doubtless due to the slight elevation of temperature that must result from the passage of the current through the selenium. The opposite action of light and heat is very remarkable, especially as the longest light undulations are those that cause the greatest decrease of resistance. It is remarkable, also, that a thin film of non-conducting vitreous selenium transmits these red rays, while an equally thin film of granular selenium is perfectly opaque to them.—*Nature.*

Absorption-Spectra of Metals volatilised by the Oxyhydrogen Flame.—J. Norman Lockyer and W. Chandler Roberts (Royal Society).

The researches of Roscoe and Schuster and Norman Lockyer establish beyond all question the facts that—

1. In addition to the well-known line spectra, channelled-spaced spectra are produced by the vapours of certain metals; and,

2. Such spectra are produced by

vapours which are competent to give, at other times, not only line-spectra, but continuous spectra in the blue, or blue and red. The number of metals examined was very limited.

It was considered by the authors desirable to extend these observations to the less fusible metals, as well as to ascertain whether the spectra of those which volatilised at the lower temperature would be modified by the application of a greater degree of heat. For this purpose they employed an oxyhydrogen blowpipe, and the lime still used by Stas for the distillation of silver, his arrangement being modified in order that the metallic vapour might be conducted into a lime tube or tunnel heated to whiteness, so placed that a beam from an electric lamp could readily transverse it.

The apparatus employed consists of a block of lime traversed by a tube 30 centims. long and 30 millims. diameter. At each end a short iron tube was inserted, making the total length of the column of vapour 60 centims. A receptacle, open at the upper surface of the lime-block, in order to admit of the introduction of the oxyhydrogen blowpipe, communicates with the centre of the tube. The ends of the tube or tunnel in the lime were closed by glass plates held on by a suitable clip. Small lateral orifices were cut in the lime for the insertion of tobacco-pipe stems, through which a stream of hydrogen could be passed into the tube and receptacle.

An electric lamp was placed opposite one end of the tube and a spectroscope opposite the other. This last instrument was capable of distinctly separating the D lines, at the same time that it enabled the whole of the spectrum to be seen in a single field of view.

The lime-block with its fittings was then placed in a charcoal furnace, and as soon as it was heated to bright redness, the metal, the vapour of which was to be examined, was introduced into the receptacle, and the flame of the oxyhydrogen blowpipe was allowed to play on its upper surface, care being taken to employ an excess of hydrogen. In almost every case the metal experimented on was rapidly volatilised (the exceptions being gold and palladium). Silver may be given as an example of the method.

Fifty grammes of pure metal were placed in the cavity, and this amount produced a continuous supply of vapour for about ten minutes.

An exquisite channelled space absorption was observed, the channels being far enough apart to render them very conspicuous in the field of view; at the same time there was continuous absorption in the blue. It was specially observable that there was no absorption in the red.

Copper, sodium, calcium, aluminium, zinc, cadmium, manganese, iron, cobalt, nickel, chromium, tin, antimony, bismuth, lead, thallium, gold, palladium, selenium, and iodine were examined in like manner.

The authors conclude that these experiments go far to support the conclusions which were drawn from the experiments at a lower temperature. First, in passing from the liquid to the most perfect gaseous state, vapours are composed of molecules of different orders of complexity; and second, this complexity is diminished by the dissociating action of heat, each molecular simplification being marked by a distinctive spectrum. There is also an intimate connection between the facility with which the final stage is reached, the group to which the element belongs, and the place which it occupies in the solar atmosphere.

Broken Lines of Metallic Spectra.—Professor G. F. Barker (American Association).—The author's purpose in this paper is to give the general result of a series of measurements made to ascertain, by Vierordt's method, the relative intensity of these lines, and to compare these with their length measured micrometrically. Vierordt's method consists in measuring the intensity of a coloured light by the amount of white light necessary to extinguish it. By means of a third telescope attached to the spectroscope, a bright slit of light may be thrown upon any portion of the spectrum, and by varying the distance of the source of this light, until it extinguished the various spectrum lines in the order of their brightness, a series of numbers was obtained which, by the law of the inverse squares, gave the relative intensity of the different spectrum lines. The metals experimented upon were copper, gold, silver, antimony, bismuth, and magnesium. The general result is, that in no case does the length of the spectrum line follow the law of brightness. Hence some other hypothesis must be suggested to account for the phenomena. The constitution of a gas is simple; the molecules composing it move in straight lines, and encounter each other and the walls of the containing vessel in so complex a way that Prof. Maxwell doubts if mathematics can follow their paths. The oscillations of the atoms within the molecule are, however, less complex; they either are simple harmonic motions themselves, or they may be resolved into such. It is these harmonic vibrations which, communicated to the ether, cause the spectrum lines; the number of the different forms of oscillation constituting the number of lines in the spectrum, the period of any one oscillation determining the wave length of the corresponding line, and the amplitude fixing the brilliancy of that line. These things being granted, we have only to suppose what is perfectly conceivable, that the amplitude of the vibration varies with the temperature differently for each of the different kinds of vibration in the molecule, or, what is the same thing, with the wave length. If, for example, the peculiar harmonic vibration of the atoms of a copper molecule which gave the longest line in the green, diminished the amplitude of its oscillation less rapidly than the one in the blue, then this is a sufficient reason why it should be the longest. We may, therefore, by inspection of a broken spectrum, conclude at once on the rapidity with which the amplitude of the different harmonic vibrations of the atoms within the molecule decreases with decreasing temperatures, this being simply in the order in which the lines are arranged as to their length.

Distribution of Bands in Primary Spectra.—G. Salet.—The question of the existence of double spectra seems at present answered in the affirmative. A few years ago the Swedish physicist, Angström, in his celebrated memoir on the solar spectrum, pronounced the opinion of Plücker, according to which an elementary body might give different spectra at different temperatures, decidedly incorrect. Yet in his last work he declares himself unwilling to deny that a simple body, when brought to the gaseous state by heat, may not, in some cases, give different spectra. An element may form with another element a chemical compound giving a particular spectrum, and in like manner the same element may form compounds with itself—isomeric compounds which, if not destroyed by heat, may give each its peculiar spectrum. This is the opinion which the author has maintained, supporting it by various experiments made, not only with Geissler's tubes, but also taking advantage of the absorbent properties of certain vapours, such as sulphur, bromine, and iodine.

The spectra with bands, or primary spectra of the simple bodies, seem absolutely similar to the known absorption-spectra; those, for example, of iodine and bromine, which no one has thought of ascribing to compounds. The author has to point out a new point of resemblance between these two sorts of spectra. It is known that Thalen, in a work on the absorption-spectrum of the vapour of iodine, has concluded that the various bands of this fluted spectrum are not equidistant; they form several intermingled series, and in each of these the respective distance of the consecutive bands varies with the length of the wave, following a law which differs little for adjacent series. The study of the primary spectrum of sulphur has led the author to similar conclusions. —*Chemical News.*

Spectra of Coggia's Comet and Tempel's Comet, 1874.—Father Secchi (Ital. Spect. Soc.)—The author spectroscopically examined these comets on every opportunity, comparing their spectra with a Geissler's tube in front of the object-glass. He found the spectra of a hydrocarbon gas did not correspond with that of the comet; the brightest band of the spectrum of marsh gas is in the blue, while that of the gas carbonic oxide or carbonic acid is in the green, just as in Coggia's comet. On the other hand, the blue band is the brightest in the spectrum of Tempel's comet; and Secchi therefore attributes its light to a hydrocarbon. From the nucleus and the surrounding portions of the comet polarised light proceeded.

Spectrum of Ruby Glass.—W. G. Lettsom has called our attention to the remarkable spectrum afforded by glass ruby-tinted with gold. In a slide prepared by him, kindly forwarded to us, we find the luminous part of the green and blue darkly clouded by a very thin slice of the glass, while the red and violet portions of the spectrum remain clear. At night, with the micro-spectroscope and a paraffin lamp, the cloudy band has a peculiar red tint, well seen if the lamp is screened so that little light can reach the eye except what passes through the spectroscope.—*Academy.*

Spectrum of the Aurora Borealis.—M. Selim Menström (Les Mondes).—The pale lights seen over the summits of the mountains of Spitzbergen and Lapland are of the same nature as the aurora. Similar phenomena observed in other regions prove that electric discharges of the same nature as the aurora may occur elsewhere besides in the arctic regions. The spectroscope is the surest means of determining the nature of these phenomena. In the spectrum of the aurora there are nine rays, which probably agree with the lines given by the component gases of the atmosphere. The spectrum of the aurora may be resolved into three different types.

Spectrum of the Aurora.—J. R. Capron (*Philosophical Magazine*).—The author disagrees with the conclusion of Angström, that the "moisture in the region of the aurora must be regarded as nil." He moreover states that the "yellow-green line, and possibly also the red, are due to phosphorescence or fluorescence; the fainter lines are partly due to the air spectrum, and the remaining bands or lines may be due to phosphorus and iron, the close coincidences in this latter spectrum with the aurora lines being very striking."

Photographs of Solar Spectra.—H. W. Vogel (*Poggendorff Annalen*).—In an ordinary photographic camera the author replaces the lens by a small spectroscope. The sun's rays are allowed to enter the camera parallel to the axis of the spectroscope. Photographs are taken in the usual way. The definition is not very distinct.

Currents of the Holtz Machine.—M. Rosetti (*Annales de Chim.*)—The strength of a current produced by a Holtz machine is very nearly proportional to the velocity of rotation of the disc, provided the hygrometric state of the atmosphere remains constant.

The ratio of the velocity of rotation to the strength of the current increases with the humidity.

The effective work spent in each second is exactly proportional to the strength of the current; the ratio of the work spent to the strength of the current diminishes as the humidity increases. If the motion of the disc be maintained by a rotation apparatus, and if the weight which is necessary to turn the disc with a certain velocity when the machine is charged be called the total moving weight, the weight necessary to turn the disc when inactive the partial moving weight, and the difference between the total weight and the partial weight the effective moving weight, it is observed that the effective moving weight remains constant, whatever be the magnitude of the total weight, *i.e.*, whatever be the intensity of the current. The effective moving weight is greater as the air is more dry.

The behaviour of Holtz's machine is in some respects analogous to that of voltaic couples. Its electromotive force and internal resistance are both constant if the velocity of rotation and hygrometric state remain constant. The electromotive force remains invariable for any velocity of rotation if the hygrometric state does not alter, but diminishes if the hygrometric state increases. The internal resistance is independent of the hygrometric state for a given velocity of rotation, but diminishes if the velocity increases.

In the Holtz machine the electromotive forces are enormously great in comparison with those of the most energetic voltaic combinations. For instance, when the hygrometric state is 0·35, the electromotive force of the Holtz was found to be more than 50,000 times as great as that of a Daniell's cell. Similarly, the internal resistances are very great; *e.g.*, when the disc makes eight turns per second, the internal resistance was found to be equal to 570 million Siemens' units.

Ohm's law is obeyed by the currents of these machines; consequently, if in the external circuit resistances are introduced which are not negligible in comparison with the enormous resistance of the electro-motor, a diminution of the current will be observed conformably to the law of Ohm.—*Academy.*

Stratification in Electrical Discharges through Rarefied Gases. — William Spottiswoode, LL.D., Treas. R. S. (Royal Society).—In the stratified-discharges through rarefied gases produced by an induction-coil working with an ordinary contact-breaker, the striæ are often unsteady in position, and apparently irregular in their distribution. Observations made by the author with a revolving mirror, have led him to conclude that an irregular distribution of striæ does not properly appertain to stratification, but that its appearance is due to certain peculiarities in the current, largely dependent on instrumental causes.

The induction-coil used was an "18-inch," worked occasionally by six large chloride-of-silver cells, but more usually by ten or by twenty small Leclanché cells. He has also, in connection with the same coil, 120 of the latter cells, connected in twenties for quantity, and forming six cells of twenty times the surface of the former. These work the coil with the ordinary contact-breaker very well, giving 11-inch sparks whenever required. A "switch" affords the means of throwing any of the three batteries in circuit at pleasure. The contact-breaker had a steel rod as vibrator, with a small independent electromagnet for maintaining its action.

With a contact-breaker of this kind in good action, several phenomena were noticeable; but first and foremost was the fact that in a large number of tubes (especially hydrocarbons), the striæ, instead of being sharp and flaky in form, irregular in distribution and fluttering position, were soft and rounded in outline, equidistant in their intervals, steady in proportion to the regularity of the contact-breaker. These results are, the author thinks, attributable more to the regularity than to the rapidity of the vibrations. And this view is supported by the fact that, although the contact-breaker may change its note (as occasionally happens), and in so doing may cause a temporary disturbance in the stratification, yet the new note may produce as steady a set of striæ as the first. And not only so, but frequently there is heard, simultaneously with a pure note from the vibrator, a strident sound, indicating that contacts of two separate periods are being made, and yet, when the strident sound is regular, the striæ are steady.

The discharges are usually those produced by breaking contact; but it often happens, and that most frequently when the strident noise is heard, that the current produced by making contact is strong enough to cause a visible discharge. This happens with the ordinary as with the high break; but in the latter case the double current presents the remarkable peculiarity, that the striæ of one current are so arranged as to fit exactly into the intervals of the other. Any disturbance affecting the column of striæ due to one current affects similarly, with reference to absolute space, that due to the other, so that the double column moves, if at all, as a solid or elastic mass. And this fact is the more remarkable if we consider, as is easily observed in a revolving mirror, that these currents are alternate, not only in direction, but also in time, and that no one of them is produced until after the complete extinction of its predecessor. This association of striæ is not destroyed, even when the two currents are separated more or less by the presence of a magnetic pole. There seems, however, to be a tendency in that case for the striæ of one current to advance upon the positions occupied by those of the reverse current, giving the whole column a twisted appearance. There is no trace, so far as the author's observations go, of this association of alternate discharges when produced by the ordinary break.

The column of striæ, which usually occupy a large part of the tube from the positive towards the negative terminal, have hitherto been described as stationary, except as disturbed by irregularities of the break. The column is, however, frequently susceptible of a general motion, or "flow," either from or towards the positive pole, say a forward or backward flow. This flow may be controlled, both in velocity and in direction, by resistance introduced into the circuit, or by placing the tube in a magnetic field. The resistance may be introduced in either the primary or the secondary circuit. For the former arrangement the author successfully employed a set of resistance-coils, supplemented by a rheostat. For the secondary current, as well as for the Holtz machine, he has used an instrument devised and constructed by his assistant, Mr. P. Ward. Wherever the resistance be introduced the following law appears to be established by a great number and variety of experiments, viz., that the striæ being previously stationary, an increase of resistance produces a forward flow, a decrease of resistance a backward flow.

When the striæ are flowing they preserve their mutual distances, and do not undergo increase or decrease in their numbers. Usually one or two remain permanently attached to the positive electrode; and as the moving column advances or recedes, the foremost stria diminishes in brilliancy until, after travelling over a distance less than the intervals between the two striæ, it is lost in darkness. The reverse takes place at the rear of the column. As the last stria leaves its position, a new one, at first faint and shadowy, makes its appearance behind, at a distance equal to the common interval of all the others. This new one increases in brilliancy until, when it has reached the position originally occupied by the last stria, when the column was at rest, it becomes as bright as the others. The flow may vary very much in velocity; it may be so slow that the appearances and disappearances of the terminal striæ may be watched in all their phases, or it may be so rapid that the separate striæ are no longer distinguishable, and the tube appears as if illuminated with a continuous discharge. In most cases the true character of the discharge, and the direction of the flow, may be readily distinguished by the aid of a revolving mirror.

Lengthening of the Electric Spark. — Mr. Mixter (*Silliman's American Journal*). — The author placed a gas flame between the two conductors of a Holtz machine. The gas current came from a glass tube drawn out to a point, and the flame had a length of about 1 inch and a diameter of only ⅛ inch. When this was brought between the two ends of the machine, the length of the spark obtained was at once increased from less than 10 in. to over 12 in., the whole of the distance by which the balls would be separated. Such an increase was not obtained when only one conductor was brought between the two ends. A conducting ball of 1 inch diameter lengthened the spark only about an inch.

Thomson's Quadrant Electrometer.—M. Terquem (*Jour. de Physique*).—In the late Dr. Becker's form of Sir William Thomson's electrometer, the aluminium needle is maintained at constant potential by means of a Leyden jar, with the inner coating of which it communicates; of the brass quadrants one pair is connected with the earth, the other with the body whose electrical condition is to be studied. In the form now described there is no Leyden jar, and the aluminium needle is suspended by a metallic wire. The quadrants are connected in opposite pairs with the two poles of a battery (zinc, water, copper) of 100 elements, and thus always exhibit a constant difference of potential. The conductor whose electrical capacity or potential is to be investigated is connected with the wire carrying the needle, and the deflections of the needle observed, and measured by means of a telescope and scale. The instrument so used gives constant and satisfactory results.—*Academy.*

Phenomena produced in Liquids by Electric Currents of High Tension.—G. Planté.—A secondary battery of forty elements, each formed of plates of lead in acidulated water, is charged by two Bunsen's cells. The current from this battery, though only temporary, has sufficient duration to exhibit in all their details the effects produced by the passage of the electricity through imperfect conductors, such as the liquids of voltameters. Platinum wires connected with the two poles are dipped into acidulated water. In the circuit is introduced also a platinum wire eighty centimètres long and one-tenth of a millimètre in diameter. If the positive terminal be immersed first, and then the negative, the latter is surrounded by an envelope of light, but there is no sensible disengagement of gas, nor does the platinum wire become visibly heated. At the end of two or three minutes the luminous envelope disappears, an abundant disengagement of gas takes place at the two electrodes, and the platinum wire at the same time becomes red throughout its whole length.

M. Planté employed also a secondary battery of 200 elements, the discharge current of which was equal to that of 300 Bunsens arranged in series. This battery may be charged in about an hour by two Bunsen's cells. When discharged through a U-tube containing a saturated solution of common salt, the negative electrode being first immersed, the approach of the positive wire into contact with the liquid determines the formation around it, with a roaring noise, of a small luminous globule of perfect sphericity. On raising the platinum wire the globule increases in size, attaining a diameter of 10 millimètres; when the wire is depressed the globule assumes a rapid gyratory motion, and having acquired a certain velocity becomes detached, as if attracted by the other electrode, and disappears with an explosion and flame at the negative electrode. This globule is not gaseous, for under these conditions the decomposition of the water takes place with great difficulty; it is a liquid globule in a peculiar spheroidal state, and since it is almost insulated, by reason of its spheroidal state, from the rest of the liquid, must naturally be charged with the same electricity as that of the wire at which it originated, *i.e*, with positive electricity.

The author observes that cases of globular lightning have generally been observed at the end of a storm, when the electricity of the atmosphere flows freely to the earth through earth saturated with aqueous vapour. He regards this portion of the atmosphere as a vast voltameter, one electrode being formed by a cloud, the other by a point of the earth,—a voltameter in which the water would be with difficulty decomposed, and in which such luminous and calorific phenomena as are described above would play a prominent part. Although fire-balls are certainly not spheres of liquid, they may nevertheless be formed of a ponderable matter charged with electricity, and we may conceive that the high tension of atmospheric electricity may produce with humid air that which dynamical electricity produces with a saline liquid.—*Academy.*

Cause of the Polar Aurora—Analogies with Natural Phenomena.—M. Planté.—A U-tube full of salt water was employed by the author as a voltameter, and was subjected to the action of the electric source indicated in a former communication. If, the negative wire being plunged in one of the limbs of the tube, the end of the positive wire is placed in contact with the glass in the other limb, a little above the liquid, we perceive at first around the wire a glittering crown produced by the saline particles which line the tube. If the wire is approached towards the liquid, a depression is produced; a luminous arch, bordered with radiating striæ, appears along the glass, and is transformed into an irregular demi-crown with sinuous outline, and animated with a rapid undulatory movement. Steam escapes in rapid jets above the sparks of fire, as if it issued from a boiler under pressure. The concavity of the luminous arch in the voltameter, turned towards the point whence the positive current issues, compared to the concavity of the aurora turned towards the earth, shows that the flow of the electric currents, brought from the equator by the higher winds is from below upwards, that is, from these regions of the atmosphere to still loftier ones. These currents, impinging upon the icy clouds of the poles, which correspond to the saline particles, and to the moist glass of the voltameter, are transformed into heat and light, and vaporise the polar clouds which are re-precipitated in the form of snow or rain. Thus the polar aurora is due, not to discharges between the electricity of the atmosphere and that of the ground—which would involve the poles in a perpetual thunderstorm—but rather to the dissemination in the higher atmosphere of the great masses of electricity derived from the surface of the globe in a calorific and luminous form. Finally, if it is permissible to carry out the analogies further, we find in the phenomena observed a reproduction on an infinitely small scale of the possible mode of formation of the heavenly bodies, spherical or annular, and a rapid image of their development down to their extinction or transformation in space. We are thus led to think that in the first impulse given, or in the number of the various movements impressed upon the ethereal matter in the work of creation, it is necessary to include that particular mode of motion which constitutes electricity, masked as it might be under the more striking phenomena of heat and light.—*Comptes Rendus.*

New Electric Lamp.—A M. Ladyguine has overcome many of the difficulties encountered in the production of the electric light, and has rendered its general use practicable. It has long been known that the carbon electric light is not due to a direct luminous effect of the electric current, but merely to the property which this current possesses of heating the conductors which it traverses, and that with the greater intensity the more resistance they oppose to its passage. The intensity of the ordinary electric light (with carbon points) arises from the circumstance that the stratum of air, a bad conductor, which is found between the two charcoal points, is heated to an excessive degree by the passage of the electric current, and thus produces indirectly the combustion of the coke or charcoal electrodes, heated to whiteness. It has also long been known that solid bodies may also be heated to whiteness without the presence of gaseous matter. Thus, slender platinum wires are intensely heated by the current. The light from this source is more fixed and constant than that of the luminous arc between the carbon points; but it is too feeble and too costly, whilst attempts to increase its intensity generally result in the fusion of the platinum. M. Ladyguine replaces the wire by slender rods of carbon (coke) hermetically sealed in a glass receiver, from which the oxygen has been removed.—*Chemical News.*

Electrolysis of Metallic Chlorides.—Professor Gladstone and A. Tribe (Physical Society).—If metallic copper be immersed in a solution of cupric chloride, insoluble cuprous chloride is formed upon it. The authors found that if a platinum strip be joined to one of copper, and the two immersed, the insoluble cuprous salt was also deposited upon the platinum. Attributing this result to the electrolysis of the cupric salt by a feeble current, they tried the effect of a zinc-platinum cell excited by common water and with platinum electrodes in the cupric chloride. Cuprous chloride appeared at the negative, and chlorine at the positive electrode. An ordinary Grove's cell also gave cuprous chloride for the first two or three minutes, but afterwards metallic copper. A zinc and a platinum plate were joined and immersed in the cupric chloride; cuprous chloride was deposited upon the platinum, the edges being also encrusted with metallic copper. With magnesium in place of the zinc, a larger proportion of copper was obtained. Mercuric and ferric chloride being analogous to cupric chloride, induced the authors to experiment with them also. Precisely analogous results were obtained, mercurous and ferrous chlorides being obtained at the negative electrode.

Electromotive Force at the Boundary Surface between a Metal and a Liquid.—H. Quincke (*Poggendorf Annales*).—When two mercury electrodes are immersed, unsimultaneously, in an indifferent conducting liquid (such as water, alcohol, glycerine, &c,); an electric current goes from the newly wet mercury surface, through the liquid to the mercury which has been longer immersed. Its strength decreases with increased resistance of the liquid column between the electrodes. The electro-motive force decreases with increasing concentration of the saline solution (where such is used); and is greater, the sooner the boundary surface between the mercury and the surrounding liquid is produced. The author considers that the current is caused by the change of molecular nature of liquid particles in the neighbourhood of the surface of contact; a change taking place gradually after immersion. Solid metals give like currents.—*English Mechanic.*

Crystallisation of Metals by Electricity.—P. Braham.—The author placed the positive and negative electrodes of a battery in a vessel containing a mixed solution of copper and zinc. With terminals of copper he obtained a dull crystallisation proceeding from the negative pole of mixed crystals of copper and zinc, and beyond this, crystals of copper alone. With terminals of zinc he got a mixture of crystals as before, and in front of these, crystals of zinc alone. But with terminals of brass (a compound of zinc and copper) a dull crystallisation of zinc across the field. He also observed that with zinc terminals, by increasing the battery power, the crystallisation is broken up; but not so when the terminals are copper or brass, for then the crystallisation extends above and beyond the positive pole. —*British Association.*

Zinc Electrodes.—A. Overbeck (*Poggendorf Annalen*). — Du Bois Reymond has shown that amalgamated zinc plates in solutions of zinc salts exhibit no phenomena of polarisation. Patry afterwards showed that the solutions must be neutral. The author has made some experiments on the subject, employing currents of gradually increasing strength, the result of which is to show that amalgamated zinc electrodes are not only unsusceptible to polarisation when the electrolysing current is weak, but that with a battery of five or six Grove's cells the zinc plates become polarised exactly as if they were platinum. M. Overbeck supposes that when the current is feeble the salt only is decomposed and not the water in which it is dissolved, but that with a more intense current the water itself suffers decomposition.—*Academy.*

Electric Conductivity of Solutions of the Chlorides of Alkalies and Alkaline Earth Metals.—Prof. Kohlrausch and O. Grotrian (*Poggendorf Annalen*).—The source of electricity employed was an induction apparatus, called by the authors a Sine-Inductor. A magnetised disc is rotated in a coil of wire with such velocity as to produce from 100 to 200 currents in alternate directions in a second. The object of employing a system of currents in alternate directions is to prevent the polarisation of the electrodes.

The authors have determined the

conductivities of aqueous solutions of nitric acid and of the chlorides of sodium, potassium, ammonium, lithium, magnesium, barium, strontium, and calcium. Three sets of experiments were made, as nearly as possible at the temperatures 0°, 18°, and 40° C. The conductivity of each substance was investigated at each of these temperatures, the strengths of the solutions varying from 5 per cent. of the anhydrous salt up to complete saturation. For a given percentage strength of the solution, it was found that the conductivity increased very rapidly with the temperature, the rate of increase being not quite uniform, but much more nearly so than might have been expected. For instance, the conductivity of potassium chloride (5 per cent. of salt) which is 421 at 0° C., becomes 931 at 40° C. : this increase is immensely great as compared with that of the electric resistance of a metal or the pressure of a gas. When the temperature remains constant, the conductivities increase continuously with the percentage strength of the solution. The chlorides of calcium and magnesium, however, are exceptions to this rule, the solution of $CaCl_2$ having a maximum conducting power when it contains 24 per cent. of salt, and that of $MgCl_2$ similarly when it contains 19·8 per cent. Nitric acid of maximum conducting power has a specific gravity 1·1945 (at 17° C.).—*Academy*.

Electric Conductivity of Carbon.—Mr. Bauermann (British Association).—A fragment of the substance to be tested is held with a strip of zinc bent in a **U**-form, and immersed in a solution of copper sulphate. In the case of a bad conductor a deposit of copper takes place solely on the surface of the zinc, but when a good conductor is employed a zinc-carbon couple is formed, and a deposit takes place on the surface of the carbon. The conducting power is greatest in coal which has been subjected to a great degree of heat, and the lowest temperature at which this change takes place appears, in the case of anthracite, to be between the melting points of zinc and silver. Such experiments appear to be specially important as giving a clue to the temperature at which anthracitic metamorphism has been effected by the intrusion of igneous rock. This mode of operating was originally devised by Dr. von Kobell.

Electric Conductivity of Glass, by Wildman Whitehouse (Physical Society).—The author employed pieces of thermometer tube about an inch in length, into the bore of which two platinum wires were inserted in such a manner that there was an interval between the points. In some cases one wire of platinum occupied the entire bore of the tube, and this tube was surrounded on its external surface by a helix of wire of the same metal. In each case the arrangement was introduced into a circuit in which were also placed a Thomson galvanometer and a set of resistance coils. It was shown that at the ordinary temperature there was no deflection, but that the current passed freely when the glass was heated to redness. The difficulty of making contact with the glass led the author to replace this arrangement by two test-tubes, one inside the other, both containing mercury, with which wires of platinum freely communicated. The flame of a Bunsen burner was applied to the outer test-tube and the temperature of the metal noted by the aid of a thermometer. In one series of experiments the diameter of the internal tube was $\frac{5}{8}$ inch, the length in contact with the mercury about $3\frac{3}{4}$ inches, and the thickness of the glass $\frac{1}{100}$th of an inch. A current was first observed to pass at 100° C., and, as the temperature rose, the amount of deflection increased. The following are approximate measurements of the resistance of the glass at different temperatures :—

Resistance.		Ohmads.
At 165° C.	=	229,500
„ 185	=	100,000
„ 210	=	69,000
„ 255	=	22,500
„ 270	=	9,000
„ 300	=	6,800

Electric Conductivity of Lead Salts.—E. Weidemann (*Poggendorf Ann.*) confirms the observation made by Buff in 1859 that the electric conductivity of chloride of lead increases with the temperature instead of diminishing, as is the case with metallic substances. He also finds that iodide and bromide of lead possess the same property. It appears, however, that their conductivity is not quite like that of a metal (as was stated by Buff), for at temperatures considerably below the fusing points of the lead compounds a certain amount of electrolysis takes place. This is shown by the production of a current when the battery is removed from the circuit and the terminals are connected with a galvanometer.

Electrical Resistance of Liquids.—W. J. Wilson.—Great difficulty has hitherto been experienced in measuring the resistance of electrolytes on account of the polarisation of the electrodes, and most of the methods hitherto employed have aimed at reducing this to a minimum by using large electrodes and very weak or rapidly alternating currents. The determinations, however, are difficult and require to be quickly performed. The following method is easy and is free from both the above objections. The arrangement in its most simple form consists of a long narrow trough filled with the liquid to be measured, say dilute acid. A porous pot containing a zinc plate in sulphate of zinc being placed in the acid at one end of the trough, and a similar pot with a copper plate in sulphate of copper in the acid at the other end, the whole arrangement forms a sort of elongated Daniell's cell, the chief resistance of which is in the long column of acid. The circuit between the plates being completed through a resistance box and mirror galvanometer, the current is shunted until a suitable deflection is obtained. One of the porous pots is now moved along the trough towards the other, and, as the resistance of the circuit is thus reduced by shortening the column of acid, the galvanometer deflection largely increases. The external resistance is now increased by means of the box, until the deflection is reduced to the same point as at first. This resistance put into the circuit is evidently equal to that of the liquid taken out, and thus a measure of the liquid resistance is obtained. Two forms of apparatus are used. In one, the vessels containing sulphate of zinc and sulphate of copper respectively, form pistons in a glass tube which contains the liquid to be examined. In the other, two pairs of concentric vessels are connected by a bent glass tube which contains the liquid under examination. The method is applicable to a great variety of liquids, and with care almost any degree of accuracy may be obtained. The chief obstacle to exact measurements lies in the fact that the resistance of liquids is greatly affected by temperature, but this difficulty is, of course, common to all methods.—*Physical Society.*

Electrical Resistance of Metals.—René Benoit (*Arch de Sciences, Bibl. Univ. de Genève*).—The author has studied the variation of conducting powers within very extended limits of temperature, varying, indeed, from 100° to 860° C. The increase of resistance is proved to follow a regular course, which continues—certainly for lead, zinc, and tin, and probably for all the metals—up to their melting points. The less elevated the fusing-point of a metal, the more rapidly does its conductivity diminish—iron and steel forming, however, an exception to this law. In metals in which the resistance is the greatest, its increase, under the influence of heat, is relatively the most rapid. The differences of compositions, in alloys, which alter considerably the absolute resistance, have but slight influence on the relative value of its augmentation by increase of temperature.

Immunity of the Torpedo from the Effects of its own Shock.—Herr Steiner (*Archiv. für Anat. du. Phys.*)—It is difficult to see why the current generated in the electric organs of this fish should not be propagated through its own nerves and muscles as readily as through any other conductor. The first set of experiments was made on torpedoes removed from the water. It was found that although no sensible shock was communicated to the finger when in contact with any part of the surface except that immediately over the electrical organs, yet a rheoscopic frog would twitch with every discharge, even when lying on the tail of the torpedo. On substituting a small living torpedo for the frog, its tail, or even its whole body, might be seen to twitch whenever a shock was drawn from the larger fish. Lastly, careful observation proved that the muscles of the discharging torpedo itself contracted simultaneously with each shock; the contraction was not very vigorous, and was less marked in proportion to the distance of the muscle from the electrical apparatus. These experiments were repeated on torpedoes while still submerged in their tank, and yielded exactly the same results. Living torpedoes were next subjected to a current from several Bunsen cells. The copper terminals of the battery were made to dip into opposite corners of the tank, and the circuit closed when the fish assumed a position between them. For purposes of comparison, frogs and a species of mullet were exposed to the same currents. It was found that as the latter increased in intensity, the frog was the first to exhibit muscular twitching, the mullet next, and the torpedo last, showing that the torpedo is less sensitive to electrical stimulation than either of the animals compared with it.—*Academy*.

Coke-Manganese Galvanic Cell.—Sergius Kern, St. Petersburg.—My cell is a modification of Leclanché's, and the experiments prove it to act very constantly.

Two parts of cleanly washed coke, and one part of manganese dioxide (MnO_2) in the state of powder, are well mixed together with a small quantity of water acidulated with some drops of nitric acid; the mixture is then strongly pressed into brown paper cartridges 0·125 metre high and 0·03 metre diameter. The resulting coke-manganese cylinders are dried in a warm place, but not over a fire, because the heat, as it is known, decomposes the manganese dioxide.

The dried cylinders are placed in glass jars containing concentrated solution of ammonium chloride (NH_3HCl), and surrounded with zinc-plates curved in the usual manner. By this arrangement the use of porous cells is avoided, and a battery of such elements acts more constantly; besides this, the construction of it is cheaper. Instead of having glass jars, I am using wooden boxes, the size of the glass jars; the internal parts of the boxes are covered with the following mixture, melted in an iron cup:—2 parts of wax, 10 parts of common resin (colophony), 2 parts of red-lead and $\frac{1}{8}$ part of gypsum.

The zinc of the element is the

negative pole; the coke, the positive pole. The reactions which take place in this element may be represented by the following equations:—

$$2NH_3HCl + 2Zn = 2ZnCl_2 + 2NH_3 + H_2;$$

$$H_2 + MnO_2 = MnO + H_2O.$$

—*Chemical News.*

Cheap Constant Battery.—A three-necked jar is used as a cell. In one of the side necks, a carbon plate is inserted, the other being occupied by a slab of zinc, amalgamated and covered with cotton. Pieces of coke and peroxide of manganese are inserted through the centre neck till the jar is about two-thirds full, when a concentrated solution of sal-ammoniac is poured in, and a flask containing some of the solution attached to the neck in such a way as to supply loss from evaporation. This cell is made in Stuttgart, but of course it is only the special form of the jar that is in any way novel.—*English Mechanic.*

Chromic Acid Battery, devised by Professor Bunsen of Heidelberg.—The battery is the charcoal-zinc battery without clay cells. The exciting liquid is a mixture of bichromate of potash and sulphuric acid. In order to prepare 10 litres of this liquid, Professor Bunsen gives the following instructions:—0·765 kilogrammes of commercial powdered bichromate of potash are mixed with 0·832 litres of sulphuric acid in a stone jar while the mass is being constantly stirred; when the salt is changed to sulphate of potash and chromic acid, 9·2 litres of water are added, the stirring being kept up and the water allowed to flow from a spout about ¼ inch wide; the crystal meal, which already is very warm, becomes warmer and warmer and eventually dissolves completely. The exciters for this liquid are: a rod of the *densest* gas coal, 4 cm. broad, 1·3 cm. thick, and immersed 12 cm. deep into the liquid, and a rolled plate of zinc 4 cm. broad, 0·5 cm. thick, and immersed to the same depth as the coal; the zinc plate is entirely coated with a layer of wax (which is put on whilst hot), except that plane which is turned towards the coal and which is amalgamated. The distance between coal and zinc is entirely optional: in the researches of Professor Bunsen it varied according to circumstances between 3 and 10 millimetres. This battery, as compared to Grove's battery, requires cells of at least three to four times more capacity. The best shape for these cells is that of narrow, high cylinders. The column of liquid, of about 1·6 litres, has a diameter of about 0·088 metres, and stands 0·28 metres high in the cylinder, which bears a mark at that height. The zinc-coal pair is only immersed up to half its height into the liquid column, and has an active zinc surface of about forty-eight square cm.

With regard to the constants of this chromic acid battery without clay cells, it considerably surpasses in electro-motive force all other apparatus with clay cells hitherto used. It possesses an electro-motive force which is about 13 per cent. larger than the ordinary charcoal-zinc or Grove battery. Its essential conduction resistance is about 12 per cent. smaller than that of Grove's battery with clay cells. As the consumption of zinc goes on whether the circuit is complete or not, it is indispensable to arrange the cells in such a manner as at every interruption of the current to bring the plates out of contact with the liquid. This is attained by a simple hand lever arrangement by which the plates can be dipped into or raised out of the liquid.

Prof. Bunsen possesses a battery of this kind, of forty pairs, with an active zinc surface on each plate of only forty square cm. For the last eight lecture-terms (more than four years) it has served for all experiments without its having been necessary during this long time to renew the zinc plates, or their coatings of wax, or the original exciting liquid, nor to clean the conducting connection parts; it has been merely necessary to renew now and then the amalgamation of the zinc plates (an operation which only takes a few minutes of time), and to replace that part of the liquid which was lost by evaporation in the air, by simply filling the cylinders with water up to the marks on their sides. The apparatus still gives an electric arc between carbon points which amply suffices for the photo-chemical lecture experiments. The currents are powerful enough for demonstrations in electrolysis, spark spectra, decomposition of gases by induction sparks, &c., and will doubtless continue to suffice for all these purposes for some time to come. But we must again repeat that effects of such magnitude can only be expected if the precaution is used (and it is very easy to do so) not to leave the pairs in contact with the liquid for one moment longer than the duration of the current necessary for the experiments requires it.—*Nature.*

De la Rue's Constant Battery (Royal Society).—Each cell is formed of a glass tube 6 inches long and $\frac{3}{4}$ of an inch internal diameter; these are closed with a vulcanised rubber stopper, perforated excentrically to permit the insertion of a zinc rod, carefully amalgamated, $\frac{3}{16}$ of an inch in diameter and 4·5 inches long. The other element consists of a flattened silver wire passing by the side of the cork to the bottom of the tube, and covered, at the upper part above the chloride of silver and until it passes the stopper, with thin sheet of gutta-percha for insulation, and to protect it from the action of the sulphur in the vulcanised corks; these wires are $\frac{1}{16}$ of an inch broad, and 8 inches long. In the bottom of the tube is placed 225·25 grains chloride of silver in powder; this constitutes the electrolyte; above the chloride of silver is poured a solution of common salt containing 1,752 grains to 1 gallon of water, to within about 1 inch of the cork. The connection between adjoining cells is made by passing a short piece of indiarubber tube over the zinc rod of one cell, and drawing the silver wire of the next cell through it so as to press against the zinc. The closing of the cells by means of a cork prevents the evaporation of water, and not only avoids this serious inconvenience, but also contributes to the effectiveness of the insulation. The tubes are grouped in twenties in a sort of test-tube rack, having four short ebonite feet, and the whole of the cells (1080 in number) placed in a cabinet 2 feet 7 inches high, 2 feet 7 inches wide, and 2 feet 7 inches deep; the top being covered with ebonite to facilitate working with the apparatus, which is thus placed on it in an insulated table.

The electro-motive force of this battery, as compared with a Daniell's (gravity) battery, was found to be as 1·03 to 1,1 (compared with a Daniell's battery, in which the zinc is immersed in dilute sulphuric acid in a porous cell, its electro-motive force is about 3 per cent. less than the Daniell), its internal resistance 70 ohms per cell, and it evolved 0·0131 cubic inches mixed gas per minute when passed through a mixture of 1 volume of sulphuric acid and 8 volumes of water in a voltameter having a resistance of 11 ohms. The striking distance of 1,080 elements between copper wire terminals, one turned to a point, the other to a flat surface, in air, is $\frac{1}{263}$ inch to $\frac{1}{250}$ inch. The greatest distance through which the battery-current would pass continuously *in vacuo* was 12 inches between the terminals in a carbonic acid residual vacuum. This battery has been working since the early part of November, 1874, with practically a constant electromotive force.

Besides 2,000 more cells like those just described, Dr. De la Rue and Dr. Spottiswoode are putting together 2,000 cells with the chloride of silver in the form of rods, which are cast on the flattened silver wires, as in a battery described by De la Rue and Müller, but in other respects similar to the battery above described; the glass tubes being, however, somewhat larger in diameter; the rods of chloride of silver are enclosed in tubes open at the top and bottom, and formed of vegetable parchment, the object of these vegetable parchment cases being to prevent contact between the zinc and chloride-of-silver rods. The internal resistance of batteries so constructed is only from 2 to 3 ohms per cell, according to the distance of the zinc and chloride-of-silver rods, and they evolve from 0·18 to 0·27 cubic inch per minute, in a voltameter having a resistance of 11 ohms. Their action is remarkably constant. These batteries are being used in researches to discover the cause of stratification of electrical discharges *in vacuo*.—*Royal Society.*

Cause of Stratification of the Electric Discharge in vacuo.—Dr. De la Rue, Dr. Spottiswoode, and Dr. Hugo Müller.—When the terminals of the battery above described are connected with the wires of a vacuum-tube which permits of the passage of the current, the wires (especially the one connected with the zinc end) become surrounded with a soft nebulous light, in which several concentric layers of different degrees of brilliancy are seen. In most cases there is no stratification or even tendency to stratification; the tubes selected for these experiments were those in which the stratification did not appear at all.

When the battery, already in connection with the vacuum-tube, was also joined on to one or more coil condensers (coupled to introduce a greater length of wire) in such a manner that the wires represented the opposite coatings of a Leyden jar, the terminals of the coil condensers being left free, then immediately well-defined stratifications appeared in the vacuum-tube.

The coil forming a sort of Leyden jar when thus used, it is clear that an interval, however short it may be, must elapse in accumulating a charge which at intervals discharges itself and causes a great flow in the vacuum-tube in addition to that which passes continuously. (It may be stated that the capacity of the accumulator has to be carefully adjusted to avoid a snapping discharge at distant intervals.) The periodic overflows, so to speak, which increase the current from time to time, would seem to have a tendency to cause an interference of the current waves, and to produce nodes of greater resistance in the medium, as evinced by the stratification which becomes apparent.

At times the terminals of the battery were placed in connection with accumulators of different kinds—for instance, two spheres of 18 inches in diameter, presenting each a superficies of 7·07 square feet, and cylinders of paper covered with tinfoil, each having a surface of 16 square feet; the globe and cylinders were in all cases carefully insulated. Other accumulators were composed of coils of two copper wires $\frac{1}{16}$ of an inch in diameter, covered with gutta-percha, in two folds, $\frac{1}{30}$ of an inch thick.

In addition to these accumulators, others were used of various capacities, from five to several hundred square feet, formed of alternate plates of tinfoil and insulating material, such as paper saturated with paraffin, and also sheets of vulcanite.—*Royal Society*.

Unipolar Conduction of Electricity through gas layers of different conductivity.—M. Braun, states that when two metallically connected wires are placed in the glowing gas mixture of a flame, a "flame current" is produced, which is the algebraic sum of two others—viz., a "thermo current," caused by the different temperatures of the wires, and a "contact current," due to difference in the surrounding gases of the electrodes. Where the latter is greatly exalted a current whose electro-motive force does not exceed that of the flame-current has always less resistance in the direction against the contact current (and mostly also against the flame current), than with it.—*English Mechanic*.

Clamond's Thermo-Electric Battery.—Count du Moncel.—In this battery the electro-positive element is of iron, and the negative element an alloy of antimony and zinc. The elements are connected circularly to increase the intensity, forming crowns, which are isolated from each other by plates of amianthus. The polar extremities of the crowns are placed in connection with a commutator, so contrived as to enable them to be grouped either for intensity or for quantity. The apparatus has been employed for six months at the galvano-plastic works of M. Goupil at Asnières. The gas consumed costs two francs per kilo. (2·2lbs.) of copper deposited. The battery is used also in the Bank of France for galvano-plastic operations. In London this battery is in use at many of the telegraph stations.

Gramme's Magneto-Electric Machine.—By the use of Janin's thin plate magnets the power of this machine is greatly increased. Sixteen inches of platinum wire can be heated to redness, whereas the original machine only ignited four inches.

The foundry of MM. Hertmann-Ducommun and Steinlen, of Mulhouse, is now lighted by means of this machine. Four magneto-electric machines supply four electric lamps, placed so as to distribute the light over a space 60m. long by 30m. broad. The lights are inclosed in globes of roughened glass. Each machine requires 57 kilogrammetres of motor force. The carbons of the lamps are replaced every three hours. There is a fifth lamp, which works continuously throughout the night. The expense of the four lamps, apart from motor force, is about 1f. an hour. During the two months the apparatus has been used, no mishap has occurred. The magneto-electric machines cost 1500f. each. The entire construction, comprising four machines and five lamps, cost 8000f. M. Gramme has made numerous attempts with a single machine supplying several lamps, but finds that it is impossible to subdivide the electric light economically.—*English Mechanic*.

New Form of Magneto-Electric Machine.—S. C. Tisley stated that the new apparatus consists essentially of an electro-magnet with shoes forming a groove, in which a Siemens' armature is made to revolve. It differs from the original machines made by Siemens and Wheatstone in the commutator, as two springs conduct the current from the cylindrical insulator, to which are attached three pieces of metal, one surrounding it for three-quarters of its circumference, the second for one quarter, and between these is a third ring insulated and connected with the insulated end of the wire from the armature, and bearing two pieces of metal which are so arranged as to complete the circles of the outer pieces of metal. By this means the currents produced are alternately used for augmenting the magnetism, and for the external work required. The armature is so constructed that a stream of water may be constantly passed through it.

A small machine constructed on this principle which, without its driving gear, weighs 26lbs., is capable of raising 8 inches of platinum wire and 0·005 inch in diameter to a red heat.—*Physical Society.*

Electrolytes under Magneto-Electric Induction.—J. A. Fleming (British Association).—When a solid conductor is moved in a magnetic field induced currents are created in it. In a solid these expend themselves partly or wholly in producing heat in the conductor. The author states that when electrolytes are made to flow or move in a magnetic field, induced currents are produced, and the electrolyte is to some extent decomposed by these currents.

On Electro-Magnetism.—A. Trève.—Referring to the discovery of De la Rive, that if in Ruhmkorff's great electro-magnet the current is closed between the two poles there is neither spark nor sound, but on opening it there is a detonation almost like a pistol shot, the author states that the phenomenon announced by De la Rive is equally produced in the sphere of attraction of either pole; that it is not inherent in an inductor current alone, but that the current of any independent battery, interrupted in this sphere of attraction, gives rise to the same effects, and that the extra current augments the tension really and considerably.—*Chemical News.*

Electro-Magnet with Concentric Tubes.—M. Camacho.—The principle of the apparatus is that of tubular magnets. A central iron tube is surrounded with a helix of copper wire furnished with an insulating coating. Around it is another iron tube with its helix, and then a third, likewise with a helix. The effect is said by the author to be beyond all comparison greater than that of any previously devised arrangement.—*Chemical News.*

Magnets Formed of Iron Filings under Pressure.—J. Jamin has repeated recently an experiment published by De Haldat in 1836. A brass tube with screw stoppers was filled with iron filings, and magnetised by ordinary means; he then found that the apparatus had acquired at its extremities two contrary poles. The polarity did not augment when the stoppers were tightened, but diminished slowly when increasing quantities of sand were mixed with the filings. In all cases the polarity was feeble, and disappeared on shaking the tube. The author has repeated the observation, compressing the filings strongly by means of a small hydraulic press, and finds that the polarity increased with the pressure. Filings were prepared from very soft iron, perfectly reduced, and free from coercitive force. The results did not diminish. Here, therefore, is a metal which has no coercitive force when it is continuous, but which acquires a force as considerable as that of steel if reduced to discontinuous fragments, and aggregated by pressure. Is it not to this discontinuity that the force observed must be ascribed, and is it not this same cause which explains the coercitive force of steel? If the filings before pressure are mixed with matters which render the mass more homogeneous, the same degree of polarity is no longer produced. For instance, on making a paste of chloride of iron and iron filings, and pressing it after some days a mass of subchloride of iron is obtained, which may be filed and polished like pure iron, but which refuses to become magnetic to any perceptible extent.—*Comptes Rendus.*

Magnetisation of Steel Bars.—J. Jamin.—(*Comptes Rendus*).—A great number of plates, after being separately magnetised to saturation, are placed together. The magnetism of the combination is found to increase up to a limit which cannot be passed, and which is reached when the polar surfaces are filled. Suppose that ten plates are required. If now the same experiment is recommenced, applying the same plates against two iron armatures with large surfaces, the intensities will increase much more slowly, because the sum of the magnetism is diffused over a more considerable extent, and the limit will not be reached till this extent is full. For this it may be needful to superpose 20, 30, or 40 plates, and, generally speaking, a number so much the greater as the armatures are larger. The total power of the magnet, therefore, increases with its armatures.

Magnetisation of Iron Bars. —J. M. Gaugain.—The author states that if the angle] formed by the magnet and the bar is made to vary from zero to 180° the magnetisation increases with the size of the angle. This law, however, does not hold good when the angle formed by the magnet and the bar exceeds 90°. It then decreases till a certain limit has been passed, which, in the author's experiments, was near 120°. —*Comptes Rendus.*

Construction of Magnets by Electrolysis. — W. Beetz. — He finds that iron precipitated from a solution of iron containing sal-ammoniac is, in a very eminent degree, capable of permanent magnetism; but that when precipitated from other solutions, iron is only in a slight degree magnetic. If the precipitate is obtained under the influence of powerful magnetism, strong magnets of homogeneous structure are formed from solutions containing sal-ammoniac. On the other hand, solutions of sal-ammoniac yield magnets containing an irregular structure, in consequence of which the feeble magnetism of the precipitate is rendered still weaker. —*English Mechanic.*

Magnetisation by Steam.— Donato Tommasi (*Comptes Rendus*). —If a current of steam at a pressure of 5 to 6 atmospheres is passed through a copper tube of 2 to 3 m.m. in diameter, and coiled spirally around an iron cylinder, the latter is magnetised so effectually that an iron needle, placed at the distance of some centimetres from the steam magnet, is strongly attracted, and remains magnetic as long as the steam is allowed to pass through the copper tube.

Measurement of Magnetic Moments.—E. Bouty (*Academy*). —Upon a rigid support of sealing wax, moveable about a vertical axis, is fixed (1) a horizontal needle, the magnetic moment (M) of which is known, and (2) at right angles to the needle (M) and a little above it, a small glass tube into which is introduced the needle whose magnetic moment (x) it is desired to determine. The system thus formed takes, under the influence of the earth's magnetism, a determinate position of equilibrium, such that the magnetic axis of the needle (M) makes with the plane of the magnetic meridian an angle a determined by the equation $x = M \tan. a$. A mirror being attached to the support which carries the needles, the angle a is read off by means of a telescope with a scale placed horizontally immediately below its object glass. With this apparatus the author was able to effect measurements relative to needles 2 millims in length and 0·2 millims in diameter.

With regard to the breaking of long needles magnetised to saturation, Professor Bouty found that the fact of breaking had no influence on the magnetic moments of the broken halves, provided the original needle was tempered hard, so as to break between the fingers like glass. If, however, the steel was tempered soft, so as to bend several times before breaking, the two halves possessed unequal magnetic moments, the difference being due to the flexions which preceded the fracture.

Depth and Superposition of Magnetic Layers in Steel.—J. Jamin (*Comptes Rendus*).—A steel rod was introduced into a steel tube, and the system magnetised in a helix, through which passed a galvanic current of gradually increasing strength. So long as the current was feeble it acted only on the tube, leaving the core in its natural state. When the current attained a certain strength magnetism began to be imparted to the steel core, and increased in intensity with the current strength, until it finally became what it would have been had the tube been absent. It thus appears that the magnetism penetrates to a limited depth, which increases with the strength of the magnetising current.

In another experiment the steel core was magnetised to saturation before insertion in the tube, and the combination magnetised in the opposite direction by a current of gradually increasing strength. So long as the current was feeble the original magnetism of the core was preserved; after a time, however, it was enfeebled and finally reversed. During this process a point is reached when the combination of tube and core does not appear to possess any magnetism; but on separating the two parts of the system they are found to be oppositely magnetised. Neutrality is produced by their superposition.

If a steel lamina which has been magnetised be put into dilute sulphuric acid, and withdrawn every half-hour in order to measure its thickness and the magnetism which it has retained, it is found that the latter diminishes, as of course it should, for the acid in dissolving the metal dissolves also the magnetism which it contained. If the lamina were uniformly magnetised throughout its mass, the ratio of the quantity of magnetisation to the thickness would remain constant; but it is not so. It is found that the magnetism diminishes to zero. It follows that the intensity of the magnetic layer on the two faces of the lamina decreases from the surface where it is a maximum, to a certain depth where it is zero.

The magnetic strata are limited to a certain thickness, which they can never exceed. This limit varies in different steels. It is very great in those which are soft, and diminishes as the proportion of carbon augments and as the temper is harder. These latter only receive what may be called a superficial magnetic coating, the thickness of which it is not possible to augment by increasing the intensity of the current. But if the depth of the magnetisation diminishes along with the magnetic conductibility, the intensity of the magnetism increases. It follows that the quantity of magnetisation is subject to two causes of inverse variation—the depth which increases, and the intensity which lessens as the conductivity increases.

Dual Magnetic Polarity.—J. Jamin (*Comptes Rendus*).—In the year 1607 Galileo wrote to a friend about a wonderful magnetic stone, one property of which was that the same pole would both attract and repel the same piece of iron. At a distance of four or five finger-lengths it attracted the iron, but at a distance of one finger-length it repelled it. He found, on examination, that the piece of iron was magnetised steel. The author magnetises a bar to saturation with a current producing (say) S magnetism. Then with an inverse current he communicates a certain amount of N magnetism, less than the S, and leaving some of it in the deeper parts. Then he dissolves the steel with acid, which gradually removes the N layers, and ere long discloses the S. Now the latter are not disclosed equally all over, they make their first appearance at the extremity, on the edges and corners, the boreal layers still occuping most of the surface; and (in contrariety to the latter), they have great tension, but small magnetic moment. Suppose, now, the S pole of a magnet to be approached. While it is still distant, it is subject to the predominating effect of the N layers of the bar, and is attracted. But when what may be called the NS pole is brought quite near, the S points gain the predominance and there is repulsion.

Distribution of Magnetism in Iron Bars.—Professor H. A. Rowland (British Association).—The author tests this phenomenon by laying on the surface of the bar a small helix connected with a galvanometer, and suddenly removing it to a distance, at the same time observing the throw of the needle thereby produced. As the helix in this motion crosses all the lines of magnetic force which spring from the area covered by it, this throw is proportional to the number of these lines of force, that is, to the surface-density of the magnetism. Another method which he employs is to put a small coil of wire round the magnet and gradually move it along the whole length of the bar, the coil being connected with a galvanometer.

Position of the Poles of a Magnet.—C. G. Müller (*Poggendorf Annalen*).—The magnet, which must be of small diameter, is attached to two pieces of cork, so as to be perfectly horizontal and place itself in the magnetic meridian when floated in water. A fine-pointed iron wire is then approached vertically from above over one of the ends of the needles, which moves until the resultant of all the acting magnetic forces coincides with the direction of the iron wire. If now the wire be cautiously depressed, it will touch the needle at the point of maximum attraction, *i. e.* at the pole. M. Müller's experiments show that for such magnetic needles, of given length, the poles approach the extremities as the thickness diminishes; that for needles of constant diameter, but varying length, the poles are nearer the extremities as the needle is shorter, but that the ratio of the distance of a pole from the extremity of the length of the needle is not constant.

Effect of Armatures on Magnets.—J. Jamin (*Comptes Rendus*).—The author employs magnets, the thickness and width of which are equal respectively to 10 and 50 millimetres, but whose lengths vary. The armatures are of the same width and thickness; they are adjusted as accurately as possible, and secured by pressure on the extremities of the magnet which they prolong.

If a single armature is placed at the northern end of a magnet, it in no wise modifies the magnetic condition of the southern end, which remains bare. In like manner on the application of an armature it takes magnetism which the steel loses, but this new distribution is no wise modified by putting an armature on or by removing one from the north side.

Hence, as regards armatures, there is an absolute independence between the two halves of the magnet. This independence proves that the application of an armature to one of the ends of the magnet occasions a new distribution there, but neither decreases nor augments the sum total of the magnetism present: the steel loses what the armature gains.—*Chemical News.*

The Effects of Stress upon the Magnetism of Soft Iron.—Sir William Thomson (British Association).—In the physical laboratory at Glasgow University the author had steel and soft iron wire stretched about twenty feet long from the roof. An electro-magnetic helix was placed round a few inches of the wire, so that the latter could be magnetised when an electric current was passed through the former; the induced current thus produced in a second helix outside the first being indicated by a reflecting galvanometer. When steel wire was used, the magnetism diminished when weights were attached to the wire, and increased when they were taken off; but with specially made soft iron wire (wire almost as soft as lead), the magnetism was increased when weights were put on, and diminished when they were taken off. The author afterwards discarded the electrical apparatus, and found that by suspending a piece of soft iron wire near a magnetometer (consisting of a needle, a small fraction of a grain in weight, with a reflecting mirror attached), the wire was magnetised inductively simply by the magnetism of the earth, and that changes in the amount of its magnetism took place on applying weights and strains, these changes being indicated by the magnetometer.

Effects of Heat on Magnets. When the heat applied to a steel magnet is moderate—when, *e.g.*, it does not exceed that of boiling water—part of the magnetism which had disappeared on the increase of temperature reappears when the original temperature is restored. It follows from this that heat produces two effects, which (in the present state of our knowledge) must be considered as distinct.

Like mechanical action, it permanently destroys a portion of the existing magnetism by enabling the two magnetisms which had been separated in each molecule to recombine. And, on the other hand, it renders latent, or neutralises, another portion of the same magnetism, which portion reappears again when the temperature is reduced to its original state.

This two-fold operation of heat, although fully recognised as a fact, has not been sufficiently considered in reference to the cause. There seems reason to believe that the two effects, so dissimilar in their conditions, are, in fact, referable to distinct causes; and that while the permanent loss of magnetism is a dynamical effect due to the molecular movement in which heat is known to consist, the recoverable portion is probably to be ascribed to the dilatation of the body and to the diminution of the reciprocal action of the magnetic elements consequent upon their increased distance.—*Treatise on Magnetism*, by H. Lloyd, D.D., D.C.L., Provost of Trinity College, Dublin.

Magnetic Rotatory Polarisation.—M. H. Becquerel.—It has long been noticed that strongly refractive bodies have generally also a great magnetic rotatory power. H. Becquerel finds that many bodies present a regular increase of rotation as the index of refraction augments. The exceptions may be attributed either to the effects of lamellar polarisation, as in the diamond and garnet; or to the presence of magnetic bodies; or to some unknown causes.—*Comptes Rendus*.

Magnetism of Railways.—M. Heyl says: I have observed that all the rails are transformed at their extremities, after they have been placed in position a few days, into powerful magnets, capable of attracting and of retaining a key or even a heavier piece of metallic iron. These rails preserve their magnetism even after they have been removed, but lose it gradually. When in position, however, the magnetism is latent, only becoming free when the chairs are removed and disappearing again when they are replaced. Hence it is necessary to assume that two opposite poles come together at each junction, and that each rail is a magnet, the poles being alternately reversed throughout the line. This production of magnetism in the rails examined, is undoubtedly attributable to the running of the trains and to the shocks, frictions, &c., thereby produced. The hypothesis of electric currents, induced or direct, is negatived by experiments made with suitable apparatus. It is possible that the magnetic currents are stronger at the moment of the passage of the trains than either before or after.

Magneto-Chemical Phenomena Produced in Rarefied Gases in Geissler's Tubes Illuminated by means of Induction Currents.—J. Chautard (*Comptes Rendus*).—In all the simple bodies of the chlorine group, and in all their derivative compounds, gaseous or volatile, which have been examined, the action of the magnet is instantaneous, and is shown—not merely by a change in the tint of the tube—but, above all, by a more complete illumination of the rays which display a wonderful brilliancy, and are sometimes split up. The substances examined, besides chlorine, bromine, and iodine, are the chloride, bromide, and fluoride of silicium, the fluoride of boron, hydrochloric acid, antimony chloride, bismuth chloride, mercurous chloride, and stannous and stannic chlorides. The lights of sulphur and of selenium are completely extinguished the moment when the magnet is set in action, and it is the same with that of tubes of chlorine, bromine, and iodine if the strength of the coil is sufficient. The lustre of the light of oxygen, always pale, undergoes no very sensible change. It is the same with the compounds of carbon, such as carbonic acid and oxide, proto- and bi-carbide of hydrogen. The fine bands of the nitrogen spectrum are merely modified in the red and orange portion. The bands of the more refrangible portion remain unaltered. The rays of hydrogen preserve the same appearance; yet, on employing an electro-magnet of sufficient strength, we see appear at the moment when it is set in action a very brilliant yellow ray, which is merely that of sodium derived from the glass. This ray vanishes as soon as the circuit is broken, and reappears if the magnetisation is resumed. Proto-chloride of tin, dry and crystalline, but bihydrated, presents a most remarkable phenomenon of dissociation under the influence of the magnet. In its normal state the spectrum is pale, and presents some of the green rays of chlorine; but as the magnet is set in action we see two of the characteristic rays of hydrogen, the red and the blue, which remain as long as the magnetisation lasts, and disappears when it ceases.

A Geissler tube with a straight constricted portion is placed between the poles of a magnet, at a short distance from the slit of a spectroscope, and a micrometer is arranged, so adjusted to the Fraunhofer lines as to allow the wave lengths of the different colours to be read off with facility. A second spectrum of the gas employed, in a tube not affected by the magnet, is also brought into the field for comparison. The electric discharge is produced either with a coil or a Holtz machine.—*Academy. Comptes Rendus, Chemical News.*

On Magnetism.—M. J. M. Gaugain. — M. Elias (*Poggendorf Annalen*) refers to a process of magnetisation which consists in heating a bar of iron to redness, suspending it from a pole of an electro-magnet, and letting it cool in that position. "This method," he continues, "as everyone knows, is without results." The author has tried this process, and considers that in certain cases it proves successful.

Magnetic Ferric Oxide from Meteoric Iron. — L. Smith, (*Comptes Rendus*).—Hydrated artificial sesquioxide of iron, dried at a high temperature, is slightly attracted by the magnet, but loses this property if heated to redness or beyond. Sesquioxide of iron, prepared in the ordinary manner from a solution of meteoric iron, and dried at a low temperature, behaves like ordinary oxide, with this difference — that it becomes decidedly magnetic on being heated from 400° C. to redness. Sesquioxide of ordinary iron, mixed with nickel or cobalt, or with both, manifests magnetic properties identical with those of ordinary iron. Sesquioxide of iron prepared from meteoric iron, entirely free from traces of nickel or cobalt, behaves with the magnet like the ordinary sesquioxide. Sesquioxide produced from a solution of oxide mixed with copper, behaves like oxide prepared from meteoric iron. Sesquioxide of iron, mixed with manganese, gold, platinum, zinc, or cadmium, does not differ in its magnetic reactions from pure iron.

Auroral and Magnetic Phenomena of Nova Zembla. — Herr Weyprecht, the leader of the Austro-Hungarian Polar expedition, says, no pen or pencil can give any idea of the beauty of the northern lights at their greatest intensity. In February, 1874, the auroral discharge made a broad powerful stream of fire from west to east across the zenith, varied by continuous and intense swift-moving waves of rainbow-coloured light from one side of the horizon to the other. The lights also danced up from the southern horizon to the magnetic pole, making altogether the most splendid firework nature could display. Three kinds of aurora were noticed: one a quiet regular arch, stretching upwards from the southern horizon over the zenith, and growing pale on the northern horizon. Another, consisting of more distant light bands continually changing their position and shape, and composed either of distinct rays, or different light; and, lastly, the appearance of a corona, with rays streaming from, or towards, the magnetic pole. This is usually white with a slight tinge of green, and in cases of great intensity and motion, rays of prismatic colours, often very bright, shoot forth. Strong flaming exhibitions were usually followed by storms.

Magnetic disturbances were closely associated with the phenomena. These have still to be reduced; the principal results of 3000 readings of magnetic instruments were as follows: — Magnetic storms are of extraordinary magnitude and frequency in that region. They stand in the closest relation to the auroral discharges, and the disturbances are greater as the motions of the light streams become more lively, and the prismatic colours become more intense. Quiet regular arches, or ray motions, have scarcely any action upon the needle. In all disturbances the declination needle moved towards the east.—*Academy.*

Magnetic dust in the Atmosphere.—A. E. Nordenskiöld (*Poggendorff Annalen*).—The author has found in the snow which falls around Stockholm, metallic particles which are attracted by the magnet, and give the reactions of iron. Snow from the icebergs near Parry's Island, in 80° N. L., was found to contain similar particles. Analogous particles were detected in hailstones at Stockholm. These and other observations now establish the fact of the existence in the atmosphere of a dust containing iron, nickel, cobalt, phosphoric acid, and carbon. May not this have some relation with the shooting star-showers, auroræ, &c.?

J. H. Groneman advances the theory that the aurora borealis may be due to meteoric fragments and dust circulating around the sun, which, on entering our atmosphere become incandescent by friction, and appear either as shooting-stars or as an aurora. This cosmical matter being composed, according to the author's view, for the most part of magnetic substances, such as iron and nickel, when it approaches the earth is brought under the influence of terrestrial magnetism, and takes the direction of magnetic lines representing the rays of the aurora. The auroral bands occasionally observed perpendicular to the meridian, he supposes to result from cosmical particles composed of diamagnetic matter.

Magnetic Alloy of Platinum.—Certain specimens of native platinum containing iron not only act on the magnetic needle, but exhibit decided polarity. M. Daubrée has found that by fusing platinum with iron in various proportions, alloys are obtained which behave exactly like the native Eisenplatin. One of these artificially-formed alloys, which exhibited strong magnetic polarity, contained 83·05 per cent. of platinum, and 16·87 of iron.

Electro-Capillary Actions.—M. Becquerel (*Comptes Rendus*) observes that among the physico-chemical forces influencing organic functions, the electro - capillary forces are the most important, and that in order to produce them nothing more is required than permeable tissues separating two liquids of different natures, which find in the organism the conditions necessary for their production. Arterial blood leaving the left auricle of the heart, before becoming venous blood, traverses capillary vessels which bring it in contact with muscles covered with exuded liquids. Electro-capillary actions are thus excited, subserving to their nutrition and growth. In a series of experiments, arterial and venous blood were brought into contact with various liquids, such as bile, urine, wine, grape-juice, and sugar solution charged with carbonic acid, and both were found negative in relation to the liquids; and it may be supposed that the same thing occurs when arterial blood in the capillaries comes in contact with the liquid exuded by muscles. The direction of the electro-capillary currents is such that the interior walls of the capillaries are the positive electrodes of couples functioning as chemical forces, and their exterior walls negative electrodes. There is thus oxidation in the interior of the capillaries, and reduction on the side of the muscles. The interior of a muscle is usually negative in relation to the fluids that moisten its external surface: the electro-capillary currents proceed from the inside outwards, and this direction gives oxidation within and reduction without.

In fruits, such as grapes, apples, pears, and in roots, as potatoes, carrots, and turnips, there are similar electro-capillary currents. In contact with water, the interior parts are constantly found to be positive. Thus, when fruits are moistened, their interior layers next to the external tissues tend to ceaseless oxidation; salt water produces opposite effects.

Before electro-capillary currents were known, it was supposed that in transmitting an electric current, for medical purposes, into the interior of an organised body, no electro-chemical action would ensue unless solid bodies, such as wires, conducted the electricity, and served as electrodes. Now, however, it is known that an infinitely thin layer of liquid adhering to the walls of a permeable tissue behaves like a metallic film in electro-chemical decompositions, and we may conceive such actions taking place in organisms, and producing very complicated results.

M. Becquerel thinks that the electro-capillary forces play the greatest part in organic beings. These forces require for their production merely permeable tissues separating two liquids of different natures, and find, consequently, in the organism the conditions necessary for their origin. Their existence, direction, and intensity are easily proved. The author found arterial blood negative with venous blood.

Desirous of ascertaining the physico-chemical action exerted by water and salt-water upon tubers and fruits, the author made several series of experiments, which led to the following results:—Water is constantly positive, and the fruit or the tuber negative, which indicates that the electro-capillary currents have the effect of oxidising the parts under the epidermis or the skin. With saline water the result is inverse. We see hence the effects which may be produced in living bodies by the introduction of different liquids, effects which should be taken into consideration in the application of the physico-chemical sciences to medicine.

The author has also investigated the possibility of augmenting or decreasing the intensity of electro-capillary action by the aid of the current of a battery of several elements. Among the bodies experimented upon was the chloride of chromium, which yielded an intense black deposit. This was found to be a hydrated sesquioxide of chromium; the black colour is due to some peculiar molecular arrangement, and the crystallisation belongs to the regular system. Perchloride iron yielded also a black crystalline deposit, consisting of hydrated sesquisulphide. Chloride of bismuth also deposited the sulphide of the metal. Acetate of lead deposited metallic lead in a very brilliant state. Nitrate of copper yielded a brilliant deposit of metallic copper on the negative surface and crystalline sulphide of copper on the other. With the chlorides of gold and of zinc no decomposition was produced. The apparatus consisted of a split tube containing the solution to be experimented upon, and plunged in a larger tube containing a solution of an alkaline sulphide. The action was augmented by means of two slips of platinum in connection with a battery, the positive being immersed in the metallic solution, and the negative in the sulphide.

M. Becquerel has also found fluorides of calcium in tubercular crystals on the face of a slit with a solution of chloride of calcium, separated by the slit from a solution of fluoride of ammonium. On acting with the monosulphide of sodium and nitric acid, the oxygen, which has a great affinity for the elements of the monosulphide, combines, on the one hand with the sulphur, and on the other with the sodium, whilst hyponitric acid is set free.—*Academy and Chemical News.*

Hydrogenised Iron.—L. Cailletet (*Comptes Rendus*).—When a plate of iron is attacked by dilute sulphuric acid, the hydrogen is in part absorbed by the metal.

On decomposing, by means of a battery, a neutral solution of chloride of iron, with addition of sal-ammoniac, metallic iron at the negative pole is obtained in the form of bright, brittle, mamillary masses which are hard enough to scratch glass. This iron, after being washed, disengages under water or any other liquid, numerous bubbles of pure hydrogen.

In free air the galvanic iron loses only a part of the hydrogen it contains. A specimen, weighing 0·90 gr., kept fifteen days in an open tube, gave, when heated, 18 cubic centimetres of gas, or more than half the quantity which it contained at the moment of its preparation. If you put a fragment of hydrogenised iron into a glass filled with water heated to 60° or 70° C., the liberation of gas becomes tumultuous, and there is often intense crackling.

The author examined a great number of specimens of iron, obtained in solutions more or less dilute, and reduced by currents of different intensity, as to the total quantity of gas they contained. For this purpose the metal was heated in the vacuum of a mercury pump, and the gas given off was measured. He found that one volume of iron contains from 248 to 244 volumes of hydrogen. If a piece of hydrogenised iron is brought near a flame, the hydrogen burns, and the metal is sheathed in a light flame, similar to that of a wick dipped in alcohol.

When the iron has lost by heat the hydrogen it contained, the gas cannot be restored to it. Using as negative electrode, in a voltameter, a plate of galvanic iron previously heated, the author found hydrogen of the decomposed water liberated abundantly on the metal; but the plate did not take up hydrogen, even though the battery was in action several hours. Galvanic iron can be easily pulverised; but, after heating, it resumes the usual ductility of the metal.

Hydrogen, uniting with iron, communicates to it a considerable coercitive force. A platinum wire coated with galvanic iron, was placed in the axis of a magnetic needle, oscillating on a pivot, and at a fixed distance from one of its extremities. The needle, drawn from its position of equilibrium, oscillated twenty-six times in a minute. The iron having been magnetised and replaced at the same distance from the needle, the latter made forty-two oscillations in the same time. Heated to a red heat the iron lost its poles. When magnetised anew to saturation, it made the needle oscillate only thirty-three times in a minute. Supposing that the magnetic forces of the iron in these three states were to each other as the squares of the number of oscillations, and taking as unity the magnetic force of hydrogenised iron not magnetised, we have, for the magnetised hydrogenised iron, 2·609, and for the iron deprived of hydrogen and magnetised 1·610. Thus the presence of hydrogen in iron appears to modify greatly its magnetic properties.

The various specimens of iron examined by the author contained, for one gramme of iron, 32·80 cubic centimetres of hydrogen, or, for one equivalent of iron, 0·950 gr.

Dissolution of Hydrogen in Metals, and Decomposition of Water by Iron.—L. Troost and P. Hautefeuille (*Comptes Rendus*).—Potassium, sodium, and palladium, combine with hydrogen, whilst a considerable number of other metals merely dissolve this gas. Iron, nickel, cobalt, and manganese offer striking analogies in the manner in which they behave with hydrogen at different temperatures. The facility with which they absorb or give off hydrogen gas depends greatly on their physical condition. An ingot of pure nickel gave out, in a vacuum, at a red heat, one-sixth of its volume of hydrogen. Laminæ of nickel, obtained electrolytically, gave out forty times their volume. Pulverulent nickel gave up one hundred times its volume, and remained pyrophoric after the escape of the hydrogen. An ingot of cobalt gave up one-tenth of its volume; electrolytic laminæ of cobalt thirty-five times their volume, and pyrophoric cobalt powder one hundred times. It also remained pyrophoric after the loss of the hydrogen. Soft iron in ingots gives off one-sixth of its volume, and grey cast-iron more than the half. Electrolytic laminæ of iron gave off 260 volumes. In fine, it may be said that iron, nickel, and cobalt absorb directly hydrogen gas, but it cannot be said that combination ensues, just as has been already shown in the case of lithium and thallium. Finely divided iron has a property which is not shared by nickel or cobalt: it decomposes water slowly at common temperatures, and rapidly at 100° C. In this respect iron approximates to manganese.

Changes in Iron and Steel by the Action of Hydrogen and Acids.—W. H. Johnson (*Nature*).—For a long time it has been well known to wire-drawers, that after cleaning iron wire with sulphuric acid the metal becomes brittle. Further, if a piece of iron wire that has been cleaned in sulphuric acid be bent rapidly to and fro till it is broken, and the fracture be then moistened with the tongue, bubbles of gas arise from it, causing it to froth. If this same wire be left in a dry warm room for some days, it will be found to have regained its original toughness, and not to froth when broken and the fracture moistened.

Experiments made by the writer during the last three years, have shown that hydrochloric, acetic, and other acids which give off hydrogen by their action on iron, produce the same effect, making it probable that hydrogen is the cause of the change. This view is confirmed by collecting the gas given off at the surface of the iron and burning it, when the characteristic flame of hydrogen is seen.

Putting the facts together, it seems probable that a portion of the hydrogen generated by the action of the acid is occluded, and subsequently given off, either rapidly, as when the iron is heated by the effort of breaking it, or, more slowly, in the cold.

The simplest way of charging a piece of iron with hydrogen, is by laying it on a sheet of zinc in a basin of dilute sulphuric acid. An electric current is here set up, and the hydrogen generated by the action of the acid on the zinc is given off at the surface of the iron. In this way two minutes or even less will often suffice to charge a piece of iron with hydrogen, and alter its properties as completely as one hour's immersion in dilute acid without the zinc.

The change in the properties of iron which has occluded hydrogen is not confined to a diminution of toughness, though this may be reduced to one-fourth, but is accompanied by a remarkable decrease in tensile strain, amounting in cast steel to upwards of twenty per cent. after twelve hours' immersion in sulphuric acid. With iron wire the decrease in tensile strain was found to be less than with steel; the reduction amounted however in some cases to six per cent. Some interesting differences are noticeable in the relative effect of occluded hydrogen on mild steel and highly carbonised steel, the diminution of tensile strain after occlusion of hydrogen being greater in the latter case than in the former.

As with palladium, so with iron, the electrical resistance is increased by occlusion of hydrogen; in fact, it seems probable that every property of iron or steel undergoes a change after the occlusion of hydrogen, and the extent of this change becomes a matter of great interest to the engineer now that iron and steel are so largely used.

Cases of the deterioration in toughness of iron of excellent quality exposed to the action of gas containing acid, as in the upcast shaft of a coal-pit, have come before the writer's notice, in which the change appeared to have resulted more from hydrogen occluded by the iron than its corrosion by the acid vapours. It is also probable that rapidly rusting iron occludes hydrogen, and is thereby weakened in strength and toughness.

That hydrogen is the sole cause of these changes produced in iron, is shown by the fact that if acids be dispensed with altogether, and pieces of iron be subjected to the action of nascent hydrogen (produced by the electrolysis of water or caustic soda), the same results are obtained. Hydrogen was not occluded in iron by leaving it in an atmosphere of hydrogen gas.

Hydrogenized Palladium, Nickel, and Zinc.—R. Böttger (*Bibl. Univ. de Genève*) finds that palladium, coated with palladium-black, is much more rapidly saturated with hydrogen than the naked metal. If, when thus saturated it is wrapped in gun-cotton, after a few seconds an explosion ensues, and the palladium plate burns for a short time with a feeble flame. He also finds that nickel, zinc, and cobalt, likewise absorb electrolytic hydrogen.

Adhesion. — Herr Stefan, of Vienna (*Nature*).—It is well known that two plane plates which are placed upon one another adhere together so firmly that they can only be separated by a certain amount of force. This phenomenon has hitherto been considered as caused by the action of molecular forces between the particles in contact between the two plates, and it was tried to determine the magnitude of this adhesion statically.

The improbability of this conception already follows from the fact that no immediate contact of the two plates takes place, but that between them there is a layer of air of considerable thickness. If two glass plates are employed for this experiment, they do not show Newton's coloured rings; these can only be produced with plates that are perfectly plane, and with the application of considerable pressure. If, therefore, molecular forces were active in this case between the particles of the two plates, then the molecular sphere of action would have to be very much larger than is generally adopted according to other experiments. The phenomenon becomes still more striking if the experiment is made under water. In that case an attraction in the two plates can be perceived, even if they are a millimetre apart. Herr Stefan used for his experiments two plates of glass, of which one was suspended from a balance in such a manner that its inferior plane was horizontal. The balance was then brought to equilibrium. The second plate was also placed horizontally under the other one. Three little pieces of wire were then placed upon it, and the upper plate was then let down so far as to rest upon these pieces of wire. By varying the thicknesses of the wires, the distance of the two plates could be brought to any desired magnitude. To tear away the upper plate from the under one, it was necessary to place a certain over-weight into the other scale of the balance.

It was found that the separation of the two plates can be accomplished by any force, however small, but the time in which the distance of the plates is increased by a certain fraction through the action of such a force, is all the greater the smaller this force is. This time is still greater if the two plates are in water or in another liquid, instead of in air. To give an idea of this we may mention that the distance of two plates, of 155 millimetres diameter, under water, which originally was 0·1 mm., was increased in consequence of the continuous pull of 1 gramme by 0·01 mm. only in 1¼ minutes, by 0·1 mm. only in 7 minutes.

The phenomenon can be explained in the following manner:—When the separating force begins to act, the distance of the plates is increased by an infinitely small part. The space contained between the plates is thus enlarged, the liquid therein contained is dilated, and consequently its hydrostatic pressure decreased. The over-pressure of the exterior liquid acts against the separating force. No equilibrium is, however, attained, because the decrease of hydrostatic pressure between the plates causes an inflow of the exterior liquid, and thus a decrease of the difference of pressure. The distance of plates may be again increased by the separating force, and then the same process is repeated in a continuous manner.

Herr Stefan has therefore given the name of apparent adhesion to this phenomenon.

On the Action of Rain to Calm the Sea. — Professor Osborne (*Lit. and Phil. Soc., Manchester*).—There appears to be a very general belief amongst sailors that rain tends to calm the sea, or, as I have often heard it expressed, that rain soon knocks down the sea. Without attaching very much weight to this general impression, my object in this paper is to point out an effect of rain on falling into water which I believe has not been hitherto noticed, and which would certainly tend to destroy any wave-motion there might be in the water. When a drop of rain falls on to water, the splash or rebound is visible enough, as are also the waves which diverge from the point of contact; but the effect caused by the drop under the surface is not apparent, because, the water being all of the same colour, there is nothing to show the interchange of place which may be going on. There is, however, a very considerable effect produced. If instead of a drop of rain we let fall a drop of coloured water, or, better still, if we colour the topmost layer of the water, this effect becomes apparent. We then see that each drop sends down one or more masses of coloured water in the form of vortex rings. These rings descend with a gradually diminishing velocity, and with increasing size, to a distance of several inches, generally as much as eighteen, below the surface. The actual size of these rings depends on the size and speed of the drops. They steadily increase as they descend, and before they stop they have generally attained a diameter of from one to two inches, or even more. It is probable that the momentum of these rings corresponds very nearly with that of the drops before impact, so that when rain is falling on to water there is as much motion immediately beneath the surface as above it, only the drops, so to speak, are much larger, and their motion is slower. Besides the splash, therefore, and surface effect which the drops produce, they cause the water at the surface rapidly to change places with that at some distance below. Such a transposition of water from one place to another must tend to destroy wave motion.

Elasticity of the Air.—Mr. Braham exhibited an experiment at the Chemical Society recently, in which he exhausted a glass receiver; and after allowing the air to re-enter through a large opening until equilibrium was restored, the opening was closed, and the vessel connected with a pressure gauge. In the course of a minute the mercury had risen through the space of an inch. A converse experiment was made by pumping air into a glass vessel, allowing it to escape, and then closing the opening. In a short time there was an appreciable pressure within the vessel.

Demonstration of the Laws of Gravitation.—M. Waldner, of

Strasburg,' describes in *Pöggendorff's Annalen,* his mode of demonstrating the laws relating to falling bodies. One of his arrangements is as follows:—Suppose a small metallic ball hung by a string some height above the ground. Under it, at a distance (say) = 1, are a pair of metallic balls connected with the poles of an electrical machine, and so far apart that no spark can pass, but so near, that through the fall of the suspended ball between them a spark will pass. Vertically, under this pair, are several other pairs, similarly arranged, at distances = 4, then 9, &c., all connected with the electrical machine, and in the same circuit. On burning the thread of the suspended ball, this falls between the others under it, giving passage, at each pair, to the current; and a simultaneous spark in another part of the circuit makes a mark, for each pair of balls, on a rotating blackened cylinder or disc. The intervals between the marks are found to be equal.

Diffusion through Soap Bubbles. — G. C. Müller (*Ber. Deutsch. Chem. Gesellschaft*).—The author employed a glass tube bent at a right angle, and furnished with a small rim to give the soap-bubble a better hold upon the glass. He blew the bubble with air from his mouth through an india-rubber tube, which he closed when it was finished. The tube conveying the bubble was then placed under a jar containing hydrogen, and removed after thirty seconds, when it was found to explode with a yellow light on exposure to a flame.

Motor Forces of the Future. —(*Boston Journal of Chemistry*).—Electrical engines of various forms have been devised, but unfortunately zinc is a costlier fuel than coal, and the battery or other means of supplying the electric force is yet to be invented that can be an economical substitute on a large scale for the steam-boiler.

Another probable motor of the future is solar heat, which science has shown to be the source, direct or indirect, of all terrestrial energy. We may confidently expect that some small fraction at least of the vast amount of solar force that now runs to waste, so to speak, will be made available for purposes of human industry. It has been calculated that the earth receives from the sun, every minute, 2,247 billions of units of heat, each unit being equivalent to 772 foot-pounds, or the force that will raise a pound to the height of one foot. John Ericsson is one of those who are endeavouring to devise some means of utilising a portion of this enormous energy.

Another inventor, at work on the same problem, is Mr. Bergh, a German engineer. He proposes the following construction for a solar engine: Conceive a vessel filled with sulphurous acid, and exposed to the sun's rays. The tension of the sulphurous acid vapour, if the temperature of this vessel exceeds that of the surrounding air by at least 10° to 20° C., must be from one to three atmospheres higher than that of the sulphurous acid vapour in another vessel, B, similarly filled with sulphurous acid, but which has only the temperature of the surrounding air. We can thus arrange an engine which agrees perfectly in principle with the steam-engine, with merely the difference in detail that the water is replaced by sulphurous acid, and the fuel by the solar heat; while the vessel exposed to the sun's rays represents the steam-boiler, the vessel kept at the ordinary temperature may represent the condenser. The sulphurous acid condensed, after doing work in vessel B, could at night be driven back by a force pump into the vessel A, which represents the boiler. The capability of work which such a machine will possess will, of course, increase the amount of heat communicated to the vapour generator A; or will be proportional to the vaporising surface which it exposes to the solar rays. In applying this construction in practice, Bergh proposes that the roof of a factory or workshop shall be covered with vessels containing sulphurous acid, the other parts of the sun machine being disposed as may be found most convenient.

Under such circumstances the engine would work while there was sunshine, but in cloudy weather the establishment would be brought to a standstill. To obviate this difficulty, there might be, in addition to the sun-machine, an apparatus for "storing up" a portion of the work done by the former. For this purpose Natterer's well-known apparatus for liquefying carbonic acid is suggested. A supply of carbonic acid could be kept in a large gasometer, like those of the gas-works, from which the Natterer apparatus could be fed. In a wrought-iron vessel, thus filled with liquid carbonic acid, an enormous amount of mechanical energy could be stored up, which might be made to replace either wholly or in part the action of the solar heat in the sun-machine.

There is certainly nothing in the plan here proposed that is impracticable, and therefore there is one form of sun-engine capable of continuous action, by appropriate devices, that can be made available in many portions of the world.

CHEMISTRY.

River Pollution.—Professor Frankland, (Royal Institution).—The great mass of polluting matter which is being discharged into rivers and streams, may be classified into organic and mineral. Under the head of organic matter we have, first, town drainage; second, drainage from the various forms of fibre manufacture, such as paper-making, the calico, woollen, linen and jute industries, and the silk manufacture. Under the head of mineral matter we have, first, mine pollution, or liquids discharged from mines; and, second, drainage from chemical works.

As examples of rivers intensely polluted by each of the above forms of matter may be mentioned the Clyde, which flows through Glasgow, as strongly polluted by town drainage; Dighty Burn, near Dundee, by fibre manufacture; Red River, at Gwythian, Cornwall, by tin mines; and the Sankey Brook, which flows through St. Helens, is a fair example of pollution by chemical works.

Polluting matter of organic origin presents itself in water in solution and suspension, whereas mineral polluting matter is nearly always present in a state of suspension, and on account of its greater specific gravity will, if allowed sufficient time, subside of its own accord. This is not the case with organic matter, to get rid of which other means have to be resorted to.

The Thames may be taken as an example of organic pollution. At its source it is a comparatively pure river. It receives polluting matters from paper factories, and from the drainage of 600,000 people, in its course before it reaches Hampton, and yet it still looks a comparatively clear and pure river. This is owing to the deceptive nature of the polluting matter, which is principally organic, and in solution, and is therefore scarcely discernible by the unaided senses. If, however, it be followed in its course down to London Bridge its pollution becomes apparently greatly augmented, but the organic matter in solution is scarcely perceptibly greater at London Bridge than at Hampton. In short, were the water filtered from the suspended mud stirred up by the steamers and currents, it would, chemically speaking, be nearly as pure at London Bridge as it is at Hampton.

Another case is the Aire, which rises in Yorkshire, a very clear and beautiful river; but before it reaches Leeds it receives, besides the house drainage of more than a quarter of million of people, the refuse from 1341 cloth and woollen factories; 1 silk mill; 1 flax mill; 10 cotton factories; 7 paper mills; 26 tanneries; 13 chemical works; 8 grease works; 4 glue works; 35 dye works.

At Leeds this mass of pollution is reinforced by the drainage of 300,000 people, and by refuse materials from 224 cloth and woollen factories; 62 dye works; 6 dye-wood mills; 25 flax mills; 7 soap works; 1 silk mill; 28 tanneries (which tan 2¾ million hides annually); 29 chemical works; 10 carpet factories; 3 glue factories.

The history of the river Calder, which joins the Aire lower down, is similar. After receiving the drainage of all the towns and factories on its banks, its water is pumped up for the supply of Wakefield.

The condition of the water may be judged of from the fact that a local manufacturer was able to write and dedicate a memorandum to the Local Board of Health with a pen dipped in the river water.

Now these two rivers—the Aire and Calder—the one running from Leeds, and the other from Wakefield, meet at Castleford, and there they fall over a high weir. At this spot the pollution of the water is so great as to blacken the very foam on its surface. Yet these streams must, at one time, have been celebrated for their cleanliness and purity; otherwise the well-known couplet would scarcely have been written:

"Castleford lasses may well be fair,
Washed in the Calder and bathed in the Aire."

In the neighbourhood of mines the amount of mineral matter present in rivers is sometimes very great. The ore and matrixes are crushed into an impalpable powder, then washed with water to separate the heavier metallic matter from the rocky matter. The effluent water from the settling pits is very muddy, and often contains poisonous matters in suspension. This is especially the case in lead mines, where considerable quantities of galena and carbonate of lead, carried down the streams during floods, are washed on the adjacent land, where cattle are grazed. The consequences resulting from this display of ignorance and carelessness are, that the farmers whose lands are washed by these poison-charged waters suffer the loss of cattle and poultry, whilst the profits of the mines leak silently away. At a lead mine in Northumberland nearly 7 tons of lead ore, worth 12*l.* per ton, are thrown away in every 100 tons of waste material. At another mine in the same county 2 tons of lead ore, and more than 9 tons of zinc ore, are thrown away in every 100 tons of waste. These metalliferous muds poison the rivers for many miles, carrying destruction to animal life. Mud containing as much as 5, 9, 13, and even 25 per cent. of lead ore is not unfrequently found in the neighbouring streams.

Such is the pitiable plight to which many of our formerly beautiful rivers have been reduced.

The methods which have been proposed for remedying organic pollution may be divided into, first, methods of precipitation; and, secondly, methods of oxidation.

Amongst the methods of purification those by precipitation have been most talked about, because they are the most easily applied on a small scale, and are, therefore, more easily made the subjects of experiment. One of these is precipitation by lime. Most drainage water contains bicarbonate of lime. This is decomposed by slaked lime or lime-water, and the resulting chalk precipitate lays hold of and carries down with it any particles of suspended matter that may be in the water. But it does more; it acts by surface attraction, and actually takes out of solution some of the organic matter which was dissolved in the water. Yet the purification by this means is very imperfect as regards the soluble organic matter.

There is, again, the A B C process, which consists in precipitation by means of a mixture of alum, clay, and an infinitesimal quantity of blood.

Then we have the sulphate of alumina method, or Bird's process; (lime and clay), or Scott's process; (lime and chloride of iron, and superphosphate of alumina and slaked lime). All these methods have failed to achieve the end in view.

They have all had their origin in two erroneous ideas. First, that the foul matter in sewage can be removed by chemical means; and, secondly, that the matter actually thrown down or precipitated is valuable as manure. In every case in which it has been tried the precipitated matter is not worth the carriage for more than a mile or two, so that it is practically worthless. In fact, the manuring constituent of this foul drainage is left almost intact in solution.

Purifying material in each case is manufactured at great cost, and is laboriously carried to the sewage, and fished out again and dried at still greater trouble and expense. This, however, would become of secondary importance if the end desired were accomplished. But this is not the case;—the foul liquids are not cleansed. These purifying materials, chalk, alumina, and oxide of iron, and other porous substances exist, however, naturally in all porous soils, and sewage will run to them by its own gravity. These materials are capable of removing nearly the whole of the polluting matter brought into contact with them. We are thus led, by a process of scientific induction, to purification by irrigation. Foul drainage is, in irrigation, mixed with vast quantities of soil, which, by surface attraction (not by chemical affinity), remove from it its polluting matter, and the roots of growing plants ramifying through the soil gather up and transform the polluting materials into healthy living tissues, thus preventing the pores of the soil from getting clogged and consequently useless for purposes of purification.

No one visiting Aldershot Camp can fail to be struck with the emerald tint of the irrigated land, contrasting as it does with the sterile soil around it. Upon the land used for the purpose of purification by irrigation, every variety of crop can be grown, and at the Barking farm we can actually realise in the summer season the drainage of London transformed into strawberries and cream.

For the purpose of irrigation, one acre of land is requisite for every hundred persons contributing to the drainage, and, when properly conducted, there is no nuisance. The only drawback to irrigation is the difficulty of obtaining sufficient land suitable for carrying on the process near large towns. This led to the experiment of making a given area of land do more work. After continuous filtration, however, the pores of the soil became clogged up, and the effluent water consequently not purified. The Commissioners therefore, availed themselves of a well known property of porous matter, its attraction for gases, especially for atmospheric oxygen, and the great chemical affinity of this oxygen for organic matter. They were sanguine enough to hope that this property might be possessed by porous earth, to a sufficient extent to cause the slow but complete combustion of foul drainage matters.

Their expectation was not disappointed; experiments made on the large scale at Merthyr Tydvil, showed that by bringing air and drainage water alternately in contact with the soil, rapid, continuous, and satisfactory purification was obtained. Indeed, the effluent water from the Merthyr drainage subjected to this process of purification is, chemically, purer than the water supplied by some of the London water companies.

This process is equally applicable to the discharges from fibre factories of various kinds. It has been carried out for three years at Merthyr Tydvil, where the drainage from each 3000 people has been cleansed upon a single acre of land. Crops may be also grown upon the land so used.

For mining pollution the remedy

is exceedingly simple, viz., subsidence in properly constructed tanks for six hours. The result, though not in every case quite satisfactory, is sufficiently so to prove that the amount of mining pollution in many of our rivers would, by its adoption, be substantially abolished.

These plans would be sufficiently effective for the treatment of the chief kinds of town, manufacturing, and mining drainage. But it is necessary, in any legislative enactment to secure the better treatment of rivers, that there should be some definition of polluting matter. The members of the Royal Commission on River Pollution have proposed after much deliberation the following definitions of polluting liquids:—

(*a*) Any liquid which has not been subject to perfect rest in subsidence ponds of sufficient size, for a period of at least six hours, or which, having been so subjected to subsidence, contains in suspension more than one part by weight of dry organic matter in 100,000 parts by weight of the liquid; or which not having been so subjected to subsidence, contains in suspension more than three parts by weight of dry mineral matter, or one part by weight of dry organic matter in 100,000 parts by weight of the liquid.

(*b*) Any liquid containing, in solution, more than two parts by weight of organic carbon, or three parts by weight of organic nitrogen 100,000 parts by weight.

(*c*) Any liquid which shall exhibit by daylight a distinct colour when a stratum of it one inch deep is placed in a white porcelain or earthenware vessel.

(*d*) Any liquid which contains, in solution, in 100,000 parts by weight, more than two parts by weight of any metal, except calcium, magnesium, potassium. and sodium.

(*e*) Any liquid which, in 100,000 parts by weight, contains, whether in solution or suspension, in chemical combination or otherwise, more than ·05 part by weight of metallic arsenic.

(*f*) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than one part by weight of free chlorine.

(*g*) Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

(*h*) Any liquid possessing an acidity greater than that which is produced by adding two parts by weight of real muriatic acid to 1000 parts by weight of distilled water.

(*i*) Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1000 parts by weight of distilled water.

(*k*) Any liquid exhibiting a film of petroleum or hydrocarbon oil upon its surface, or containing, in suspension, in 100,000 parts, more than ·05 part of such oil.

Of these standards the first two are by far the most important—the standards referring to suspended matter, and to the quantity of organic carbon and organic nitrogen which ought to be allowed to be transferred into streams. These supremely important standards, if enforced by proper and judicious enactments, giving sufficient time for manufacturers to carry out improvements necessary for the purification of foul drainage, would abolish fully nine-tenths of all the river pollution by which streams are now affected in Great Britain.

To make the rivers pure for drinking purposes is, perhaps, impossible; but it may reasonably be hoped that they may become sufficiently so to delight the eye and to repress the pestiferous and sickening exhalations which at present affect the multitudes of our population compelled to pass their lives on the banks of such rivers.

Arsenic in English Rivers. Prof. Frankland (*Times*).—It is a well-ascertained fact that 165 tons of white arsenic are competent to destroy the lives of more than 500,000,000 of human beings; and as this quantity is manufactured and sold monthly at one single English mine, whence streams of water strongly impregnated with arsenic flow into a neighbouring river, the Rivers Pollution Commissioners cannot be fairly accused of exceeding their instructions when they reported these facts, and recommended that, as arsenic is largely used in several important manufactures, though no serious impediments ought to be placed in the way of its production, the manufacture of a poison so virulent should be subject to special State supervision, and that any officer appointed for such purpose should be empowered to require that the best practicable means be taken not only to hinder the access of the poison to running water, but also to prevent the poisoning of the air by the volatilisation of the arsenic. They were driven to this special recommendation in the case of mines upon which arsenic is manufactured, because there is no effective method of removing arsenic from water in which it is dissolved. With reference to the liberation of arsenic in a soluble form during the slow decomposition of mundic or arsenical pyrites, the Commissioners have ascertained that such is the case, not merely by experiments, but by the actual analysis of streams of water flowing over the decomposing mundic; and they have learnt, from their own observation, and from evidence given before them, that such streams are destitute of fish, and continue so for long periods of time after the mining operations have entirely ceased.

The Faraday Lecture of the Chemical Society.—(Thursday, March 18th, 1875; delivered before H.R.H. the Prince of Wales). Dr. Hofmann "On Liebig's Contributions to Experimental Chemistry."

The speaker, after noticing the great value of this tribute of homage to the memory of the immortal Faraday, who belonged not merely to the island of his birth, but to the civilised world, said he had selected as the theme of his discourse the labours of one of Faraday's most eminent scientific contemporaries, of a master mind like his, Justus von Liebig, the only name fitted to stand on equal terms by that of Faraday. If we consider the vast number and great importance of the chemical facts established by Liebig, we must proclaim him one of the greatest contributors to our science, whilst of organic chemistry he is the very source and fountain head. It was he who was the first to found the great institutions of chemical education; at the University of Giessen, Liebig organised the first educational laboratory. From England more especially was it that a large number of young chemists thronged to his school, many of whom have since attained the greatest eminence. And to these great services may we not add the inspiration bequeathed to us by his illustrious example? For us and for our successors for years to come, it will be our duty to work not only with Liebig's instruments in our hands, but with his dauntless spirit in our hearts.

Like Faraday, Liebig's labours in abstract science have borne abundant fruit in the useful arts; to mention but a few instances,—the industries of the fatty bodies and of acetic acid, the manufactures of the fulminating compounds, of prussiate of potash, and potassic cyanide. His noble researches in the field of agricultural chemistry will ever associate his name with those of Davy and Lavoisier, the great law-givers of modern agriculture. To Liebig we especially owe our knowledge of the important part played by the saline ingredients—the ashes of plants—in their nutrition, and consequently, of the necessity of returning these ashes to the soil, after each harvest, in order to renew its fertility. It was in 1842 that, passing on to the intricate chemistry of animal life, he published his work "On Organic Chemistry in its Application to Physiology and Pathology;" and as an outgrowth of these researches, we may allude to the food industry, which has already attained such colossal proportions in the southern hemisphere.

He would now ask them to review rapidly Liebig's labours in pure chemistry; but even here he must confine himself to a few illustrations amongst several hundreds. Of these, though not the most brilliant, were three which had conduced more than any other to the marvellous development of modern chemistry—the apparatus, so simple and yet so perfect, for the analysis of organic bodies by combustion; the method for determining the molecular weight of bases by the combustion of their platinum salts, and that for the analysis of air by means of an alkaline solution of pyrogallic acid were all Liebig's.

In passing to his researches, we find among the first to claim our attention his investigations in the cyanogen group begun by an examination of the fulminates, from which he naturally passed on to the cyanic group at large; then cyanic acid, cyanuric acid, and their salts became successively the object of his labours. It was he who first gave a satisfactory explanation of the processes involved in the preparation of the yellow prussiate of potash by fusing animal matters with potash in iron vessels, the product first formed being potassium cyanide, which then takes up iron during lixiviation. Amongst the interesting and valuable results arising from his investigation of the ferro-cyanides, were the preparation of hydro-ferrocyanic acid, of potassium cyanide, and potassium cyanate. From the cyanates to the sulpho-cyanates was but a step; and as, in the course of his experiments, he required large quantities of ammonium sulphocyanate, he ultimately found the best method of preparing this to be the treatment of hydrocyanic acid with yellow sulphide of ammonium. This naturally led to the delicate test for hydrocyanic acid by converting it into ammonium sulphocyanide, when a drop of a solution of ferric chloride produces the well-known blood-red colour. After glancing at the benzoyl compounds, the lecturer noticed the importance of the acid chlorides, first obtained by Liebig from the aldehydes, although Cahours's method is now universally adopted in preparing them. These chlorides furnished us with acids, ethers, and amides, a source of new compounds, not shaken by time, but still fresh and fruitful as on the first day of their discovery.

To Liebig and Wöhler are we indebted for the investigation of the properties and the determination of the formula of uric acid. Its liability to change, while increasing the difficulty of the inquiry, enabled these chemists to reap a rich harvest of results such as few have ever gathered from one field of research; the discovery of not less than sixteen new bodies rewarded their labours, and it is noteworthy that only one of these has since disappeared from our science. To them are we indebted for the first analysis and the first exact and complete description of murexide, the precursor of rosaniline.

Liebig's first experiments on alcohol, the action of chlorine upon it, led to the discovery of chloral and chloroform, two compounds now in continual use for the alleviation of human suffering—an illustration of the practical advantages ever following the pursuit of truth. Of the former compound, in 1868, probably there was not a kilogramme in existence in the whole world; now the factories of Berlin alone produce 100 kilogrammes daily. The object of the investigation of alcohol was to elucidate the constitution of this important compound, and gave rise to that long-protracted contest between Dumas and Boulley, on the one hand, who considered ether and alcohol to be hydrates of olefiant gas, and Liebig, on the other, who regarded them as derivatives of a radical to which he gave the name of ethyl. It ended in a signal victory for Liebig, and a universal adoption of his theory.

To Liebig, also, we owe the explanation of the formation of acetic acid by atmospheric oxidation. This action takes place in two stages, the first being the removal of hydrogen and the formation of aldehyde, the second the direct oxidation of this to acetic acid. Aldehyde was first made out by this great chemist, who at the same time discovered another compound—acetal—scarcely less interesting. It was on this occasion that Liebig first observed the lustrous mirror-like deposit of silver, formed on gently warming a slightly ammoniacal solution of silver with a few drops of aldehyde; a reaction which has since developed to a gigantic industry.

The compounds discovered by Liebig are amongst those in most frequent use; the reactions are those most commonly employed in research. Could a more eloquent testimony be borne to the influence which Justus von Liebig has exercised upon the progress of chemical science than that his teachings have become familiar as "household words."

In whatever epoch we may seek for models of human existence, "no two grander examples will in any age stand forth more dignified by their intellectual work, more conspicuous for their moral beauty, than those whose great names we have been commemorating this day—

"Michael Faraday;
Justus Liebig."

Oxygen, proportion of, in the air.—Dr. Ucke (J. für Meteor.) has discussed this question in relation to the sanitary efficiency of various climates. Samara is in 34 deg. N. lat. on the Tigris, and although it is on the open steppe, and exposed to great vicissitudes of temperature, consumption is hardly known there. Dr. Ucke thinks this may be due to the greater amount of oxygen inhaled in a given time at Samara. He compared this climate with that of seventeen other health stations, situated in Europe and Asiatic Russia. The amount, in pounds, of oxygen passing through the lungs in a week varies from 200 lb. at Barnaul, to 167 lb. at Seringapatam. London does not come very badly off, giving us 192 lb., while the central European stations and those at high level give lower figures. Excluding the three Indian stations, Sitka, and the mountain station Peissenberg, in Bavaria, the remaining twelve places are divided into four groups, which give the following results as to the yearly amount of oxygen in pounds:—Siberia, 2,385; Eastern Europe, 2,326; Western Europe (Brussels and London), 2,305; Central Europe, 2,272. Practically, therefore, rather more than a ton of oxygen is inhaled by everyone in a year. The amount of oxygen is increased by high barometrical pressure, and reduced by high temperature and humidity. When we compare the results for the several months with the average of the year, we find that London shows a slight excess in the summer, evidently owing to its moderate temperature.

Compound of fluorine and

phosphorus.—T. E. Thorpe (British Association).—This new body was obtained by acting upon terfluoride of arsenic with pentachloride of phosphorus. The product is a gas which is stable at ordinary temperatures, can be kept over mercury, but is decomposed by water. The author believes it to be a condensable gas, and from an analysis shows that it is a pentafluoride of phosphorus.

Protosulphide of carbon.—M. Sidot (*Comptes Rendus*).—The author in a previous research, mentioned that bisulphide of carbon was decomposed on exposure to light, giving rise to a gas, and a red flocculent matter. On collecting a large quantity of these products, he found the gas to be air; and on taking due precautions to prevent its entrance into the apparatus, he effected the decomposition of sulphide of carbon without the production of any gas, obtaining sulphur, which remained in solution, and a brown matter which was precipitated.

The process was conducted in U-tubes, of 1 metre in length by 0·015 metre in diameter, one of the limbs being surmounted by a capillary delivery tube, and the other by a straight gas tube, both closed at the lamp. The light was allowed to act upon these tubes for about two months. At the end of this time the operation seemed terminated. The liquid contained in the tubes was filtered, and then distilled, when there remained in the retort crystalline sulphur. The precipitated matter remained attached to the interior of the tubes, from which it was removed by washing with distilled water. The weight of this matter, when purified, is to that of the residual sulphur as 3 to 4, that is to say, in the ratio of 1 equivalent sulphur to 1 equivalent of protosulphide of carbon. On analysis it was found that this compound is really the protosulphide, SC, resulting from the dissociation of CS_2 into CS and S. The protosulphide of carbon is a maroon powder, tasteless, and inodorous. Its specific gravity is 1·66. It is insoluble in water and alcohol, oil of turpentine, and benzol. In boiling bisulphide of carbon and ether it dissolves in very small quantities. Boiling nitric acid dissolves it, and turns red; the monohydrated acid poured upon the protosulphide of carbon in a stoppered tube, ignites it, and takes a deep brown colour. Sulphuric and hydrochloric acid do not appear to attack it. Concentrated boiling potash dissolves it with a black-brown colour, but if the solution is neutralised with an acid the liquid is decolourised, and the protosulphide is liberated in flocks. If heated to about 200° C. it decomposes into sulphur, which escapes, and carbon, which remains. In this decomposition there is always produced a little bisulphide from the reaction of the liberated sulphur upon undecomposed portions of protosulphide. On heating protosulphide with excess of sulphur the synthesis of the bisulphide was effected.

Decolourising Ozone. — A. Boillot (*Comptes Rendus*).—One of the most striking properties of ozone is its bleaching power. Ozone employed directly, acts as an oxidising agent, laying hold of the hydrogen of the substance with which it is in contact, whence results bleaching, if the body is coloured. On allowing chlorine to act upon any animal or vegetable matter, it decomposes a certain quantity of water and seizes its hydrogen, forming hydrochloric acid. The oxygen set free by this reaction is transformed into ozone, which in its turn lays hold of hydrogen present in organic matter. Thus the effects which have been ascribed to chlorine are really due to ozone.

Temper of fused Boracic Acid. — V. de Luynes. — Fused boracic acid approaches glass in some of its external characteristics. In the viscid state it may be drawn out into threads, which solidify rapidly. Its hardness, between 4 and 5, places it between fluor-spar and apatite ; it scratches glass, and is with difficulty attacked by sand, or even by emery, dry or with oil. It takes seven to eight times as much time in grinding as glass under the same circumstances. This resistance to friction, which does not accord with its hardness, depends on a speciality of structure. Melted boracic acid, in mass, becomes slowly hydrated in contact with water. In powder it is acted on rapidly. If the powder is sprinkled with water, its temperature may rise to 100° C. Boracic acid is chiefly remarkable for the persistence of its temper. If poured upon a cold metallic surface, glassy plates are obtained, the under surface of which, chilled by the metal, is more strongly tempered and more expanded than the upper. Hence results a flection which may be strong enough to cause the rupture of the plate and its projection in fragments. If poured into oil it may be obtained in small masses with short tails, under the same conditions as Prince Rupert's drops. A tempered plate of boracic acid, with parallel surfaces, acts upon polarised light like tempered glass ; but whilst the latter loses this property by re-heating, boracic acid preserves it with great tenacity.—*Chemical News.*

Solution of Difficultly-Soluble Substances.—A. H. Allen (British Association).—The author stated that he had found that many so-called insoluble substances could, when heated with fuming hydrochloric acid in sealed combustion tubes, be either completely dissolved or decomposed with separation of silica. In some cases where hydrochloric acid failed, sulphuric acid succeeded. The heating of the tubes is generally done by means of a water bath but for some substances a chloride of calcium bath must be used.

Solubility of Nitrate of Soda.—A. Ditte (*Comptes Rendus*).—Nitrate of soda forms at low temperatures a compound with water. Nitrate of potash presents no similar phenomenon. If we plunge into the same freezing mixture at—13° or—14° C. two tubes containing solutions saturated at zero, the one of nitrate of soda, and the other of nitrate of potash, the latter in a few moments becomes a solid mass, whilst the former remains liquid, in spite of agitation and of the presence of crystals of nitrate of soda in the tube. The melting-point of the hydrate, NO_5NaO, 14 HO, being below the temperature of the freezing mixture, it remains liquid.

Molecular Equilibrium of Solutions of Chrome Alum.—Lecoq de Boisbaudran (*Comptes Rendus*).—Blue solutions of chrome-alum, recently prepared in the cold, acquire gradually a greener shade, and green solutions of the same alum, recently prepared in heat, gain by degrees a more blue tint. These changes of colour are observed whether the liquids are in closed or open vessels, with or without contact of crystals, and whether concentrated or dilute. Still, the changes of colour being very slow, we cannot, by observing them, obtain an exact measure for the progress of the transformation. The author takes, therefore, advantage of the variations in volume which should accompany the change of molecular equilibrium of the salt. On the one hand, the blue alum of the solution made in the cold loses a part of its water of hydration in becoming green. On the other, the green alum of the solution made in heat gains water in becoming blue. In the former case, there is dissociation with change of volume ; in the second, the combination produces a decrease of volume.

Salts of Chromium.—A. Etard (*Comptes Rendus*).—The green salts become violet under the influence of nitric acid after the expiration of a longer or shorter time. Certain reagents produce an immediate effect. The green salts become a carmine violet if mixed in the cold with a little nitrite of potash. The carmine tint developed at the moment of the mixture of the two solutions, and which resembles that of the amido-chromic compounds, gradually disappears to give place to the blue-violet which has chrome alum for its type. Sulphocyanide of potassium produces the same phenomena, but more slowly. The green solutions of chromium salts, if precipitated by potash, give a hydrate insoluble in ammonia, and which, if re-dissolved in acetic acid somewhat concentrated, takes a carmine-violet colour. In this case the carmine tint does not pass into the violet-blue in course of time. Under the influence of the arseniates, or of free arsenic acid, the violet salts become a bright green in a few seconds in the cold, and cannot be brought back to a violet by the nitrites. Nitrate of silver does not precipitate the arsenic acid of these salts. Lœwel admits four modifications of hydrate of chrome—two green, one violet-carmine, and one violet-blue. The violet-carmine salt obtained with a nitrite gives with potash a grey precipitate insoluble in ammonia, which distinguishes this salt from the ordinary one violet-blue salt.

Relation of the Arrangement of the Acids and Bases in a Mixture of Salts.—Prof. Gladstone (British Association).—The question proposed is—Supposing two salts, such as sulphate of potassium and nitrate of magnesium, are dissolved and mixed together in equivalent proportions, is the solution identical with a mixture of sulphate of magnesium and nitrate of potassium in equivalent proportions? Evidence of the point was sought principally in the action of the two mixtures on a highly-coloured salt, such as ferric sulphocyanide, bromide of gold, or potassio-iodide of platinum. According to the laws of reciprocal decomposition, every addition of a colourless salt ought to reduce the colour of these solutions, and every different salt will probably cause a different amount of reduction; nevertheless, in a series of experiments with various salts, it was always found that the coloured salt was equally diminished in colour in which ever way the acids and bases had been originally combined.

Dissociation of Nitric Acid.—P. Braham and J. W. Gatehouse (Chemical Society).—Three series of experiments were made, the first of which consisted in exposing the vapour of the acid (sp. gr. 1·5) to various temperatures; at that of melted tin only 2·5 per cent. of the acid was decomposed, whilst at that of melted lead 20 to 30 per cent. was affected, and at a low red heat 54 per cent.; at a bright red heat 89. The products are tetroxide of nitrogen, nitrous oxide, oxygen, and nitrogen, the reaction being represented by the equation $8HNO_3 = 4NO_2 + 4OH_2 + N_2O + N_2 + O_{11}$. A very neat experimental illustration was shown by pouring nitric acid into the bowl of a tobacco-pipe placed in an inclined position, and the stem of which was heated to redness; the evolved gas was collected over water. In the second series, where the acid was exposed to sunlight, it was found that decomposition ceased before the amount of nitrous acid had reached 1·5 per cent. If, however, the products of decomposition are removed as they are formed, the action continues. From the third series of experiments it was found that nitric acid containing nitrous acid is not decomposed by boiling.

Dissociation of Sulphate of Copper.—Alex. Naumann.—If a crystal of blue vitriol is exposed, in the vacuum of Hofmann's apparatus for determining the density of vapours, to the temperature of the vapour of boiling alcohol, if the crystal is sufficiently large in comparison with the size of the vacuum, a few spots become white, especially those which receive the heat first by contact with the mercury or the side of the glass tube. As the increase of the tension becomes gradually slower and slower, the white spots extend, and arise on parts of the crystalline surface previously unattacked. But even after an hour's observation the tension still increases, whilst the white of the parts first attacked becomes a dirty or greenish white, and the crystal is affected to a greater depth. If the crystal is small the whole surface is at once attacked, but becomes gradually darker again as the tension of the vapour rises.—*Chemical News.*

Anhydrous Sulphuric Acid from the Combustion of Iron Pyrites.—A. Scheurer Kestner.—(*Comptes Rendus*).—The white fumes which accompany the sulphurous acid produced by the combustion of pyrites have been ascribed to sulphuric acid, due to the concourse of the sulphurous acid and of the moisture contained in the pyrites. But these vapours are formed with equal facility from dry pyrites, and on examination the author finds that they are condensed with difficulty, and that they are chiefly composed of anhydrous sulphuric acid, to the formation of which moisture or water can have contributed nothing. The sulphurous acid produced by the combustion of sulphide of iron in pyrites-kilns is in prolonged contact with very hot walls of masonry, or of pyrites completely or imperfectly burnt. Hence it follows that anhydrous sulphuric acid can only be formed by the decomposition of the sulphurous acid itself, or by its oxidation, the two phenomena being occasioned by the great heat to which the gases are exposed. Direct experiment proves that sulphurous acid is not decomposed, even at a temperature higher than that of pyrites-kilns. Its aqueous solution is easily decomposed if heated to 200° C. in a sealed tube, into sulphuric acid, and a deposit of free sulphur, but the gaseous acid resists heat. The presence of anhydrous sulphurous acid must therefore be ascribed to the oxidation of sulphurous acid. The sulphurous gas in pyrites-kilns being mixed with large quantities of air, we are led to suppose that the elevated temperature favours the combination of atmospheric oxygen with sulphurous acid. To determine this point, the author passed sulphurous acid, mixed with double its volume of air, through a platinum tube of 40 centimetres in length, and heated to redness. The gases before entering the tube traversed a solution of chloride of barium to serve as a proof of the absence of sulphuric acid before their passage through the tube. A solution of chloride of barium, which the gases passed through after issuing from the tube remained perfectly clear. No white vapour was perceived; consequently there was no trace of the formation of anhydrous sulphuric acid. To explain the oxidation of the sulphurous acid there remains merely the intervention of the oxygen of the ferric oxide already formed by the combustion of the sulphur of the pyrites. Further experiments proved, in fact, that the sulphurous acid is oxodised at the expense of the oxygen of the ferric oxide. This is a new instance of the remarkable oxidising powers of ferric oxide which serves to transfer oxygen from the atmosphere to the oxidisable body. The presence of sulphuric acid in the gases derived from the combustion of pyrites explains, to a certain extent, the default of oxygen which has been observed in these gases at the moment when they are directed into the leaden chambers for the manufacture of sulphuric acid. When these gases are analysed we never find a quantity of oxygen sufficient to represent, with the sulphurous acid which they contain, and the oxygen combined with the iron of the pyrites, all the oxygen of the air which has served to support the combustion of the sulphide of iron. The following is a comparison between the composition of the gas of a pyrites-kiln as found, and as calculated on the basis of 4·34 per cent. of sulphurous acid:—

	Found.	Calculated.
Sulphurous acid .	4·34	4·34
Oxygen	11·18	15·41
Nitrogen . . .	84·48	80·25

Chemical Theory of Fired Gunpowder. — Professor Debus (British Association).—The author deduced, from the analytical results published in Messrs. Noble and Abel's excellent researches on fired gunpowder, as well as from the analyses of the products of the combustion of powder published by Bunsen and Schiskoff, the following general results concerning the products of combustion—(1) the sum of the potassium contained in the potassic hyposulphite, sulphate, and sulphide, stands to the potassium in the potassium carbonate approximately in simple proportions; (2) the carbon of the carbonic oxide stands to the carbon of the potassic carbonate also approximately in a simple proportion. From this, as well as from the relation of the sum of the potassium contained in the sulphide and hyposulphite to the potassium in the sulphate, it is possible to form a theory for the combustion of powder. There are several re-actions between the constituents of powder when the latter is fired. Two of these are simultaneous; the way in which the others succeed each other cannot be accurately determined. As first, when a portion of the carbon is burned, potassic carbonate, carbonic oxide, nitrogen, and carbonic acid are produced. Simultaneously with this reaction another takes place—a portion of the saltpetre and the whole or a portion of the sulphur form potassic sulphate and carbonic acid. The action of still unburnt carbon and of free sulphur on the potassic sulphate, in a succeeding stage of the combustion, causes the formation of potassic sulphide and hyposulphite.

Combustion of Iron in Air. —The experimenter takes a straight bar magnet of some power, and sprinkles iron filings on one of its poles. These filings arrange themselves in accordance with the lines of magnetic force, and however closely they may appear to be placed, of course no two of the metallic filaments are parallel, and consequently a certain portion of air is enclosed as in a metallic sponge. The flames of any ordinary spirit lamp or gas burner readily ignites the finely divided iron, and it continues to burn most brilliantly for a considerable length of time, the combustion being, apparently, as natural and easy as that of any ordinary substance. If the experimenter with this operation stands on a slight elevation and waves the magnet to and fro while burning, a magnificent rain of fire is produced.

Vanadic Compounds in Water.—A. A. Hayes (American Association).—The beautiful suburb of Boston, Brooklin, owes its varied surface and scenic effect largely to water action in forming the gravel drift into elevations and depressions, having curved and graceful lines.

The water which supplies the wells of the district of the drift is a transparent, colourless solution of magnesian calcic, manganous, and ferrous silicates, phosphates, carbonates, and vanadates.

The deposit which forms on boiling this water resembles in composition the matter taken from rocks by weak solvents; although some of these compounds remain dissolved in water after it has been boiled.

Detection of vanadium as oxide is effected, by dissolving the deposit formed from boiling water by means of diluted nitric or sulphuric hydrate. In this solution, the addition of a slight excess of ammonic hydrate, and a moment after a considerable excess of ammonic carbonate, insures the reduction of any vanadic compound by the manganous and ferrous oxides, and separation of other compounds than magnesic oxide and the blue vanadous oxide, which appears in solution of a rich blue colour. In a nearly closed vessel, a bright strip of zinc will withdraw vanadous oxide from the blue solution, at first as a thin bronze coating, afterwards as a black crust.

I believe this is the first discovery of vanadic compounds in water.

Manganous salts have been observed in waters where humic acid has acted on rocks containing manganous carbonate, and the existence of a water of this kind is known to me; but it must be considered quite apart in composition from a water in which soluble silicates include manganous silicate as part of a compound possessing novel characters.

Strontium Sulphide.—Sergius Kern (*Chem. News*).—By the following method, strontium sulphide (SrS) is easily formed :—Concentrated solutions of strontium chloride ($SrCl_2$) and sodium hyposulphite ($Na_2S_2O_3 + 5H_2O$) are mixed together; the solution contains, then, sodium chloride (NaCl) and strontium hyposulphite (SrS_2O_3), both soluble salts, so that no preciptate is formed :—

$$SrCl_2 + Na_2S_2O_3 = SrS_2O_3 + 2NaCl.$$

The strontium hyposulphite may be precipitated by ordinary alcohol, or, as it was found better, by methyl alcohol (C_2H_4O); the precipitate is washed, dried, and strongly heated. The strontium hyposulphite is then decomposed by the heat, and the remainder is a mixture of strontium sulphide (SrS), strontium sulphate ($SrSO_4$), and a small quantity of free sulphur. The following equation represents the decomposition of the salt :—

$$2SrS_2O_3 = SrS + SrSO_4 + S + SO_2.$$

To obtain pure strontium sulphide, the mass resulting from the heating of strontium hyposulphite is converted into powder and dissolved in water; the strontium sulphide (SrS) remains in solution, and a precipitate is left containing strontium sulphate and free sulphur; the solution is filtered and evaporated on a sand-bath, and the pure strontium sulphide is dried over sulphuric acid.

Titanium Oxychloride.—Friedel and Guérin (Soc. Chim. de Paris).—This compound was previously observed by Ebelmen, who took it to be the protochloride. It is produced by passing a current of hydrogen and of tetrachloride of titanium through a tube heated to bright redness, and containing titanic acid. Sesquichloride, Ti_2Cl_6, is formed simultaneously. The oxychloride appears in brown rectangular lamellæ, which are red by transmitted light, and under the polarising microscope present the characters of orthorhombic bodies. Its composition is $Ti_2O_2Cl_2$. If treated with ammonia it yields titanic acid, with disengagement of hydrogen, resulting from the oxidation of the sesquioxide of titanium. The titanic acid in the tube is transformed into a crystalline mass of a fine coppery metallic lustre. This is the sesquioxide, Ti_2O_3, and presents exactly the crystalline form of oligistic iron ore from Elba. This identity of form confirms the explanation which M. Friedel has already given of the varying composition of titaniferous irons. They are merely mixtures of isomorphous compounds.

Alloys of Platinum and Iridium with Iron.—H. Sainte-Claire Deville.—On analysing platin-iridium, by a method which will soon be made public, iron and platinum are united in the state of oxides intimately mixed. If this matter is treated with a current of hydrogen, oxide of iridium is reduced at common temperatures, and the iron at temperatures from 200° to 600° C. The metals are then alloyed, for if digested with hydrochloric acid, a few bubbles only of hydrogen escape, and very little iron is dissolved, even when it exists in the alloy to the extent of 10 per cent. Iron and iridium are thus capable of combining at low temperatures, and the same is probably the case with iron and platinum. Under these conditions the alloy is evidently not homogeneous. Breithaupt admits the existence of platinum ores containing 14 to 19 per cent. of iron. Berzelius, only once, however, found a specimen containing as much as 12·98 per cent.; and M. Debray and the author have never found more than 12. Platinum may be freed from iron by cupellation in chlorine gas. If heated from 1200° to 1500° C. in this gas, the iron is volatilised in the form of brilliant crystals, and deposited in all the hot parts of the apparatus.

Ruthenium and its Oxides.—H. Sainte-Claire Deville and H. Debray (*Comptes Rendus*).—Pure ruthenium is as sparingly fusible as iridium; and if heated in an oxidising atmosphere it burns with brilliant sparks, a smoky flame, and a decided odour of ozone. The authors submitted ruthenium to the action of oxygen in a porcelain tube, heated to a temperature a little higher than the melting-point of copper. Fremy's crystals were thus reproduced in very fine specimens, into which the whole mass of oxide was transformed, only a very small portion having been transported by sublimation outside the "boat" which it had filled. This observation connects the phenomena with the "apparent volatilisations" of which Troost, Hautefeuille, Ditte, and the authors have given numerous examples. These facts have been explained by the momentary production of an unstable compound, which is dissociated almost at the time of its formation. Hyper-ruthenic acid (RuO_4), the analogue of osmic acid discovered by Claus, is yellow, crystalline, but so unstable that its form has not been determined. It melts at 40° C., and at 108° C. it is destroyed with explosion. When decomposed, it yields strongly ozonized oxygen. Osmic acid, on the contrary, produced by the direct action of oxygen upon metallic osmium, may be maintained in the state of vapour without decomposition. Ruthenic oxide is not reduced by heat like the oxide of iridium. It is found along with iridium, iron, and even platinum in most precipitates and solutions which contain at the same time the two former metals. Iridium, especially, retains ruthenium with great tenacity. Mr. Matthey informs the authors that four or five repetitions of Claus's process do not always suffice to free iridium from the last traces of ruthenium.—*Chemical News*.

Barium.—Sergius Kern (*Chem. News*) proposes to prepare metallic barium by a new process. Pure iodide of barium is first obtained by acting on barium hydrate with iodine, and passing a current of sulphuretted hydrogen through a solution of the product; any iodate is thus converted into iodide. On heating the iodide with metallic sodium, the barium is set free, and may be separated by means of mercury.

Thallium.—The following method of obtaining thallium from the soot of sulphuric acid works has been devised by Herr Stolba. In repeatedly working up the soot of two sulphuric acid works in Germany, where pyrites from Meggen were employed, a method was employed for separating the thallium, which depended upon a formation of a thallium alum. The soot is first passed through a coarse sieve to remove the pieces of brick, mortar, and clay mixed with it, and then boiled in water acidified with sulphuric acid. It is next placed on a suitable filter and stirred during careful washing with hot water until all the acid is removed. The wash-water, after acidifying, can be used for boiling a second portion in, and so on. The first filtrate, which is tolerably concentrated, is evaporated in very shallow dishes to such a degree as to crystallise. Beautiful large reddish crystals of thallium-alumina-iron alum are formed as it cools. The mother liquor has sulphate of alumina added to it, and is again evaporated, when a small quantity of mixed alums separates. The last mother liquor, as well as the rinsings from the crystals, when precipitated with crude hydrochloric acid, yield a surprisingly small quantity of chloride of thallium.

The crystals of thallium-alum are recrystallised twice from water containing sulphuric acid. The alum thus obtained is so pure that it yields pure thallium when acted upon by pure zinc and pure sulphuric acid, and with a pure hydrochloric acid, pure chloride of thallium is precipitated.

The crude chloride of thallium may be prepared in the usual manner, and next converted into sulphate by means of sulphuric acid, and finally, by means of sulphate of alumina, into thallium alum, which can be purified by recrystallisation. The first method is, however, more convenient, because it does not involve the troublesome decomposition of the chloride by means of sulphuric acid. As the thallium alum is considerably more soluble in hot than in cold water, the conversion of the much less soluble sulphate into the more soluble alum offers the great advantage that the latter can be recrystallised from a much smaller quantity of water, which is more convenient and requires less time. Besides this, the alum is a compound easily converted into the chloride or iodide, from which the metal is easily obtained.—*English Mechanic.*

Dr. Hammerbacher (*Liebig's Annalen*) states that he has detected thallium in the mineral called Carnallite: which is a chloride of magnesium and potassium, occurring above the rock-salt of Stassfurt in Prussian Saxony. The carnallite exhibited in the spectroscope traces of thallium, rubidium, and cæsium; but it was not found possible to isolate the thallium. Sylvine, or native chloride of potassium, from the same deposits, showed the presence of rubidium and cæsium, but not of thallium; whilst the other potassium-salts, polyhalite and kainite, appear to contain none of these metals.

Salicylic Acid.—E. R. Squibb.—Salicin is a glucoside, or neutral vegetable principle discovered by Leroux in 1830, in the bark of the willow, *Salix*, whence its name. It was afterwards found in various species of poplar, and in other trees and plants. Salicin was chiefly investigated by Piria, who gave an elaborate account of its derivatives, and among these, of salicylic acid. Early in its history the acid was prepared by Löwig and Weidmann from the flowers of *Spiræa ulmaria;* and later, a research by Prof. Procter, of Philadelphia, showed that our oil of wintergreen, *Gaultheria procumbens*, was really a salicylous ether; and from this source salicylic acid was obtained by Cahours. Gerhardt and others contributed to the researches by which the properties and reactions of salicylic acid were accurately determined and its composition fixed; but as yet it was but a chemical curiosity whose potential possibilities were quite unknown. It still belonged to that class of substances which had simply consumed a large amount of patient labour, and in relation to which the rigid utilitarian asked Michael Faraday, "What is the use of such things?" and received for reply the answer, "What is the use of a baby?"

The physiological and pathological effects of salicin, though imperfectly investigated, seem to have gradually and slowly directed attention to those of its derivatives, and occasional paragraphs have appeared in current scientific literature, from time to time, upon salicylic acid for some years past. But only within the last year or two have German writers alluded to its peculiar and powerful effects as an antiferment, and antiseptic.

These reactions of salicylic acid producing a demand for it, the German chemists, Kolbe and Lautemann, sought for an organic compound which from its elementary composition might be split or dissociated into the desired new compound salicylic acid. This substance, whose molecule might be broken up, they found in phenol, the so-called carbolic acid. The agent which they selected to resolve the molecule of phenol into other molecules, one of which should be salicylic acid, was dry carbonic acid. Thus from the action of carbonic acid on carbolic acid, salicylic acid is produced; a process which is about as far from the original willow tree as a source of the acid as can well be imagined, and yet a process which is as much the result of human knowledge based upon human research as that by which Le Verrier and Adams discovered the planet Neptune.

It appears that where phenol or cresol, and perhaps others of the class of phenols, are combined with an alkali metal such as sodium or potassium, thus forming phenol-sodium (often called phenate of soda) for example, and well dried carbonic anhydride is passed through the dry powder of phenol-sodium heated to 100° to 250° C. = 212° to 482° F., the reaction occurs which produces salicylate of sodium and other compounds. The salicylate of sodium thus formed is dissolved in water and decomposed by hydro-chloric acid, which, uniting with the sodium by superior affinity, sets free the salicylic acid in the form of small crystals. These crystals are washed and re-crystallised from a hot solution, and when dried form a crystalline powder of a light brown colour, somewhat resembling the powder of pale cinchona bark.

This is unbleached salicylic acid, and is probably pure enough for most of the purposes to which the acid is at present applied. The small proportion of colouring matter which it contains is held with great tenacity, and the further processes by which it may be obtained white are so troublesome and expensive, that they more than double the cost of production. This bleaching may be accomplished in various ways. Kolbe recommends that it be converted into an ether, and this ether be again decomposed. Whether bleached or unbleached, the acid is in minute broken acicular crystals, which give it the appearance of a granular powder, soft and smooth under the pestle or knife, but somewhat rough or resinous when rubbed between the fingers. The powder is odourless. It has a sweetish and astringent after-taste, though itself tasteless.

It is insoluble in cold, but is very soluble in hot water; and the water of a hot solution retains when cold, in proportion to its coldness, from about 1 part in 250, to 1 part in 500 of the solution. The presence of various neutral salts in small proportion in the water render it far more soluble. Up to this time phosphate of sodium seems to have been chiefly used in Germany to render it more soluble in water for medicinal purposes, and it is said that 3 parts of phosphate of sodium will render 1 part of the acid easily soluble in 50 parts of water. It is much more soluble in alcohol and ether than in water. It melts at about 125° C. = 257° F., and sublimes at about 200° C. = 392° F. In common with other similar acids it forms salts with the principal bases, but these seem thus far to be difficult to make, and their effects have not been investigated.

It is used for medical and surgical purposes either dry or in solution. When used dry it is sprinkled on to wounds, ulcers, or dressings in the form of very fine powder, in very small quantities, either simply powdered, or mixed in various proportions with some diluent, such as starch. When used in simple solution either for spraying surfaces, or for washes or gargles, it is used in tepid solution of about 1 part to 300 parts of water. Where stronger solutions are required for washes, gargles, or to moisten dressings, 1 part of the acid and 3 parts of phosphate of sodium to 50 parts of water have been used.

Its alleged advantages over all other antiseptics are: First, that it is far more powerful and effective in smaller quantities; and secondly, that it is, in all quantities necessary for complete effectiveness, entirely devoid of irritant action upon the living tissues. It is not caustic nor corrosive in any quantity, and never produces inflammation. In large quantities it may be irritant and painful, but yet rarely surpasses a stimulant effect, while it appears to be quite neutral in the very small quantities which are yet thoroughly effective; thirdly, it is said to reach and prevent processes of decomposition which are beyond the reach of all other antiseptics or antiferments. These processes are of two kinds, namely—vital, or those in which living organisms have an important part, such as that produced by yeast and many of those which occur in putrefaction; and chemical, or those which occur independent of vitality, as the production of the volatile oils in mustard and bitter almonds, the effect of diastase, &c. Now, while carbolic acid and other antiferments are azymotic, or completely arrest or prevent fermentations of the first kind, they are powerless with the chemical processes. Salicylic acid is said to be more effective with the vital ferments, and equally effective with the chemical.

Fourthly, in quantities said to be thoroughly effective, it is entirely odourless and tasteless, and harmless, whilst it has no poisonous effect in any reasonable quantity.

It prevents or arrests the souring of worts, washes, and beers of the brewers, and prevents or arrests the putrefactive agencies which are so troublesome and destructive to the glue manufacturers; and these and similar trades have thus far seemed to be its principal consumers. Separate portions of fresh milk set aside to become sour, one to which 0·04 per cent. of salicylic acid was added, soured thirty-six hours later than the other.—*Chemical News.*

Carbolic Acid.—M. Schnitzler (*Chem. News*).—Raw phenate of soda is strongly heated in a copper still. Water, naphthalin, oils, and a little carbolic acid pass over, and the fire is removed when the distillate begins to run milky: 15 kilos. require about ten hours. The greater part of the carbolic acid remains combined with the soda as a solid mass. The temperature of the vapour, during distillation, may reach 170° C. The solid residue is afterwards dissolved out in triple the quantity of water necessary. This liquid is allowed to settle for some days, when certain impurities are deposited. Dilute sulphuric acid is then added to the clear liquid, the carbolic acid is decanted and distilled in glass vessels. Water passes over first, then pure carbolic acid, which crystallises entire; and, lastly, a less pure carbolic acid, which, even after crystallization, retains some oily impurities.

Tartaric and Citric Acids.—R. Warrington (Chemical Society).—The author has found that the crystallised citric acid, as prepared in Mr. Lawes's manufactory, invariably contained one molecule of water, which it lost in the water-bath, but not always *in vacuo* over sulphuric acid, for, strange to say, he had noticed that, in some instances, the acid did not lose weight under these circumstances. Citric acid is now made almost entirely from lemon-juice prepared from the windfalls and imperfect fruit. In its unconcentrated state it contains 8—9 ozs. of acid per gallon, whilst that expressed from the fruit imported into England contains 10½—12½ ozs. There are usually about 64 ozs. of free citric acid per gallon in the concentrated juice, and 6 or 7 combined with bases; of the total acid about 8 per cent. is not citric acid. In treating of tartaric acid the author, after noticing the fact that tartaric acid can never be fused without the production of ditartaric acid, and the effects of various salts and acids on the solubility of potassium bitartrate, explained what "lees," argol, and tartar were. The lees which are deposited at the bottom of the cask vary in the amount of tartaric acid which they contain in the state of potassium bitartrate, and of calcium tartrate, the latter being very large in proportion to the former in those countries, such as Spain and France, where it is the custom to add plaster to the grape-juice before fermentation, whilst in Italian lees, where plaster is not used, the tartaric acid exists chiefly as the acid potassium salt. The beneficial effect of the addition of native plaster, which contains calcium carbonate, in reducing the acidity is due to the fact that calcium tartrate is precipitated, and a solution of neutral potassium sulphate produced in which potassium bitartrate is very slightly soluble. Argol is the impure potassium bitartrate deposited on the sides of the cask, whilst tartars, some of which contain as much as 76 per cent. of tartaric acid, are manufactured from the argol by extraction with hot water and crystallization. He had found that the indirect methods of estimating the amount of tartaric acid in these substances by determining the potash, lime, and sulphuric acid present, and calculating the tartaric acid as acid potassium tartrate, and neutral calcium tartrate, were open to grave objections, since the sulphuric acid present might exist either as potassium or calcium salt. These objections applied with still greater force to the analysis of lees. It was necessary, therefore, to devise a method for determining the amount of tartaric acid directly. This was effected by adding a slight excess of potassium oxalate, neutralising with potash and separating the calcium oxalate precipitate. To the filtrate, which now contains all the tartaric acid as neutral potassium tartrate, citric acid is added in excess; this precipitates the tartaric acid as acid potassium tartrate, which is collected and weighed, a correction being made for that remaining in solution. It is a curious fact that, although pure citric acid can be neutralised by chalk, concentrated lime-juice cannot. This seems to be owing to the phosphoric acid and iron present in the latter, as it was found to be impossible to neutralise a solution containing iron, citric acid, and phosphoric acid even by protracted boiling with chalk.

Inverted Sugar.—M. Maumené has described to the French Academy a series of experiments on inverted sugar, so called from its action on polarised light. Cane sugar, consisting of $C_{12}H_2\ O_{11}$, is crystallisable, and produces a right-handed rotation of polarised light. Inverted sugar, stated to be composed of $C_6H_{12}O_6$, is not crystallisable, and gives a left-handed rotation. M. Maumené finds inverted sugar has no constant composition, but is a mixture of various proportions of glycose, chylariose, and neutral sugar. Acting upon very white Narbonne honey with alcohol of 90° C., then cooling the solution to near zero C., separating a heavy layer, adding water, and filtering, gives a fluid which is easy to examine with a saccharimeter and marks zero—it contains neutral sugar. Acting upon this sugar with lime water, passing through it a current of carbonic acid, which occasions a pure blue precipitate of carbonate of lime, and filtering, affords a solution that gives a right-handed rotation of 8° to 10°. The substance left on the filter was divided into two parts, and to one water was added, dissolving the chylariose and giving a very white preciptate of carbonate of lime. The clear fluid produced a left-handed rotation of 5°, equal to 47·5° for a volume of 100. The insoluble matter diffused through water carbonated and filtered showed 13° left rotation, or 91° for a volume of 100. M. Maumené adds that inverted sugar burns much more readily than common sugar—a fact of importance in analysis when the quantity of ash has to be ascertained. —*Academy.*

Action of Ammonia on Flowers.—If flowers naturally coloured violet are exposed to the smoke of a cigar, they are observed to change colour and assume a green hue, which is more pronounced the more intense the original colour. This effect may be had, *e.g.*, with the Thlespi violet, or *Iberis umbellata*, and the Julian, or *Hesperis matronalis.* The change is due to ammonia in the tobacco. Starting from this phenomenon, Professor Gabba has made a number of experiments to ascertain the changes produced by ammonia in the colours of different flowers. His method was to put a little ammoniacal solution in a basin, and place a receiver over it, containing the flower. In this way he found blue, violet, and purple flowers became green, carmine-red flowers black, white flowers yellow, &c. The most singular changes were presented by flowers in which several tints are combined; the red lines changed to green, the white to yellow, and so on. Another remarkable example is that of fuchsias with white and red flowers, which the ammonia changed to yellow, blue, and green. After the flowers have undergone these changes, if they are placed in pure water, they retain their new colouration several hours, then gradually resume their original hue. Another observation by M. Gabba is, that the flowers of Aster, which are naturally inodorous, acquire an agreeable aromatic odour under the influence of ammonia. They change from violet to red when moistened with dilute nitric acid. On the other hand, if enclosed in a wooden case, where they are exposed to vapours of hydrochloric acid, they assume, in six hours, a beautiful carmine red, which they retain, when placed in a dry and shaded place, after being dried in the air, and in darkness.—*English Mechanic.*

Moderated Oxidation of the Carbides of Hydrogen: Amy-

len.—M. Berthelot (*Comptes Rendus*).—The constitution of organic compounds, *i.e.*, the system of more simple bodies by means of which the former may be produced, and which may in turn be reproduced therefrom, should be studied by having recourse to the most moderate reactions, the lowest temperatures, and the least violent agents. For instance, pure chromic acid should be preferred to bichromate of potash mixed with sulphuric acid, which most chemists employ in studying the constitution of the carbides of hydrogen by way of oxidation, and which they designate by the abridged but incorrect name of chromic acid. In fact, true chromic acid gives rise to products less remote from the oxidised body, especially if it is used cold, and in a dilute solution, under which circumstances it gives up merely the fifth part of its oxygen, and becomes chromic chromate, instead of losing the half, and passing into chrome alum. The author has already shown the efficacy of this reagent for changing camphen into camphor, ethylen into aldehyde and acetic acid, acetylen into acetic acid, allylen into oxide of allylen and propionic acid, propylen into aceton and propionic acid. He now extends his researches to amylen derived from amylic alcohol of fermentation, as well as hydride of amylen of the same origin. A mixture of acids was formed in about the following proportions:—

Valerianic acid . . .	36
Butyric acid	16
Propionic acid . . .	17
Acetic acid	28
Formic acid	3

In the course of his experiments he finds that propionic acid is displaced by all the others; next follows the butyric; valerianic displaces the two former, but it is in turn expelled by the acetic, and this again by the formic. These results, however, are merely approximate, as there is always some partition of the base among the acids employed. The regulated oxidation of propylen yields, as main products, propionic acid and aceton, with a little acetic, formic, and carbonic acids.

Salts of the fatty acids.—M. Berthelot (*Comptes Rendus*).—The author finds that the alkaline salts of the fatty acids, in presence of water, behave like compounds intermediate between the salts of the strong acids, which are not appreciably decomposed by water, and the salts of the weak acids (carbonates, borates, &c.), which are partially decomposed by water in the ratio of its quantity, and with a tendency to the simultaneous formation of an acid salt and of free base. This analogy between the fatty acids and the weak acids becomes more striking as their equivalents rise; from formic acid, which is almost as energetic as the powerful mineral acids, to the valerianic, whose neutral salts easily become acid by evaporation; and to the stearic and margaric, whose alkaline salts (soaps) are readily decomposed by cold water.

Purpurin, synthesis of.—Felix de Lalande (*Comptes Rendus*).—Having caused nitrate of methylen to act upon alizarin in sealed tubes at 100° C. for several hours, the author obtained, after evaporation of the liquid, a body having the aspect of alizarin, and dyeing with aluminous mordants an orange-yellow; not very bright. In contact with water, and more rapidly with alkalies, this substance is transformed into a new colouring matter, the properties of which have a certain analogy with purpurin, being, like it, soluble with a gooseberry-red in alkalies, and dyeing a red with alum mordants. Strecker, in 1869, obtained an analogous body by the action of fuming nitric acid upon alizarin.

When boiled in water it gave rise to a compound analogous to purpurin, which Strecker named nitroxyalizarin, or nitro-purpurin. The author has prepared this body according to Strecker's process, and finds it identical with the substance obtained by the action of the nitrate of methyl. Purpurin treated with nitric acid gave a body having the same properties as nitroxyalizarin, whence the author concludes that the latter is the nitro-compound of purpurin. Hence he inferred that in the action of nitric acid upon alizarin it may be divided into two phases—the transformation of alizarin into purpurin; and, secondly, the nitro-substitution of the latter.

Photographs without Silver Salts.—*Photographic News.*—Dr. Diamond has obtained very good prints by the following process:—

Solution No. 1:—

Nitrate of uranium...350 grains
Nitrate of copper.....100 ,,

Dissolve in 5 oz. of distilled water, and pour into a flat glass dish. Pass any ordinary paper through it which has been sized with gelatine; ordinary writing-paper answers remarkably well, but thin Whatman or Turner's paper he finds to be the most reliable; an immersion of a couple of minutes is sufficient to enable the paper to be thoroughly permeated by the solution; it is then suspended and dried in the dark, and will keep any length of time good for use, just as the old iodised paper does in the calotype press. The paper will acquire a compactness very similar to what is called the vegetable parchment. In use, he believes it to be as sensitive as the usual excited silver paper—ten minutes may be a medium time for exposure under an ordinary glass negative. When removed from the printing-frame, a faint resemblance of the future picture is observed. It should then be passed through the following solution, drawing it to and fro to insure equality of immersion. The image immediately starts out, of a rich, brownish red, and a bronze-like lustre; and when the exact exposure has taken place, there is little difference in viewing the image on either side, the deposit being in the very substance of the paper; in fact, it gives a very pleasing result viewed through as a transparency.

Solution No. 2:—

Ferridcyanide of potassium.. ½ oz.
Distilled water....................20 oz.

When the image is fully developed, remove the picture to another vessel having clear water in it, and wash away the soluble salts remaining, continuing the washing until the paper is clear, and then dry it.

No fixing is required, and it may remain without being mounted unless desired; if printed with a margin, and a shaped mask used, it becomes admirably adapted for book illustration, and avoids the disagreeable curling up which so often is the case.

If the paper, after being sensitised, has more than a small amount of light admitted to it, there will be a difficulty in removing the waste salts. This is the chief care found to be requisite.

Some prints of equal excellence, possessing a velvety black tone, are produced by means of a final immersion in a solution of the chloride of platinum, and other tints by various other solutions.

Photographic Properties of the Salts of Vanadium.—J. Gibbons (*Les Mondes*) finds that a sheet of paper steeped in a solution of a vanadic salt, and dried, gives, on exposure to the light, a good image under the influence of uranic salts.

Silver Nitrite.—Mr. Gatehouse (British Association).—The author gave the results of investigations into the causes of what is termed by photographers "woolliness" in their negative baths.

The five methods given of preparing the nitrite were as follows:—

1. By mixing solutions of potassium nitrite and silver nitrate.

2. By sensitising a collodion film and evaporating to dryness a mixture of nitrite and nitrate is obtained.

3. By fusing silver nitrate with organic matter.

4. By electrolysis of silver nitrate with platinum electrode.

5. By means of metals placed in neutral solution of silver nitrate.

By this last method he found that metals which produced reduction, viz., K, Na, Bi, Hg, As, Th, did not produce nitrite, but those which did not produce reduction, viz., Fe, Ni, Co, Mg, Zn, Cu, Pb, Sn, Sb, did produce nitrite. The former, it was observed, have an uneven equivalency, and the latter an even equivalency, with the exception of Hg and Sb. The physical forms of the crystals were observed to vary from nodular masses to filiform crystals.

Some Reactions of Bromine and Iodine.—Professor C. Schorlemmer (Lit. and Phil. Soc., Mancheser).—Although it is well known that iodine dissolves in chloroform and some other liquids, such as carbon-sulphide and petroleum-naphtha, with a fine purple and bromine with a yellow colour, it seems not to be known that, under certain conditions, a colourless solution may be obtained containing both these elements in the free state.

Thus on adding dilute chlorine water drop by drop to a weak solution of potassium iodide and bromide, containing an excess of the latter, and shaking the liquid at the same time with chloroform, the purple colour of the iodine makes its appearance, but gradually becomes fainter and at last disappears completely. It is, however, not easy to hit exactly the point, when the chloroform becomes quite colourless, but this is readily effected by adding so much chlorine water that the chloroform assumes a faint yellow tint, and then shaking the liquid with a cold and dilute solution of sodium bicarbonate, which must be carefully added drop by drop. It is easily proved that the colourless solution thus formed contains both free bromine and iodine, for on adding more bicarbonate, in order to remove the free bromine, the purple colour gradually appears again.

I am not able as yet to explain these facts; it is not a case of two complementary colours neutralising each other as I first assumed; for on mixing dilute solutions of the two elements in dry chloroform no colourless solution can be obtained. It seems that the presence of water has something to do with it, for on adding the solution of bromine to that of chloroform until the purple is changed into a light brown, then shaking well with water, the colour of the chloroform becomes much paler and even disappears almost completely.

Action of Electrolytic Oxygen on Vinic Alcohol.—A. Renard (*Chemical News*).—When vinic alcohol, mixed with about 5 per cent. of water acidulated with one-fourth of sulphuric acid, is submitted to the current of four or five Bunsen elements, there is observed an abundant escape of hydrogen gas at the negative pole, whilst at the positive pole no gas is disengaged, the oxygen being consumed in oxidising the alcohol. After forty-eight hours, when operating upon about 100 c.c. of a mixture of alcohol and acidulated water, the experiment is concluded. The liquid has a faint amber tint. If distilled, it begins to boil at 42° to 43° C., and its boiling point gradually rises to 80° C. The distillate, treated with chloride of calcium, sends up to its surface a liquid of a powerful odour, the quantity of which increases on adding water to the saline mixture. If the liquid is submitted to fractional distillation, it yields formiate of ethyl mixed with aldehyd, and a large quantity of acetate of ethyl; but, besides these products, there are formed acetal, and a new body—monoethylate of ethyliden. These two compounds, in spite of their elevated boiling points (88° to 90° and 104° C.), are nevertheless found among the first portions which distil over, by reason of their small proportion.

Inflammability of Glycerine.—Herr Oppenheim (*Deut. Chem. Ges.*).—Using some chemically pure glycerine (sp. gr. 1·2609) from a candle manufactory in Vienna, the author found, that when heated to 150° C. it took fire and burned with a steady, blue, non-luminous flame, giving out no smell (even after extinction), and leaving no residue. Glycerine of less specific gravity may be lit from a wick.

Passing the Mixed Vapours of Carbon Bisulphide and Alcohol over Red-Hot Copper.—T. Carnelley (Chemical Society).—The author thought it possible that by this means normal pentane might be formed; but it was found that the products consisted of ethylene, acetylene, methane, hydrogen, and carbon oxysulphide, but that neither sulphuretted hydrogen nor sulphurous anhydride was produced. With the exception of the carbon oxysulphide, therefore, the same result was obtained as when alcohol vapour is passed through a red-hot tube.

Kauri Gum.—(*Nature*).—One of the chief products of Auckland, New Zealand, is this gum, the semi-fossil resin of *Dammara australis*. It is found in no other part of the world. The resin is found at a depth of from two to three feet from the surface, over a large area of land once covered by Kauri forests, and as many as 2,000 men have found employment at one time digging up the Kauri resin. The Maoris bring a considerable quantity to market. The best quality fetches at Auckland from 30*l.* to 33*l.* per ton.

Tobacco Smoke.—Dr. Otto Krause (*Dingler. Polytech. Jour.*) finds tobacco smoke always to contain a considerable quantity of carbonic oxide. The after effects of smoking, he says, are principally caused by this poisonous gas, as the smoker never can prevent a part of the smoke from descending to the lungs, and thus the poisoning is unavoidable. The author is of opinion that the after effects are the more energetic, the more inexperienced the smoker is. A writer in *Nature* asks, with reference to the above statement:—"Is Dr. Krause acquainted with the manner in which cascarilla bark modifies the physiological effects of tobacco smoking? The addition of a few very small fragments of the bark can hardly be supposed to materially affect the amount of carbonic oxide produced; and yet, with such an admixture, the strongest tobacco may be smoked by a tyro without, in most cases, the production of the usual nauseating effects."

Wax and Honey.—Dr. de Planta Reichenau (*Bibl. de Genève*).—The presence of nitrogen in honey has often been questioned. The author, however, after analyses of many varieties, has proved the existence of nitrogen, although not in greater proportion than 0·0781 per cent. This nitrogen occurs under three distinct forms; as an albuminous substance coagulable by heat, and as two other nitrogenous bodies, one soluble and the other insoluble in alcohol; the latter substances are found in nectar, but the coagulable albumen not occurring in the juice of the flowers, is referred by the author to a secretion by the bee, which becomes mixed with the nectar. Honey is therefore strictly a nitrogenous body, and not simply a carbo-hydrate. Bees' wax contains 0·597 per cent. of nitrogen.

Milk in Health and Disease.—A. H. Smee (Chemical Society).—The author finds that, although milk taken from herds of cows exhibits great uniformity in composition, yet the milk from individual cows is liable to considerable variation; moreover it is possible for good average milk to be watered to a limited extent without detection. He observed, also, from a comparison of the milk from cows fed on ordinary meadow grass and on grass from a sewage farm, that in the latter case the milk went putrid after thirty-six hours, and the butter became rancid rapidly compared with that made from the milk of cows fed on ordinary meadow grass. These effects were more apparent in spring than in the latter part of summer. On three or four occasions, also, he noticed that, when the milk of cows fed on sewage grass was placed on a dialyser, the casein passed through the membrane, from which it would appear that the casein existed in these milks in a modified form. Moreover, milk which had been exposed to sewer-gas from an untrapped drain, although on analysis it appeared to be unaltered in composition, yet when distilled at a low temperature (160° F.) yielded a distillate which had a very offensive smell. It also caused intense headache, which was followed by diarrhœa. He also examined the milk of cows suffering from foot-and-mouth disease and from milk fever, and thought that the methods employed by public analysts were not sufficiently delicate to detect the slight physiological changes which may take place in so complex a fluid as milk.

Presence of Peroxide of Hydrogen (H_2O_2) in the Sap of Plants. — J. Clermont (*Comptes Rendus*).—The researches of Schönbein and Meissner demonstrate that the molecule of oxygen (which they regard as diatomic), is transformed under the influence of electricity into ozone and antozone, one of the two atoms composing the molecule being charged with negative, and the other with positive electricity. Antozone, or electro-positive oxygen, cannot be produced without a parallel development of electro-negative ozone, and *vice versâ*. M. Meissner has further shown that antozone has the power of causing water to pass to a higher state of oxidation, H_2O_2. On the other hand, it appears that a great part of the oxygen liberated by plants is found in the state of ozone. The author has, from these considerations, been led to seek for peroxide of hydrogen in the juice of a great variety of plants, such as tobacco, the vine, lettuce, &c. The plants were quickly bruised in a vessel containing distilled water, which being then examined with Schönbein's test —a mixture of iodide of potassium, starch, and a proto-salt of iron—gave distinct indications of the presence of peroxide of hydrogen.

Formation of Sugar in Fruits.—M. Mercadante (*Chemical News*).—In the first period of their existence fruits behave like leaves, decomposing carbonic acid under the influence of the sun's rays, and giving out oxygen. In the second period they absorb oxygen and give off carbonic acid. In the third the sugar which they contain passes into the alcoholic fermentation. On the 20th of May the author began to determine the acidity and the sugar in green plums. The acidity and the sugar were found to increase very sensibly. The branches contained no other acid than the malic, accompanied by pectic and gummy matters. The fruit behaved exactly like leaves with respect to the air, giving out oxygen by day and absorbing carbonic acid. Continuing his analyses he found that the maximum acidity was when the fruit began to give off carbonic acid by day. It contained then 2·76 of malic acid in 100 of pulp. The sugar is derived from the prolonged action of the malic acid upon the gummy matter, which in the earlier analyses amounted to 6·21 per cent. of pulp, but in the second to 3·34, at which quantity it remained nearly constant, 3·27 per cent. of gum being still found on July 18. The successive changes in the amounts of sugar and malic acid are shown in the following table:—

	Sugar.	M lic Acid.
June 20 . .	16·52	2·76
,, 24 . .	16·64	2·46
,, 30 . .	16·78	2·16
July 4 . .	17·048	1·57
,, 12 . .	17·38	0·82

The acids themselves thus appear to be transformed into sugar.

Functions of Fungi. — M. Müntz (*Chemical News*).—It is well known that fungi, placed in an atmosphere containing oxygen, absorb this gas, and give out carbonic acid in equal volume. Marcet shows that when the oxygen is consumed they develop carbonic acid at the expense of their own substance, but their production of hydrogen is not unanimously accepted. The author's experiments prove that if oxygen is excluded the production of hydrogen is considerable.

Guano. — George Birdwood (*Athenæum*).—The mention of Guano in the following work is probably the earliest use of the word in any book in the English language. The title of the book is "The Art of Metals, &c.," by A. A. Barba, Curate of St. Bernard's, Potosi, Peru, 1640. Translated in the year 1669, by the R. H. Edward, Earl of Sandwich.

The extract is from pp. 6, 7:—"Out of Islands in the South Sea, not far from the City of Arica, they fetch Earth . . . . It is called Guano (*i. e.* Dung), not because it is the dung of Sea-fowls (as many would have it understood), but because of its admirable vertue in making ploughed ground fertile. It is light and spongy, and that which is brought from the island of Iqueyque is of a dark grey colour, like unto Tobacco ground small. Although from other Islands near Arica, they get a white Earth inclining to a sallow, of the same vertue. It instantly colours water whereinto it is put, as if it were the best leigh, and smells very strong. The qualities and vertues of this, and of many other simples of the new world, are a large field for ingenious persons to discourse Philosophically upon, when they shall bend their minds more to the searching out of truth than riches."

Powdered Manure. — M. Menier (*Ann. de Chim.*), seeks to show that pulverisation renders the effect of the manure more rapid; and that in pulverising the manure mechanically, instead of leaving it to be done by the weather, there is considerable economy; that wind or watermills which have been abandoned as mills for corn or oil, may be used as mills for manure; and, lastly, that phosphatised or potassic minerals, that are useless in the rock-form, become fertilisers when reduced to impalpable powder.

Solubility of Phosphates.—Jules Joffre (*Chemical News*).—In France it is generally admitted that the soluble phosphate of all manures is immediately rendered insoluble under the influence of the carbonate of lime found in arable soils. These views require to be considerably modified when certain substances are present. The acid phosphate of lime ($CaP_2O_6 2H_2O$) brought in contact with carbonate of lime in excess and with much water gradually loses its solubility. But if certain substances are added, the result may be very different. The author placed 0·11 grm. of phosphoric acid, in the state of acid phosphate, in contact with 4 to 5 grms. of carbonate of lime, and left them for some days. There remained, after the lapse of a few days, only 21·8 per cent. of soluble phosphoric acid. On adding oxalate of lime there remained, after an equal time, 39·1 per cent. On adding sulphate of ammonia there remained 30·9 per cent.; and on adding oxalate of ammonia there remained 68·2 per cent. A mixture of oxalate of lime and sulphate of ammonia acted like oxalate of ammonia. The author finds also that phospho-guanos, *i. e.*, guano rendered soluble by the addition of sulphuric acid, preserve their solubility much better than super-phosphates, owing doubtless to the organic matters, and especially to the oxalic acid which guano contains.

Effects of Manures on Crops.—Messrs. Lawes and Gilbert.—With regard to root crops, the authors give the following general results of their Field Experiments at Rothampsted. (1) Without manure of any kind the produce of roots was reduced in a few years to a few cwts. per acre; but the diminutive plants (both root and leaf) contained a very unusually high percentage of nitrogen. (2) Of mineral constituents phosphoric acid (in the form of super-phosphate of lime) was by far the most effective manure; but, when this manure is used alone, the immediately available nitrogen of the soil is rapidly exhausted; three really large crops of turnips can be obtained only when the soil supplies a liberal amount of nitrogenous (and carbonaceous ?) matter, as well as mineral constituents; and when they are already available within the soil, or are supplied in the form of farm-yard manure, rape-cake, (3) Peruvian guano, ammonia salts, &c., the rapidity of growth and the amount of the crop are greatly increased by the use of superphosphate of lime applied near to the seed.

Alum in Bread.—Prof. Wanklyn (Soc. of Public Analysts).—The author prefers Dupré's mode of analysis. This method has been submitted to a prolonged investigation in his laboratory, with the following results. He says:—The quantity of bread which I operate upon is 100 grms., which, having been weighed out, is incinerated in a large platinum dish capable of holding the whole quantity at once. The incineration is managed at a comparatively low temperature, and takes some four or five hours, the platinum dish being heated by means of a large Bunsen burner, abundantly supplied with air. It is well to continue the ignition until the bread-ash is nearly completely burnt, and it is advisable to weigh the dish containing the ash. The weight of the ash should not sensibly exceed 2 grms. The ash having been obtained, is then moistened with 3 c.c. of pure strong hydrochloric acid, and then some 20 or 30 c.c. of distilled water is added, and the whole is boiled, filtered, and the precipitate washed several times with boiling water. In this manner a precipitate, consisting of silica together with some unburnt carbon, is left on the filter, whilst the filtrate contains the phosphates. The precipitate, which, after being burnt, consists of silica, is weighed. The filtrate is mixed with 5 c.c. of liq. ammoniæ (sp. gr. 0·880) whereby it is rendered powerfully alkaline and opaque, owing to the precipitation of the phosphates. It is finally mixed gradually with some 20 c.c. of strong acetic acid, and as the acid is being poured in, the observation may be made that the liquid is alkaline and opaque until some 5 c.c. of acid has been added; that when about 10 c.c. has been added the liquid is acid and much clearer, and that at least 10 c.c. of strong acetic acid is added after the establishment of a distinctly acid reaction. The liquid is then boiled and filtered, and the precipitate, consisting of phosphates of alumina and iron, well washed with boiling water, ignited, and weighed. The last step is the determination of the iron in the weighed precipitate, and this is accomplished either by reduction and titration with standard solution of permanganate in the well known manner, or else by a colour-process, viz., by titration with ferrocyanide of potassium. In cases where the quantity of iron to be measured is minute, I prefer the colour-process, which is very simple and easy of execution to all persons who are familiar with the ammonia-process of water-analysis.

Fluorescence as a Test for Adulteration.—Dr. C. R. C. Tichborne (Royal Irish Academy) shows that fluorescence may be employed as a method for detecting adulteration. If the substance used in adulteration possesses fluorescent properties and the body so sophisticated does not,—as, for example, turmeric employed to adulterate mustard,—the fluorescence of the turmeric, even in the smallest quantity, determines the fact of its presence. Castor oil passed through adulterated mustard is perceptibly fluorescent if only 0·5 per cent. of turmeric is present.

Detection of Lead in the Tin Lining of Vessels.—M. Fordos (*Comptes Rendus*).—Place, with a tube plunged in pure nitric acid, a slight layer of acid upon any part of the tinning, selecting by preference the thickest parts. Both metals are attacked, forming stannic oxide and nitrate of lead. After a few minutes, heat slightly to expel the last traces of acid, and allow to cool; then touch the pulverulent spot produced by the acid with a tube dipped in a solution of 5 parts of iodide of potassium in 100 of water. The iodide has no action upon the oxide of tin, but with the nitrate of lead it forms yellow iodide of lead.

Detection of Methylic Alcohol (Wood-Spirit) in Vinous Alcohol.—A. Riche and C. Bardy (*Comptes Rendus*).—The wood-spirit used in the adulteration of ordinary alcohol marks 98° on the alcoholometer, and its smell and taste are so slight as to escape notice when it is mixed in slight proportions with an alcoholic liquid. If a mixture of alcohol, containing 10 to 15 per cent. of this wood-spirit, is distilled, a small quantity of liquid may be separated by means of fractional distillation, which goes over at 78° C. The authors detect and estimate methylic alcohol in ordinary alcohol by the following neat method:—Introduce into a small flask 10 c. c. of the alcohol, with 15 grms. of iodine, and 2 grms. of red phosphorus, and distil immediately, collecting the product in 30 to 40 c. c. of water. The alcoholic iodide precipitated at the bottom of the liquid is separated by means of a funnel, which is stoppered with the finger, and is collected in a flask containing 6 c.c. of aniline. The mixture grows hot; the reaction is assisted by holding the flask for some minutes in warm water, and moderated by placing it in cold water if a brisk ebullition sets in. After the lapse of an hour, very hot water is poured into the flask to dissolve the crystals formed, and the liquid is brought to a boil until it becomes clear. To this is added an alkaline solution, which sets free the alkaloids in the form of an oil, which is raised up into the neck of the flask by the addition of a sufficient quantity of water. The oxidation of the alkaloid may be effected by means of perchloride of tin, or, better, by Hofmann's mixture, consisting of 100 grms. of quartz sand, 2 grms. of chloride of sodium, and 3 grms. nitrate of copper. Of this 10 grms.

are taken, upon which 1 c. c. of the oily liquid is allowed to flow, and carefully incorporated by means of a glass rod. The mixture is placed in a test-tube of 2 centimetres in diameter, which is heated to 90° C. in the water-bath for eight to ten hours. The matter in the tube is then exhausted by three successive treatments with luke-warm alcohol, which is thrown upon a filter, and made up to the volume of 100 c. c. Pure alcohol gives a liquid of a reddish-wood shade. Alcohol containing 1 per cent. of methylic spirit gives a solution which appears distinctly violet when compared with the former. With 2·5 per cent. of wood-spirit the result is a very decided violet, which is deepened considerably as the proportions rise from 5 to 10. The liquids may be examined colorimetrically, in tubes of the same calibre, being compared with the results with those yielded by mixtures of wood-spirit and alcohol in known proportions. Or swatches of bleached woollen tissues, of equal weights, may be dyed in the liquids. If the alcohol is free from methylic spirit, the wool remains white, whilst samples containing methylic spirit yield violet shades.

Detection of Coal - Tar Colours in Sugar.—The method described above also serves to show whether coloured sugars owe their shade to the natural matter formed during the boiling of the juice, or if they have been artificially coloured with coal-tar compounds. Take 8 to 10 grms. of the sugar, and agitate it for about ten minutes with a few centimetres of alcohol mixed with a little ammonia. The solution is next to be decanted, evaporated almost to dryness, the residue taken up in a little water, and a small piece of white merino suspended in the boiling liquid for some minutes. If the colour is natural, the stuff is not dyed, but if the sugar has been coloured with any coal-tar preparation, it takes a very decided yellow or brown tint.

Detection of Amylic Alcohol in Spirit of Wine.—Dr. Ciro Betelli (*Gaz. Chim. Ital.*). — Dilute 5 c. c. of the suspected alcohol with 6 or 7 volumes of water. Add 15 or 20 drops of chloroform, shake strongly, and leave at rest. The deposit of chloroform is collected, and allowed to evaporate spontaneously, when the amylic alcohol is left as a residue, and may be recognised by its well-known odour, its reaction with sulphuric acid, &c.

Alcoholometry.— Ascertaining correctly the per centage of alcohol in wines is a matter of great importance to the wine-growers and to ourselves, as it determines the customs duty they have to pay. The processes ordinarily used are said to be defective, and to render an error of half per cent. or more very easy. Accordingly, the French Academy has referred to MM. Dumas, Desains, and Thenard an apparatus presented for examination by M. Malligand. It is a modification of the instrument contrived thirty years ago by the Abbé Vidal, and its indications depend on the different boiling-points of alcohol and water in various proportions. When such a mixture is brought to the state of ebullition in an open vessel, there is a rapid escape of alcohol, with corresponding change of the boiling-point. This was one of the defects of the Vidal apparatus. In that of M. Malligand, the vapours are condensed, and returned to the boiler, so that the indications are constant for several minutes. The little boiler is first filled with water, then heated to ebullition by a "thermo-siphon" and spirit-lamp, and a movable register placed against the degree indicated by the thermometer of the apparatus. The water is then replaced by wine, and the difference of the boiling-point noted. The referees made numerous experiments, detailed in their report, on various wines, on the influence of saccharine and other matters upon boiling-points, and the best means of avoiding errors, and they sum up their conclusions thus:—"The Malligand ebullioscope shows, that if the greater part of the fixed and soluble matters retard the boiling-point of an alcoholised liquid, they also lower it sensibly; that such matters are always found in wines, though in different proportions; that in table wines, whose fermentation is completed, these matters are so compensated that the boiling-points correspond with those of water alcoholised to the same degree: that with liqueur wines, and those whose fermentation is incomplete, the boiling-point is raised, but by diluting them with a convenient quantity of water, the anomalies disappear; that under the worst conditions the error will not exceed one-sixth of a degree, and in most cases not more than one-twentieth; that the testing operation is easy and rapid; that more than 100 instruments, at present made, give similar results; that the Malligand ebullioscope supplies the best known means of ascertaining the percentage of alcohol in wines."—*Academy*.

Detection of Alcohol in Wood - Spirit. — M. Berthelot (*Comptes Rendus*). — The process consists in mixing the suspected liquid with double its volume of concentrated sulphuric acid. In these conditions methylic alcohol yields gaseous methylic ether, entirely absorbable by water or concentrated sulphuric acid, whilst ordinary alcohol produces ethylen, a gas almost insoluble in water and concentrated sulphuric acid, but which may be recognised and determined by causing it to be absorbed in bromine.

Gas-Hydrometer.—E. J. Maumené (*Comptes Rendus*).—Manufacturers of sugar have long wished for a simple, practical, and inexpensive means of rapidly estimating the quality of lime as it comes from the kilns, that is to say, the true degree of its alkaline power at the moment when it is used in the form of milk. The author has contrived a new instrument for this purpose, and to which he gives the name gas-hydrometer, because the gas disengaged in the analyses for which it is adapted is measured by an equal volume of water. It is not a mere calcimeter, or instrument for measuring lime, but at the same time a potassimeter, an acidimeter, &c. The same instrument will serve the sugar manufacturer in estimating the value of the lime, that of the limestone, that of the scum from carbonating, of the cakes from the filter, that of the acids employed in washing the bone-black, that of the black itself before and after revivification. The essential portion is an india-rubber bottle, fastened by its neck to the end of a copper tube. The other extremity of this tube carries a caoutchouc tube fastened to a copper tube, twice bent, which traverses a caoutchouc stopper serving to close a flask in which the reactions are produced. Suppose, for example, that it is required to assay a limestone. Ten grms. are weighed and passed into the flask by means of a gutta-percha funnel. The funnel is washed with the amount of water which a tube of hardened caoutchouc contained therein will hold. The outside of the tube is then wiped, and filled to 2 centimetres of the mouth with hydrochloric acid, of sp. gr. 1·18 or 1·20. This tube is laid hold of by introducing into it a pair of brass forceps, the two arms of which, diverging at the extremities, lodge their hooks under a ledge in the interior of the tube and thus permit it to be easily lifted. It is let straight down into the flask, and the forceps are carefully withdrawn without spilling a drop of the acid. A copper cylinder, which encloses the caoutchouc bottle, set in an upright position, is filled with water round about the bottle. It is closed with a stopper of caoutchouc, pierced with two holes, through one of which passes the copper tube above mentioned, and through the other a tube of metal to lead away the water. The flask being then closed with its stopper, the copper cylinder is raised into a horizontal position, and the apparatus is ready for use. The flask is sloped gently to mix the acid with the 10 grms. of stone. A disengagement of carbonic acid gas immediately swells the caoutchouc bottle, and the water surrounding it being displaced, flows into a graduated tube, where it is collected. The reading on the tube gives the volume of the gas.

Nitrous and Nitric Acids in Water. — Hermann Kaemmerer (*Moniteur Scientifique*).—The author adds first acetic acid and a solution of starch in iodide of potassium. If the water turns blue, nitrous acid is present. If it remains colourless, a few drops of sulphuric acid are to be added. A blue colouration which darkens rapidly proves the simultaneous presence of nitrates and of easily decomposable organic matter.

Methods of Determining Phosphoric Acid, used at the Agricultural Station at Halle, on the Saale.—O. Abesser, W. Jani, and M. Maercker (*Chemical News*).—The results of the authors, as far as the gravimetric methods are concerned, may be summed up as follows :—For precipitation with molybdate of ammonia a quantity of the sample is taken, containing from 0·1 to 0·2 grm. of phosphoric acid. The bulk of the liquid should be from 50 to 100 c. c. The molybdic solution is prepared by dissolving 150 grms. molybdate of ammonia in 1 litre of water, and pouring this solution into 1 litre of pure nitric acid. The quantity of solution used should be such, that for 1 part of phosphoric acid there may be about 50 parts of molybdic acid. As the ammonium molybdate of commerce contains about 83 per cent. of molybdic acid, about 100 c. c. of the above solution are required for 0·1 grm. of phosphoric acid. It is sufficient for the complete precipitation of the phosphoric acid to let the mixture digest for four to six hours at 50° C. After cooling, the yellow precipitate is filtered, and washed with a mixture of solution of molybdate of ammonia and water, equal parts. The yellow precipitate of phospho-molybdate of ammonia is dissolved upon the filter with as small a quantity as possible of dilute hot ammonia, 1 part of commercial ammonia to 3 of water. It is necessary to neutralise the excess of ammonia with hydrochloric acid. Hydrochloric acid is added as long as the precipitate formed re-dissolves quickly. The liquid must then be cooled before adding the magnesian mixture, for, if hot, basic salts of magnesia are sometimes thrown down. The magnesian mixture is prepared with 110 grms. of crystalline chloride of magnesium, 140 chloride of ammonium, 700 of liquid ammonia, and 1300 of water. To precipitate 0·1 grm. of phosphoric acid, we require 10 c. c. of this mixture. After adding the magnesian mixture, we pour in one-third of its volume of concentrated liquid ammonia. The total bulk of the liquid should not exceed from 100 to 110 c. c. In three or four hours the precipitate is ready for filtration. The precipitate is washed on the filter with dilute ammonia (3 : 1) until chlorine can no longer be detected in the filtrate. No subsequent correction is needful. When dry, the precipitate is removed from the filter (which is burnt separately). The flame must be feeble at first, and be gradually increased. It is finally ignited with the gas blowpipe.

Distinctions between the Coal-Tar Colours.—(*Chemical News*).—The coal-tar reds most generally met with are magenta, saffranin, and red corallin. The aqueous solution of magenta is coloured by acids a yellow; that of saffranin a violet-blue; and that of corallin gives a yellow precipitate.

Three principal violets are met with, the phenylic, the iodine, and the methylic. Dissolve a part in alcohol, and add ammonia. If the solution becomes red, the colour is a phenyl-violet; if it is completely discharged, we have an iodine- or a methylic-violet. To decide between these two, dissolve a little of the colour in water and add ammonia. The iodine-violet is decolourised, and gives a clear solution, whilst methylic violets become colourless, but troubled.

The two coal-tar blues at present in the market are aniline blue and Nicholson blue. The latter may be known by its forming a colourless solution in water, which turns blue on the addition of an acid.

The most common greens are aldehyd green and iodine green, with or without picric acid. If the colour dissolves in water it is iodine green; if not, it is dissolved in alcohol, and a solution of potassium cyanide added. Aldehyd green is decolourised under the influence of this re-agent, whilst the picrate of iodine green is turned brown.

The yellows are picric acid, with its salts, and naphthalin yellow, all being soluble in water. Mix the aqueous solution with a solution of potassium cyanide, and heat. If the liquid becomes a reddish brown, picric acid or one of its salts is present. If the colour is merely somewhat deepened, we have naphthalin yellow. To distinguish between free picric acid and its salts, a portion of the sample is moistened with benzol, and heated. If the body dissolves, it is picric acid, if not a picrate.

Among the oranges the chief are —"Yellow corallin," the salts of chrysaniline and chrysotoluydin and "Victoria orange," as well as a mixture of naphthalin yellow and of magenta, known as "aniline orange." Dissolve a little of the sample in alcohol, and add some zinc and dilute sulphuric acid. If the liquid is decolourised it is corallin; if it preserves its colour it is a compound of chrysanilin. If ammonia does not produce a red colouration, dissolve a part of the sample in water, and add an acid. If there is no change, it is a compound of chrysotoluydin; if a precipitate appears it is Victoria orange, or a mixture of both. To decide, take a small portion of the aqueous solution, and add solution of cyanide of potassium. If the liquor turns brown on heating we have Victoria orange; if the shade is but slightly modified, it is a mixture of naphthalin yellow and magenta.

The chief browns are—Analine brown, maroon, garnet, and two phenyl browns; that prepared with carbolic acid, and that with phenylen-diamin. Examine if the substance is soluble in water; if not, add hydrochloric acid. If the solution turns yellow it is maroon; if there is no change add a little ammonia. If a precipitate appears, it is either aniline brown, or phenyl brown prepared with phenylen-diamin. If the ammonia produces no effect the colour is garnet (isopurpurate of potash). Phenyl brown is distinguished from aniline brown by adding cyanide of potassium, which precipitates the latter, while it has no effect on the former.

Simple Method of Determining Iron. — W. Noel Hartley (Chemical Society). — This process was originally devised as a rough and ready one in the absence of proper chemical apparatus, but has since proved to be remarkably accurate, and a good method for students beginning quantitative analyses. Equal weights of the ore to be examined and of fine iron wire (about 4 or 5 grms.) are dissolved and made up to the same bulk. A pipette full of each solution is then taken, and the ferric salt reduced to the ferrous state by warming with granulated zinc. Permanganate is used for the titration, the comparative amounts required for the pure iron and for the ore giving the percentage of iron in the latter.

Testing Leather.—M. Bitner (*English Mechanic*). — A simple means of testing the quality of leather consists in watching its behaviour when treated with acids — preferably acetic acid. Leather not completely saturated with the tannin will swell up; but if the tannin has penetrated, the leather will not swell.

Analysis of Burnt Pyrites.— G. Lunge (*Chemical News*). — According to the analysis of M. Gibb, the pyrites of San Domingos, of Tharsis, and of Rio Tinto, contain, on an average, 47 to 49 per cent. of sulphur.

	Copper. Per cent.	Silver. Ozs. per ton.
Rio Tinto . .	3·80	1·20
Tharsis . . .	3·50	0·75
San Domingos .	3·70	0·75

The burnt ores, as delivered by the sulphuric acid makers to the copper-works, have the following composition :—

	Rio Tinto.	Tharsis.	San Domingo.	Ytteroen, Norway.
Copper } Calculated as $Cu_2Fe_2S_4$	1·6500	1·500	1·5500	1·01
Iron } Calculated as $Cu_2Fe_2S_4$	3·6400	3·2300	3·7600	3·33
Sulphur . . .	3·5300	3·1500	3·6200	3·10
Oxide of copper . .	2·7500	2·5600	2·7000	0·39
" zinc . .	2·0200	0·5500	0·4700	6·46
" lead . . .	0·4700	0·7000	0·8400	0·06
Silver	0·0037	0·0023	0·0023	—
Oxide of cobalt . .	0·0070	0·0320	0·0330	—
" bismuth .	0·0130	0·0100	0·0130	—
Lime	0·2000	0·2500	0·2800	2·30
Oxide of iron . .	77·4000	77·0000	78·1500	68·06
Sulphuric acid (SO_3) .	6·1000	5·2500	5·8000	6·56
Arsenic acid . . .	0·2400	0·1700	0·2500	0·05
Insoluble remnant .	1·4500	5·8500	1·8500	8·74
	99·4700	100·2600	99·3200	100·06

Distinction between Natural and Artificial Alizarin.—J. Weber proposes the following method to show whether goods are printed red with extract of madder or with artificial alizarin. If the red in question is steeped in a solution of permanganate of potash, and then passed into an acid, the red produced with extract turns a reddish yellow, whilst that produced with artificial alizarin retains a decided rose colour. The two reds are still better distinguished by successive treatment with bichromate of potash and nitric acid. The red produced with extract is almost entirely discharged, whilst that from artificial alizarin retains a decided rose shade. If the tissue thus treated is boiled for two minutes in soda-lye at 18° B., washed and dipped in hydrochloric acid at 20° B., the red from artificial alizarin becomes light yellow, and that from extract a dirty orange. The experiments may be performed as follows:—The swatches are steeped for two minutes in a solution of 1 grm. permanganate in 200 c. c. of water, washed, plunged into hydrochloric acid at 3° B., washed, passed again into permanganate of potash, washed, and finally passed into solution of oxalic acid at 1° B. If chromate is preferred, the swatches are steeped two or three minutes in a solution of 10 grms. bichromate in 200 grms. water, drained, passed through nitric acid at 5° B., and washed.—*Chem. News.*

Weighted Black Silks.—J. Persoz (*Moniteur Scientifique*).—The author shows that weighting—which began with the modest aim of making up the loss sustained in ungumming—is now carried to the extent of 100, 200, and 300 per cent. This increase of weight is produced by treatment with salts of iron and astringents, salts of tin and cyanides. The bulk is augmented proportionably to the weight. What is sold as silk is a mere agglomeration of various matters devoid of cohesion, held temporarily together by a small portion of silk. The elasticity and tenacity of the fibre are reduced, and from being one of the most permanent of organic bodies, and sparingly combustible, it becomes fragile, and burns like tinder. It is, moreover, liable to undergo spontaneous decomposition, and to absorb gases with the evolution of heat, which sometimes leads to actual combustion. The adulterated silk leaves an ash of oxide of iron, exceeding 8 per cent. Let us hope this adulteration is confined to French silks.

On the Estimation of Carbon Bisulphide in Coal Gas.—A. Vernon Harcourt (British Association).—The principle upon which the success of the method depends is the following:—When carbon bisulphide is heated in the presence of hydrogen, sulphuretted hydrogen is formed.

The apparatus consists of a flask filled with pebbles and asbestos (to expose a large surface to the action of heat), and surrounded by fire-clay cylinders, in which gas is kept burning. This flask is connected through a solution of lead with an aspirator. There are other connections also by means of which gas from the source requiring to be tested circulates through the flask and is burnt. When the flask has been heated for about twenty-four hours continuously (to expel all moisture), a measured quantity of water is drawn off from the aspirator, which causes the same volume of gas to bubble through the lead solution, and on account of the presence of sulphuretted hydrogen to produce a decolourisation of the lead solution. A similar vessel containing the same quantity of lead solution and a known quantity of sulphuretted hydrogen is placed beside it, the gas being allowed to bubble through the first until the colour is judged to be equally intense; the amount of sulphuretted hydrogen in a known volume of the gas is thus found, and hence the amount of carbon bisulphide. Having once got the apparatus started, gases from several different sources may be tested.

Value of Coals for Naval Purposes.—E. Eckersley, R.N. (Royal United Service Institution).—That coal should be selected which contains the least water. Coal containing sulphur should be avoided, as sulphur is very injurious to iron and destroys the boilers. Coal containing the most lead is richest in carbon, the most valuable property of coal. The amount of carbon in coal can easily be discovered by powdering a little coal and burning it in a crucible with litharge. The button of lead found in the bottom shows the proportion of carbon according to its weight—the heavier it is the more carbon is there in the coal.

Appliances for Enabling Persons to Breathe in Dense Smoke (Tyndall's Respirator). —Captain Shaw (Society of Arts).—To enable a man to enter into and remain in a place strongly impregnated with mephitic or noxious gases two courses are open—one is to supply him with pure air from an external source; the other to provide him with the means of filtering for himself such air as he found. For the first a convenient apparatus is the smoke jacket, consisting of a blouse of cowhide mounted with a hood that completely envelops the wearer's head. Air is driven into the jacket by means of a pump outside. Another mode is to carry an air bag and two tubes which contain a supply of air that will last several minutes.

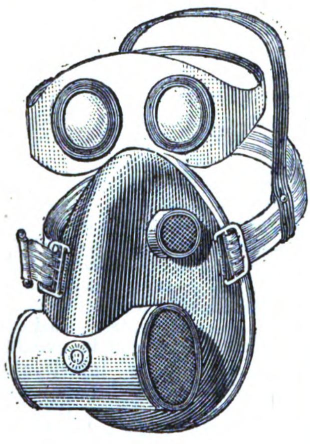


Fig. 9.

For the second method the smoke cap is used, by means of which a man is able to breathe when working in dense or poisonous vapours. It partially closes the nose, and provides for the mouth a light closely-fitting filter with valves, and for the eyes a complete cover which will act as a protection, without obstructing the sight, the whole being capable of being put on and adjusted for use in a few seconds by the wearer without aid from any one else. The filter which separates the pure air from the smoke or noxious vapours, and which constitutes the specialty of the apparatus, is the invention of Professor Tyndall, who has in the kindest and most liberal manner placed it at the disposal of the Metropolitan Fire Brigade. The hood fits close to the head, the lower flap, or apron part, being tucked away under the collar of the tunic. The respirator (fig. 9) consists of a valve chamber and filter tube about four inches long, is screwed on outside, with access to it from the inside by a wooden mouthpiece. The charge for the filter consists of the following materials, which are put in with the tube turned upside down, and the lower valve removed:—Half-an-inch deep of dry cotton wool, an inch deep of the same wool saturated with glycerine, a thin layer of dry wool, half-an-inch deep of fragments of charcoal, half-an-inch deep of dry wool, half-an-inch deep of fragments of lime, and about an inch of dry wool.

New Nitro-Glycerine Compound. — (*Athenæum*). — Herr Trauzl, of the Austrian Engineer Corps, has prepared a cellulose tissue, which will absorb from 70 to 75 per cent. of nitro-glycerine, forming therewith an explosive compound, which possesses the property of remaining unchanged in contact with water, and of perfectly regaining its former explosive power, after being pressed and dried.

Gun-Cotton Water-Shells.—(*Nature*).—The term *water-shell* denotes not a shell of special form or construction, but simply a new system of bursting shells of ordinary construction, elaborated by Prof. Abel nearly three years ago, by which the breaking up of cast-iron shells into a large number of fragments and their dispersion with considerable violence is accomplished by filling the shell with water instead of with an explosive agent.

In a memoir communicated by Prof. Abel to the Royal Society, it was pointed out that detonation was transmitted from a mass of dry compressed gun-cotton to distinct masses of the material saturated with water and separated from each other and from the detonating (or "initiative") charge by small spaces filled with water, the whole being enclosed in a case of stout wrought iron; and Mr. Abel stated that the suddenness and completeness with which detonation was transmitted through small water-spaces had suggested to him the possibility of applying water as a vehicle for the breaking up of cast-iron shells into numerous and comparatively uniform fragments, through the agency of force suddenly developed in the perfectly closed shell, completely filled with water, by the detonation of a small quantity of gun-cotton or other similarly violent explosive substance, immersed in the water. Mr. Abel considered that if such a result were obtained, a shell or hollow projectile of the most simple construction could be made to fulfil the functions of the comparatively complicated *shrapnel* and *segment* shells.

A few experiments with ordinary cast-iron shells, spherical and cylindro-conoidal, afforded conclusive demonstration of the power possessed by water, in virtue of its slight compressibility, to bring to bear uniformly in all directions upon the walls of the shell, force developed by an explosion which is made to occur suddenly in the completely confined water-space, and showed, moreover, that the disruptive effect was proportionate not merely to the amount of explosive agent used, but also to the suddenness of the concussion imparted to the completely confined water by the explosion.

A 16-pounder (cylindro-conoidal) shell, filled with 16 ounces of gunpowder, was broken by the explosion of this charge into 29 fragments. The detonation of a quarter of an ounce of gun-cotton confined in a shell of precisely the same construction and weight, the chamber being filled up with water and tightly closed, burst the shell into 121 fragments, which were violently dispersed. A corresponding charge of gun-cotton, confined in a third similar shell, the chamber being filled with air, did not burst the shell when detonated. One ounce of guncotton confined in a similar shell, filled up with water, broke it up into 300 fragments, and in addition there were 2 lb. 1 oz. of the shell pulverised by the force of the explosion.

The manner in which this system is applied is very simple. The ordinary bursting fuse which is used in field-artillery service has fitted to it a small metal cylinder closed at one end, into which is tightly packed from a quarter to half an ounce of dry compressed gun-cotton. The open end of the cylinder is closed with a screw plug containing a small chamber filled with fulminate of mercury, the upper side of which is in close contact with the fuse when the cylinder has been attached to the latter. To employ common shells as *water-shells* it is now only necessary to fill them completely with water, and then to insert and screw down firmly the fuse with its little detonating cylinder attached. When the detonating charge is fired by the action of the fuse, the shell is instantaneously burst into a large number of fragments by the concussion transmitted by the water.

Extinction of Fire.—(*Athenæum*).—Chloroform-vapour has been lately found to act with great rapidity in extinguishing the flame of the vapour of petroleum. Combustible gases mixed with chloroform-vapour immediately lost their explosive properties, and even their combustibility. It is suggested that chloroform might be advantageously employed upon a large scale for extinguishing fires in petroleum stores and on board ship.

The Chandor Light.—Prof. Archer—(*English Mechanic*).—This apparatus consists of a little tube about three or four inches long, having at one end a button which turns a screw, and at the other an angular point of metal which revolves over the small orifice in the top of the tube. A fuse, formed of a thin strip of solidified collodion, one side of which has a little ridge of hardened phosphorus, is forced by means of the button and screw against the opening in the top of the tube, and is there ignited by the little metallic point passing over the phosphorus. The new lighter can, it is said, be affixed to a gas or lamp-burner, or can be carried in the pocket for use as required. In either case no more of the fuse is burned than is absolutely required, while it is perfectly "damp-proof"—that is to say, that it will burn after being dipped into water.

Voltaic Gas Lighter.—Horatio Yeates—(*Nature*).—This ingenious scientific apparatus entirely obviates the use of matches or tapers, and does away with the attendant danger in lighting gas. It consists of a small bichromate of potash battery, the zinc plate of which is so arranged that by the pressure of the finger it can be immersed in the exciting fluid and put the battery in action. Rising from the top of the battery is a light brass stem, like a taper-holder, but in the form of a swan's neck, terminating in a little bell, within which the two "poles" of the battery are united by a spiral of platinum wire; this wire, when the battery is put in action by the immersion of the zinc plate, becomes white hot, and will instantly ignite the gas if held over the open burner.

Faded Ink.—Mr. Garside, of Southport — (*Pharmaceutical Journal*).—A letter which had been submerged in the wreck of the *Schiller*, and was quite illegible, was carefully brushed over with solution of sulphocyanide of potassium (1 in 20), and then, still damp, held over a dish containing hot hydrochloric acid. The writing was thus developed of a deep red colour. The *rationale* of the process is this:—The iron of the ink is precipitated as peroxide upon the fibres of the paper, and remains when all other colouring matters are washed away. Being in an insoluble form, however, no effect is produced by the reagent until the fumes of the acid have rendered it soluble. Probably ferrocyanide of potassium would answer as well or better than sulphocyanide.

Fire-Proof Starch.—In order to make ladies' apparel fire-proof, a starch is used to which sulphate, phosphate, or borate of ammonia, or what is better, tungstate of soda is added. It appears, however, according to Professor Gintl, that manufacturers do not always act with correct understanding, and do not take into consideration that the compound used must be perfectly pure. It is not sufficient to use the ordinary commercial article, for instance, tungstate of soda, which often contains considerable quantities of carbonate of soda, or ordinary sulphate of ammonia, and this is especially very impure; so much so, that the impurities cannot stand the application of the hot iron during the process of ironing without ruining the colour as well as the texture of the material. The result of such mistakes, is that the fire-proof starch has not become of universal application, and as long as the makers of this preparation do not use sufficient care in its manufacture, its universal introduction is out of the question. Professor Gintl also calls attention to the fact, that according to his experiments, ammonia alum (sulphate of alumina and ammonia) and hyposulphate of soda are also additions to starch which make it very effectually fire-proof. This is very important, as both are cheap substances, easy to obtain, and without any action on most colours. The latter substance prevents, if not so perfectly as some other compounds, a full inflammation, while it is a fact worthy of remark, that the quality of the starch which causes it to give stiffness and gloss to the material to which it is applied is not in the least affected.—*Journal of Applied Science.*

Cement for Marble and Alabaster.—(*Chemical News*).—Mix 12 parts of Portland cement, 6 parts of slaked lime, 6 parts of fine sand, and 1 part of infusorial earth, and make up into a thick paste with silicate of soda. The object to be cemented does not require to be heated. It sets in twenty-four hours, and the fracture cannot be readily found.

Cements for Iron.—(*Iron*).—Glycerine and litharge stirred to a paste, hardens rapidly, and makes a cement for iron upon iron, for two stone surfaces, and especially for fastening iron in stone. This cement is insoluble, and is not acted upon by strong acids. Cloth can be cemented to polished iron shafts, by first giving them a coat of best white-lead paint; this being dried hard, coat with best Russian glue, dissolved in water containing a little vinegar or acetic acid.

Tracing Paper.—Herr Tuscher.—If one volume of castor-oil be dissolved in two or three volumes of spirits of wine it will render paper transparent, and the spirit rapidly evaporating, the paper, in a few minutes, becomes fit for use. A tracing in pencil can then be made, and if the paper is placed in spirits of wine, the oil is dissolved out, restoring the paper to its original condition. The drawing may then be completed in Indian ink or in colours.

Preservation of Flowers.—(*Pharmaceutical Journal*).—A vessel with a movable cover at each end is provided. Having removed one of the covers, a piece of metallic gauze of moderate fineness is fixed over it and the cover replaced. A quantity of sand is then taken, sufficient to fill the vessel, and passed through a sieve into an iron pot, where it is heated, with the addition of a small quantity of stearine, carefully stirred, so as to thoroughly mix the ingredients. The quantity of stearine to be added is at the rate of half-a-pound to 100 lb. of sand. Care should be taken not to add too much, as it would sink to the bottom and injure the flowers. The vessel with its cover on and the gauze beneath it is then turned upside down, and the other cover being removed, the flowers to be operated upon are carefully placed on the gauze and the sand gently poured in, so as to cover the flowers entirely, the leaves being thus prevented from touching each other. The vessel is then put in a hot place—such, for instance, as the top of a baker's oven—where it is left for forty-eight hours. The flowers thus become dried, and they retain their natural colours. The vessel still remaining bottom upwards, the lid is taken off, and the sand runs away through the gauze, leaving the flowers uninjured.

Perpetual Paste.—*English Mechanic.*—To make perpetual paste—which will remain sweet for a year—dissolve a teaspoonful of alum in a quart of water, to which add sufficient flour to make a thick cream. Stir in half a teaspoonful of powdered rosin and half-a-dozen cloves, to give a pleasant odour. Have on the fire a teacup of boiling water, pour the flour mixture into it, stirring well at the time. In a few minutes it will be of the consistency of mush. Pour into an earthen vessel; let it cool; lay a cover on, and put it in a cool place. When needed for use take out a portion and soften it with warm water.

Manufacture of Oxygen.—*Laboratory.*—In the establishment of Krebs, Kroll, and Co., Berlin, oxygen is prepared by heating together in a glass flask, in a water bath, 10 quarts of water, 10 lb. chloride of lime, and 1 lb. nitrate of copper. It produces 14 cubic feet of oxygen.

Peat.—Dr. R. Angus Smith (Lit. and Phil. Soc., Manchester).—Calculations as to the age of peat bogs are frequently much exaggerated, though it is true that the more highly combustible bodies called "hydrogen and rich hydrogen compounds" increase in proportion to age, not by addition to their substance, but by the oxidation of the other parts, and removal of carbonaceous bodies in the brown water.

On recent inquiry, the author had found peat which, on good evidence, had grown 30 inches in 44 years, and observers with still better opportunities gave amounts much higher, equal to 88 inches in a similar time. Taking the lower estimate, it seemed clear that Sprengel's statement was correct, that peat grew more combustible matter in an acre than forest trees grew. The specimen in question, from Deeside, on a spur of the Grampians, had a considerable density, viz., 0·92, measuring externally, or a cubic foot weighed 57 lbs., whereas a cubic foot of water weighs 62·32. The probably very old peat of a coaly fracture spoken of by several persons is not here alluded to, and did not come under the author's observation. The amount of the wet material that grew in an acre was 2,454 cubic feet in a year, and of the dry material, taking the lowest estimate of 1–6th, 10·2 tons, say 10. The estimated amount for wood in the plains below was considered to be 2½ tons per acre per annum, and this may be high, as Liebig gives only half this amount, and hay and straw, which he considered able to produce the same amount of dry material, do not produce more. The value of the peat and the wood as combustibles would differ little. The value of the ten tons may be considered as equal to four tons of coal. These four tons, then, were grown on land which could scarcely be said to have agricultural value. Of course, all bogs are not always growing at this rate, and there is a limit in time to their increase; on the other hand, by care and proper feeding, we may be able to grow the material much faster than ever it has grown, and the black bogs may become for us rich coal fields and oil wells. The fuel is not important for those places where coal is cheap, but there are many places in Great Britain where coal is difficult of transport. Since peat will not bear much carriage, its value is limited in distance, and in many places now without any, it would be well to grow along with oat and patato fields a field also of this despised fuel. This is actually done, but it is rarely systematic, and in many places peat is driven out where a portion of land otherwise almost useless might be set aside for it. The systematic fostering of peat so as to increase its produce is advocated for many places, although this may appear absurd in the eyes of those who are desirous of removing entirely all its traces.

The peat which had grown rapidly was fine in texture, and became heavy on drying; not of the heaviest kind, as 0·92 is high but not of the highest class. (The lightest peat examined was 0·2.) The first had grown from fine or small mosses, *hypnum* chiefly, and the fineness of the fibre was apparently the cause of the rapid breaking up. It is not time alone then that is always required to make fine dense peat. Large pieces of wood may endure and be preserved long. Henceforth a new classification of peats is necessary, and this according to the prevailing plant. To grow good peat, all plants with thick stems must be avoided as giving too much woody fibre, rendering the structure too open and the peat too light, as well as giving an inferior amount (in the case of some woods at least) of the resinous and very inflammable bodies, and generally taking too long to form. The great peculiarity of good peat is the oleaginous and resinous matter, to which also wax and fats may be added, as they have been found by some. It has been generally believed that these bodies have been produced during the decomposition of the plant, although one writer considers they were produced by the growing plant.

The author believes that woody fibre does not produce substances rich in hydrogen, the compounds resulting from its decay being rather of a humous character and not good combustibles. If woody fibre did not leave its hydrogen and carbon in such quantity as to form the resins, &c., of peat, then we must look for the origin in the growing plant. The mosses from which the peat from Deeside was evidently grown were examined, and on drying gave about a fourth of dry matter which readily crumbled into a powder and which contained 1·27 per cent. of substances soluble in a light naphtha. It much resembled that obtained from the peat, but was softer, being about the consistence of butter and capable of being distilled so as to give a yellowish substance of the same consistence. Besides this there was 1 per cent. of a substance extracted by alcohol, resinous in appearance, fusible, and containing apparently the chlorophyl.

The author believed that these bodies produced similar matter in the peat, or rather were the matter itself with little or no change. In the peat it had been hardened, perhaps by oxidation or perhaps by the removal of the more fluid portion by water. In this way he explained the possibility of having a flow of oil from a peat moss. When the substances in the plants themselves were of a more fluid character, the removal of the woody fibre and absorbing humous bodies would set them free, and the fusibility or otherwise of the substances at ordinary temperature would depend on the plants. The oil formed by distilling the resinous bodies obtained from the peat was of a light yellow. Its true character has not been fully determined, but analysis gives—carbon 83·86 p.c., hydrogen 12·70.

The author inclined to believe that there is a great variety of oils and solid hydrocarbonaceous bodies, if not true hydrocarbons, in the plants, which, so far as he knew, had not been examined. The resins of the peat had been carefully examined by Mulder.

The author had not found any of the coaly peat spoken of by some authors. It might readily be supposed that when the woody fibre was removed various compounds insoluble in water would remain and account for fossil resins, ozokerit, &c. A similar action might produce coal, although the plants forming peat and coal were different and most probably the climate; and the idea of Professor Morris (see Professor Huxley and Professor Dawkins on coal) that the bituminous part of coal was composed of spores and sporangia primitively supplied with resinous or oleaginous matter would so far agree with the above reasoning, although in forming peat we cannot confine ourselves to the spores, so far as the author knew at least, when wood is present having resin dispersed in it. Perhaps the same may be said of coal.

The author also spoke of the great value of peat as a water reservoir in a country demanding much water, which did not always require to be bright, and of the possibility in many positions of cleansing it as it was leaving the mosses. Water reservoirs could thus be grown at a cheap rate in many spots, instead of being banked in or dug at a great expense, although growing might require perhaps more time. A reservoir formed of peat 10 feet thick would hold as much as a water reservoir of the usual kind 8 feet deep, or say 7½, and still be easily walked over.

The capacity of growing possessed by peat was so great, if the results found could be readily attained in many places, in suitable situations it might be used for filling up swamps and making dry surfaces; for after rising to a certain height the top easily drained and left a part dry.

Swamps were sources of fever and ague. True peat bogs never were, so far as the author knew, and probably the growing of peat would render many places healthy which could not otherwise easily be made so. Gases from peat mosses he intends to examine more fully, and also many peat-forming plants.

Sulphate of Copper Process for Preservation of Wood.—Max Paulet.—The author's experiments tend to show that the action of sulphate of copper on the ligneous tissue produces a compound which is not absolutely insoluble in pure water, and is soluble to a considerable extent in water charged with carbonic acid. After having lain for some time, railway sleepers which had been injected with sulphate of copper were found to contain a considerable proportion of iron in those parts near the rails, whilst away from the neighbourhood of the rails the carbonate of lime derived from the ballast took the place of the copper-salt; and although the lime-compound is not itself a septic agent, it yet acts prejudicially by removing the preservative medium. From these results it appears that wood thus prepared is far from being a durable material for construction of permanent way.

Preservation of Wood. — S. W. Moore (*Chemical News*).—The following process was devised by Mr. Weatherby, and investigated by myself.

The wood to be prepared is first kiln-dried, to deprive it of all moisture and much of its volatile turpentine and other inflammable matter; it is then put into suitable cylinders, in which lime and water with sulphurous acid gas are forced into its pores under considerable pressure, the sulphurous acid being a by-product from the wasting of pyrites.

The wood is removed and dried, and is then ready for use.

When sulphurous acid is passed into lime under pressure, a sulphate of lime is formed which is soluble in water, capable of crystallising as a bisulphite, which is readily oxidisable and convertible into sulphate of lime or gypsum.

As this is an exceedingly insoluble salt, it is not easily removed, from the pores of the wood, and therefore, not only protects the wood by its presence as a non-conductor of heat, but deoxidises all matters which are likely to prove objectionable as ferments.

The advantages presented by this wood are that its weight is less after treatment than of the same wood before kiln-drying; a series of pieces gave a mean specific gravity of 0·3501. The process for working is very much cheaper than that of any other yet devised; it is an admirable means for preventing dry rot, and decay from the action of water, as its pores are coated with an insoluble salt; it thus wears longer and vibrates less than ordinary pine; it resists the attacks of insects, and from the removal of the volatile inflammable matter, as well as from the introduction of a non-conducting material, it is well able to withstand fire, the interior parts not giving up gaseous matter, which always so readily inflames.

The wood, although answering these ends, contains but little matter foreign to itself.

Woody fibre	87·2
Moisture at 115° C.	8·5
Ash	4·3
	100·0

The idea here presented is much the same as that noticed accidentally in the late Franco-Prussian war; many houses there were found to have been protected from fire when they were largely built with plaster; lath and plaster walls were absolutely uninjured by the fire when surrounding parts were destroyed.

M. Lostal has communicated to the Society of Mineral Industry at St. Etienne, the results of his observations on the effect of lime in preserving wood, and his method of applying it. He piles the planks in a tank, and puts over all a layer of quicklime which is gradually slacked with water. Timber for mines requires about a week to become thoroughly impregnated, and other wood more or less time, according to its thickness. The wood acquires remarkable consistency and hardness, and, it is said, will never rot. Wood has been prepared in this manner for several mines on a considerable scale. Beechwood has been prepared in this way for hammers and other tools for several ironworks, and it is said to become as hard as oak without losing its elasticity or toughness, and to last much longer than when unprepared. It has long been known that wood set in lime or mortar is preserved from decay, but no systematic plan for its preservation has until now been attempted.

Report by M. Cloëz on the Superphosphate Works of MM. Michelet and Thibault.—(*Soc. d'Encourag. l'Indust. Nat.*).—The peculiarity of this establishment is that the phosphates are mixed with the acid in closed vessels from which the noxious vapours are drawn by an aspirator, traverse a tower filled with coke, upon which water is trickling, and pass finally into the chimney of the works. The phosphatic minerals are ground and sifted for use, and the acid is employed at 53° B. The phosphorites used are those of the Lot, the Ardennes, and of Estremadura. The vapours given off by the first-mentioned kind yield a certain amount of iodine. — *Chemical News.*

Iodine from Superphosphates.—This is liberated during the above process and collected in the coke-tower. The iodine by attacking the apparatus is reduced to the state of proto-iodide of iron. Some chloride and fluoride of iron are also formed, but no bromide. The iodine may be separated from the proto-iodine of iron by Serullas' method, precipitating as cuprous iodide, and heating with an excess of sulphuric acid. This process is incomplete, since by no means all the iodine is expelled in the gaseous form, and in view of the high price of iodine, it is highly desirable that some method should be devised of expelling all the iodine from the phosphate of lime.

Sprengel's Sulphuric Acid

Process.—(*Nature*).—We have received a circular calling attention to the success attending the working of Dr. Herman Sprengel's improvement in the manufacture of sulphuric acid. The process was patented in 1873, and consists in injecting water in the form of spray into the chambers instead of steam. To effect this a jet of steam escapes from a platinum nozzle at a pressure of about two pounds, and blows through the centre of a flowing jet of water by means of an apparatus similar in principle to Herapath's blow-pipe. These jets are let into the side of the chamber at distances of 40 feet. The advantages gained are economy of fuel, nitric acid, and pyrites. The method has been in use at the works of the "Lawes Chemical Manure Company" at Barking, and the returns show that a saving of coal to the amount of ⅜ of the quantity formerly burned has been effected—the total saving in steam, nitric acid, and labour during three months amounting to five shillings per ton of acid of sp. gr. 1·6 made from pyrites.

"Glover's Tower" in the Manufacture of Sulphuric Acid.—M. Vorster (*Chemical News*).—Glover's tower is placed between the furnaces evolving sulphurous acid and the lead chambers. The hot gases proceeding from the kilns pass through a rain of chamber acid and of nitrated acid. The heat concentrates the acids by evaporating water, and the nitric acid present in the nitrated acid is converted partly into nitric oxide, and partly into free nitrogen. At the foot of the tower the acid, concentrated and freed from nitrogen acids, is collected. From 3·5 to 4 per cent. of the sulphuric acid passing through the tower is volatilised and lost. Although the acid is freed from nitrogen compounds to a satisfactory extent by the action of the sulphurous acid, yet from 40 to 70 per cent. of these compounds—according to temperature—are reduced to the state of nitrogen gas.

Deacon's and Weldon's Chlorine Processes. — Thos. Gibbs. (Tyne Chemical Society).—A most striking feature in the chemical arts during the last year is the transposition of places, in the estimation of manufacturers, between Deacon's and Weldon's chlorine processes. The steady progress of Weldon's process was suddenly checked by the brilliant advent of that of Deacon; the latter, in its early promise of producing chlorine by decomposing hydrochloric acid gas by the oxygen of the atmosphere itself in passing through an arrangement not much more complicated than the ordinary condenser, and using no solid renewable re-agent, was received by manufacturers with a trust and avidity unprecedented in the history of inventions. Plant was put up all over the country and speedily set to work, but after working for a considerable time, the conclusion appears to have been arrived at that the range of heat, and perhaps other influences still imperfectly understood, under which the decomposition of hydrochloric acid in contact with the so-called catalytic agent succeeds, is far too narrow for a manufacturing process, and whilst the plant may work for some weeks or months well, it has the unfortunate peculiarity of suddenly coming to a stand, only to be set going again after vexatious delays and expensive operations, such as re-saturating the marbles in the decomposing tower with sulphate of copper. Whether the decomposition depends on mere contact, as argued by Mr. Deacon, in his lecture to the Chemical Society, in June, 1872, or on the more easily understood rapid formation and decomposition of the chlorides, and oxychlorides of copper, in an atmosphere highly charged with oxygen and hydrochloric acid gas, the conditions of success are far from being well understood. Weldon's process, although much less direct than Deacon's, and although the plant has proved much more expensive than was at first anticipated, has proved workable under ordinarily skilled supervision. No better example of success by chance, although that chance was appreciated and applied with shrewd keenness, can be adduced. The successful oxidation of the manganous oxide being only possible in presence of a base, presumably combining with the manganic oxide formed, was a condition unsuspected by Weldon at the date of his early patents, and is almost on a par with the Bessemer process, failing utterly as patented for the manufacture of malleable iron, but proving a success amounting to a revolution on the application of Mushet's discovery, that spiegeleisen added to the blown metal, produced steel.

Manufacture of Silicate and Carbonate of Sodium.—At Saint Gobain there is in practice a new method of manufacturing soda; yielding, at the same time, accessory products of a certain importance. It is based on the property which carbon possesses of transforming sulphate of sodium into silicate of sodium, in presence of silica, giving sulphurous acid and sulphur. The operation is effected at a red heat in a retort similar to those for gas, and heated in the same way. The sulphur is obtained by simple condensation. As to the sulphurous acid, it can be transformed into sulphuric acid, or absorbed by carbonate of soda. In this case there is obtained bisulphite of sodium, which, treated with zinc, gives sulphide of sodium, which is now used to dissolve indigo. The silicate of sodium, the principal result of the operation, can be advantageously employed in glass works; but if it be desired to obtain soda from it, there are two modes of treatment: by decomposing with carbonic acid, carbonate of sodium is obtained; while, by bringing it into the presence of lime, we have carbonic acid. By the above process all the sulphur contained in the sulphate treated is utilised; in the ordinary process, it is lost.—*English Mechanic.*

Decomposition of Salt by Superheated Steam.—S. Cabot (*Chemical News*).—The apparatus used was a cylindrical stove made of cast-iron pipe, and so arranged that all the doors and the top could be closed by iron flanges and air admitted below the grate through a tube, while the products of the decomposition could be taken out above by another. A hot anthracite fire was kindled (without the use of wood, to prevent any alkaline ashes), and a stream of mixed air and steam was blown in by a very simple little tin injector, formed by inserting a fine jet of steam half way into an open cone of tin in the shape of a funnel. The writer has found by experience that a fire may be kept alive for a long time by the blast of mixed air and steam resulting from such an injector, and believes that, by passing the blast through a sufficiently long iron tube, the air would be sufficiently dry to support combustion for an indefinite length of time, and might be used with advantage in many cases where a blast is required. In this case, however, the steam was a more important ingredient than the air. While the fire was still very hot, and the blast passing through it, about a pound of salt was thrown in at the upper door, which was quickly closed. Volumes of hydrochloric acid streamed from the upper tube and were collected in water and tested. The ashes, upon examination, also were found to be alkaline, as should be the case if the reaction is, as usually formulated—

$$H_2O + 2NaCl = 2HCl + Na_2O.$$

Of course, the yield was no approach to the theoretical one, and could not be applied as a technical process.

(Messrs. Grüneberg and Vorster, of Kalk, near Cologne, do not agree with the author's opinion, for they have patented, in England, a process for obtaining caustic soda by passing superheated steam over a heated mixture of common salt and of alumina, or its hydrate.)

Refining Sugar in Bristol.—H. T. Chamberlain (British Association).—The method in the old days was very rude. The sugar was turned into large open pans, mixed with water, melted over the fire, and brought, under constant stirring, to a thick consistency at a certain temperature. When concentrated to the right condition, it was ladled out into large moulds of the sugar-loaf shape, plugged at the ends, which were then placed downwards, and when the sugar was set the plug was removed, and the sugar allowed to drain itself of the syrup or treacle. This sugar was then remelted, defecated, and clarified fit for making refined sugar. The use of animal charcoal and the manufacture of loaf sugar were great improvements, and went on up to the introduction of the vacuum pan. The sugar being melted and clarified was run into loaf moulds, which were placed upon the floors, as with the coarser kinds; but the finer sorts were carefully liquored by white syrup poured upon them, which, passing downward, washed through, purified, and bleached into whiteness the mass in the moulds; the loaves, after being allowed to run dry, were trimmed and papered, and then "stoved." The stove was a massive building of fire-brick with iron doors, and fitted with racks, heated to and kept at a temperature of about 150° Fahr., where the loaves were placed, and remained a few days until all moisture had passed off, when they were taken out and stacked in a dry warehouse ready for sale. This long and uncertain process was much shortened by the introduction of the vacuum pan, centrifugal machine, and other improvements.

It must be here mentioned that, with the exception of a moderate quantity made during the last Franco-German war, loaf sugar has long ceased to be manufactured at Bristol. The French manufacturers of loaf sugar are able to undersell English manufacturers not only in this city, which has so long been a place of production, but also throughout the United Kingdom.

The refiners now confine their operations to the production of crystals, and syrup or treacle.

The packages of raw sugar, as imported, are received into the sugar house, raised by steam pulleys to the highest floor, where they are opened and the sugar turned into the first melting pan with a little water: in some houses this is an open pan with a coil steam pipe, in others a vacuum pan. The first melting produces a rather thick syrup. This is run into filter bags, which are placed round the floor, generally at a lower level, to run by gravitation to save pumping; the filter bags retain the first impurities, and the syrup passes from them into large cisterns underneath prepared for that purpose; from these it is pumped or run into the tops of the charcoal cisterns or filters, which are tall and generally cylindrical, made of iron, and filled with many tons of animal charcoal, through which the syrup passes and comes out free from all impurity, clean, and rich, the first runnings as colourless as water, the clearness depending upon how long the charcoal is used. The syrup is then run into cisterns and is ready for the vacuum pan, where it is boiled at a very low temperature, which prevents all danger of burning, the heat being generated by steam. The boiling *in vacuo* is continued up to the granulating or crystallizing point; and the greatest skill of the practical man is requisite to determine the right moment to cease boiling, and discharge the now almost formed sugar from the pan. This is done into vessels below upon wheels, which cart it away to the centrifugal machines, where it is whirled round with inconceivable rapidity, washed with liquor whilst rotating, which, with all other liquid, is thrown off through the sieve-like sides of the machine, and runs down into cisterns prepared for it, to be afterwards dealt with. In a few minutes the sugar is finished and fit for use; it is then scooped out and carried away to the mixing floor, where it is turned over and over by manual labour, and finally run down a chute into casks and packed. This process applies, with but little change, to all the various qualities at present made by the Bristol refiners, and the result is according to the strength and purity of the filtered syrup and skilful boiling *in vacuo*. The syrup remaining uncrystallizable forms treacle, which is put into cisterns, and thence into tight casks ready for use. The empty packages or anything else saturated with sugar are thoroughly steamed, and the sweet water and all washings are boiled and evaporated, so that every available particle of saccharine matter is obtained and nothing is lost.

Colouring Sugars.—P. L. Simmonds (*Jour. of Applied Science*).—Experiments have been made in dyeing sugars for the English market. The first sample was of a bright canary colour, produced by a bottle of Judson's patent aniline dye, and struck me as possessing a most diabolical taste; in the second a less liberal administration of the dye had produced a suitable tint and less disgusting taste, but personally I prefer molasses as a colouring agent. Supposing the idea succeeds, it might be carried out still further by varying the colour as well as the shade; a bright magenta or a brilliant green is very attractive to the consumers of sugar-candy and other saccharine compounds in their more juvenile years; and Demerara might supply the confectioners direct, as she now does the grocers.

Beet-Root Sugar.—E. Pesier (*Les Mondes*).—Whatever may be the details and the name of the procedure adopted, it is indispensable to admit only the juice obtained by tearing and pressing the tissues; in other words, the liquor from the rasps and the presses, and avoid the products of boiling the beet-root; consequently to leave no pulp in the juice. To employ for defecation a dose of lime, so as to saturate the juice. To keep the defecated alkaline juice at a boil until the ammonia is completely expelled. The injection of steam, or of carbonic acid, or mechanical agitation, promotes this object. Not to neutralise all the free lime with carbonic acid. To employ animal charcoal well burnt, well washed, and free from caustic lime, from sulphides, and from chloride of calcium. To avoid every stoppage, and even slowness in the operations. Finally, to evaporate as rapidly as practicable at the lowest possible temperature.

TECHNOLOGY.

Tempered Glass.—The principle of the process patented by M. F. B. de la Bastie is based on the theory that the fragility of glass is caused by the weakness of the cohesion of its molecules, and that, consequently, if this cohesion can be increased, the strength of the material will be augmented in proportion. At first, M. de la Bastie tried to obtain the desired result by forcibly compressing the glass while in a fluid or soft condition, but without success. At length he discovered the method of tempering it which forms the subject of his patent. Dropping fused or heated glass into water produces a violent contraction of its particles. By dipping the glass into oil or other liquid capable of being heated to a temperature considerably above that of water, it is found that it is not only hardened but tempered, so to speak—*i.e.*, it has lost its brittleness. The conditions for the success of the tempering process are two: the glass must be at a certain temperature, and also the liquid in the dipping bath. The latter, which may consist of oils, grease, wax, resin, tar, or pitch, must be capable of being raised to a comparatively high temperature without boiling; and the heat at which the glass is found to be best fitted for the tempering process is that which just precedes the soft condition, though when the glass is thin it may be tempered sufficiently at a red heat before it begins to become soft. The hotter the glass the less risk there is of breaking it, and the greater the shrinkage or compression; but these advantages are attended with the difficulty that the softened glass is readily put out of shape. It is necessary, then, to so construct the furnace and the dipping bath that the glass can be passed from one to the other without touching it to such an extent as to alter its shape; and it is also necessary to place the oil or other liquid forming the bath under such conditions that it will not inflame when the red-hot glass is dipped into it.

The sectional diagram of one of the forms of furnace and bath employed by M. de la Bastie (see title page) gives the general construction of the plant necessary for carrying out the process. The engraving represents a furnace for tempering flat sheets; other designs are employed, according to the nature and shape of the articles to be tempered. The general principles are, however, the same in all the furnaces. The oven A is heated by the furnace seen at the side, and is separated from the preparatory oven by the wall seen at the back. The sheets of glass are placed in the preparatory oven, and thence, one by one, are pushed on to the floor of the oven A through the opening shown in black. When the oven is sufficiently heated the furnace and ash-pit doors are closed and luted, and the draught is stopped by placing a cap on the chimney. Small pieces of fuel are introduced through a hole in the furnace door. A sheet of glass having been pushed from the preparatory oven into the oven A, and having nearly reached the requisite temperature, is further pushed on to the table B, which is normally in the horizontal position, though shown in position for sliding off the glass. C is the bath of oil, heated by a separate furnace situated at the back, and having a separate chimney, as shown. The bottom curves into a kind of trough to receive any glass which may be broken by accident, and a thermometer T is placed in a pipe which serves as an overflow outlet; and, as will be seen, the bath is entirely covered in by iron covering-doors, the parts being so arranged that the bath is not affected by the heated gases proceeding from the glass-furnace nor subjected to the action of the chimney. A rocking table E is supported on a frame capable of separate movement, such movement being communicated by means of a lever and shaft. The lower end of this rocking-frame is fitted with a buffer of wire gauze, which breaks the fall of the glass as it slides over the table, the surface of which consists of a smooth refractory material. The rocking table E being placed in the position shown, and the bath and sheet of glass (the latter resting on table B) ready for the tempering process, table B is by means of a lever tilted into the position shown in the engraving, when the plate of glass slides off on to table E, and so into the fluid contained in the bath. Table B is then returned to its horizontal position, and another plate of glass pushed on to it. The glass plate which has been immersed is removed in the following way:—By means of a lever, the table E and the rocking-frame to which it is connected are raised till a stud on the table engages with the latch attached to the counterweight seen at the top of the bath; the lever is then allowed to return a short distance, when it is held by a catch-rod actuated by a spring. This movement separates the table E from the rocking-frame to such an extent that the buffer of wire gauze and the end of the frame are brought below the level of the table E, which is held up by the latch above mentioned. The glass plate is then withdrawn into the chamber D by means of a rake, whence it is removed with others when the chamber, being full, is lifted out of the bath. The chamber D rests upon horizontal bars as shown. The plate being removed from the table, a reverse motion of the lever restores the parts to the position seen in the engraving, ready for another plate. If the glass is required to be perfectly clear, or when ornamental glass works are to be tempered, a muffle furnace is used, as it is found that the dust from the open furnace is apt to settle on the glass and chill its surface.

So far as its ordinary applications are concerned, there is no reason why we should not have windows proof against the majority of chance missiles. It must not be supposed that the tempered glass of ordinary thickness is proof against stones deliberately thrown; but it will probably escape unharmed from missiles which nine times out of ten would effectually demolish ordinary window glass. As far as the export trade is concerned, the mere saving in breakage alone during transport will, it is calculated, cover the extra cost of the tempered glass. It is, however, chiefly in the application of glass to purposes for which, but for its brittleness, it would be well adapted, that this discovery will meet with its greatest development. Thus, it is admirably adapted for cups and saucers, plates and dishes, and, in fact, for all kinds of domestic hardware: [these may be violently thrown across a room without breaking. In the manufacture of alcohol and alcoholic liquors, especially beer, the tempered glass will find an extensive field for employment, while, in the production of acids and various other chemicals, it offers advantages which will be readily seized. The careful housewife will welcome the tempered glass lamp chimneys, which will not fly even when directly touched by the flame, and as an ordinary-sized pane only ⅛in. thick will bear a man's weight, the new glass can be substituted for the thick and not very transparent material at present used as pavement-lights to underground rooms. In fact, it is impossible to mention all the applications of the tempered glass; but we must point out one disadvantage: it cannot be cut into sizes like ordinary glass. A diamond merely scratches it, and the fracture is no longer clean, like the old glass. The two kinds of glass resemble one another only in appearance and in chemical composition.—*English Mechanic.*

Tobacco Trade of Bristol.—T. Davey (*British Association*).—There are in Bristol seven manufacturers of tobacco, and two of cigars. The principal articles made by them are cut tobaccos, viz., shag, bird's-eye, fine returns, the various kinds of smoking mixtures, whose names are legion, roll tobacco, and snuffs of various kinds. Cut tobaccos may be divided into two kinds, shag and bird's-eye.

The method employed in making shag is simple. The leaves of the raw tobacco are first carefully selected and sorted; they are then wetted, and, in some cases, steamed also, to render them soft and pliable. The stalk is then carefully stripped off from the leaf by girls and women, and, after lying for a few hours, or perhaps a day and night, it is in a proper condition to be transferred to the cutting machine, which is a sort of a highly-finished and powerful chaff-cutter. The leaf tobacco, being filled in from behind, is pressed down into a compact mass by weighted levers, and gradually worked forward by a series of screws and rollers until it arrives beneath the blade of the knife, which cuts it up into long and silky threads.

Bird's-eye is made in the same way, the only difference being in the kind of leaf used, and in the fact of the stalk being allowed to remain, instead of, as in shag, being stripped out of the leaf.

In this stage the tobacco is close, sticky, and wet, and it is therefore placed on a hot stove until it is in fit condition for picking and cleaning, which is done by hand. In some manufactories the cooling is effected by a fan or blower, but only when great rapidity is required.

The varieties in the article of snuff are infinite, and they comprise tobacco-dust in every stage of dampness and dryness, from the saturation of rappee, to the highly-dried Welsh and Irish snuffs. These again vary from each other according to the different modes of treatment in manufacture, and the varieties of delicately-mixed scents which are imparted to them, every separate one being a carefully-kept and jealously-preserved trade secret. Generally, the process of making what is called Scotch snuff is as follows:—The different proportions of leaf, stalks, and dust or smalls of tobacco being mixed together, they are first moistened; they are then allowed to pass through a process of fermentation, and, after a certain time are placed in a metal pan, and exposed to a powerful open fire. When sufficiently dried, they are conveyed to the grinding mill, and there ground up beneath granite stones, and afterwards in wooden mulls. It is next carefully sifted, to free it from impurities or coarse grains. In the case of scented snuffs, the scent is added after manufacture. The moister snuffs, such as rappee, &c., differ somewhat in their mode of manufacture, and some of the inferior qualities of Scotch snuff are made without passing them through any fermentation.

Vulcanizing of Caoutchouc.

— Professor Böttger states that Gaulthier de Caulbry has established by experiment that, upon mixing flowers of sulphur and dry chloride of lime in a porcelain mortar very intimately, a decided odour of chloride of sulphur soon becomes noticeable, accompanied by an elevation of the temperature of the mixture, while the sulphur softens, and a plastic mass is finally formed. If the sulphur is largely in excess of the chloride of lime, and they are mixed without hard grinding, the product, with or without the addition of chalk, zinc-white, &c., when added to caoutchouc, softened in bisulphide of carbon or oil of turpentine, causes so-called vulcanization at the ordinary temperature, or upon slightly warming. With chloride of lime in excess the action is so energetic that the mixture becomes greatly heated, while vapours of chloride of sulphur are evolved, and the mass remains pulverulent, instead of becoming pasty.—*English Mechanic.*

Camphor.—Vice-Consul Allen describes the distillation at Tamsuy and Kelung of the camphor of commerce from *Cinnamomum camphora* as a most hazardous trade, the distillers having to be constantly on the alert for fear of attack by the aborigines, who are naturally opposed to the continual encroachments into their territory for the purpose of cutting down the trees for extracting the camphor. No young trees are planted to replace those cut down, nor do the officials take any cognisance of the diminution which is being surely effected in the supply of a valuable commercial article. The stills are described as being of a very simple construction, and are built up in a shed in such a manner that they can be moved as the Chinese advance into the interior. A long wooden trough, coated with clay and half filled with water, is placed over eight or ten furnaces; on the trough boards pierced with holes are fitted, and on these boards are placed jars containing the camphor-wood chips, the whole being surmounted by inverted earthenware pots, and the joints made air-tight by filling them up with hemp. When the furnaces are lit the steam passes through the pierced boards, and saturating the chips, causes the sublimated camphor to settle in crystals on the inside of the pots, from which it is scraped off and afterwards refined. During the summer months the camphor often loses as much as 20 per cent. on its way from the producing districts to the port of shipment.

Pure Sulphate of Nickel.—A. Terreil (*Chem. News*).—The salts of nickel employed in the electro-deposition of that metal are prepared from commercial nickel, which is an alloy of nickel, copper, and iron, with traces of arsenic, containing from 40 to 90 per cent. of actual nickel. The author's process consists of four operations—solution of the crude metal in acids; precipitation of the copper by iron; peroxidation of the iron, and conversion of the metals into sulphates; precipitation of the iron by carbonate of barium, and crystallisation of the sulphate of nickel. The nickel is first dissolved in seven to eight times its weight of aqua regia; the solution is evaporated almost to dryness; the residue is re-dissolved in water, using about five times the weight of the nickel employed. A little arseniate of iron remains insoluble, and is removed by filtration. Metallic iron, preferably small nails, is introduced into the hot liquid, to about the weight of the nickel employed. It is stirred from time to time to detach the copper from the iron. As soon as a piece of bright iron, introduced into the liquid, is no longer coated with copper, this part of the process is complete.

The whole is thrown on a filter, and washed repeatedly.

The copper is then collected by sifting it under water, in a sieve coarse enough to let pass the coppery metallic powder, but retain the iron. The copper is dried, and is then marketable.

The filtrate now contains merely nickel and iron. The latter is peroxidised, either by a current of chlorine, or by treatment with nitric acid. Sulphuric acid at 66° B. is then added in the proportion of 2 parts to 1 of nickel employed, and the whole is evaporated to dryness to expel nitric and hydrochloric acids. The dry residue is re-dissolved in water, a part sometimes remaining insoluble, consisting of sub-sulphate of iron. From the solution the iron is thrown down by means of carbonate of barium (artificial precipitated). This carbonate separates the iron as sesquioxide, and forms at the same time insoluble sulphate of barium, without acting upon the sulphate of nickel. The last traces of arsenic are thrown down along with the sesquioxide of iron. The precipitation is effected by gradually adding a slight excess of carbonate of barium to the liquid, slightly heated, but not so as to exceed 50° to 60° C. It is complete when a further addition of carbonate occasions no effervescence, and does not become covered with peroxide of iron. Pure sulphate of nickel then remains in solution. It is separated from the precipitate by filtration, and the filtrate is evaporated till a pellicle appears on the surface, when it is set aside to crystallise.

Chrome Green.—Adolfo Casali (*Gaz. Chim. Ital.*).—The existing chrome greens, such as Guignet's green (hydrated sesquioxide of chrome), called also emerald green, and Pannetier's green; green ultramarine (anhydrous chromic oxide), Leune and Castelhaz's green (hydrated chromic oxide), Arnaudon's green (chromic metaphosphate?), Matthieu Plessy's green (phosphate), are very beautiful, and are free from injurious properties, but are too expensive to compete with the arsenical greens. The author proposes to calcine strongly an intimate mixture of 1 part of bichromate of potash and 3 parts of baked gypsum, of the variety commonly known as scagliola. The result is a grass-green mass, which, on boiling with water, or mixing with dilute hydrochloric acid, leaves a fine powder of an intense and beautiful green, and possessing a very high colouring power.

Painting on Zinc.—A simple process, depending on the use of acetate of lead, which renders every kind of painting applicable to sheets of zinc, has recently been invented. By mixing black lead, for instance, with the salt, a very agreeable light brown hue is obtained. It is by this means that the cupola of the synagogue at Nuremberg has been painted; and for more than two years, during which this work has stood, the atmosphere has had no influence on the zinc sheeting of the roof. By the addition of other colouring matters, the lightest or darkest shades of grey or yellow may be produced. For writing with dark ink on sheets of zinc, a solution of chlorate of copper is employed. After a few minutes the zinc sheet is washed and then dried. This application might be found useful in making labels for the names of plants.—*Journal of Applied Science.*

Green Bronze on Iron.—Paul Weiskopf.—One part of sylvate of silver is dissolved in twenty parts of oil of lavender, forming a sort of varnish. The surface to be bronzed is cleansed and dried, but need not be polished. The varnish is thinly applied with a camel's-hair brush, and the object heated quickly to 300° Fahr. The proper temperature is indicated when the article shows a bright green colour, which is even all over it. To produce a bronze drawing, Venetian turpentine is substituted for part of the lavender oil. It is better to rub up the dry sylvate of silver with resin in a mortar or on a palette, and then add enough lavender oil to make it as thin as ordinary paint. Articles of iron bronzed in this way can afterwards be electro-plated, the copper not being deposited on the portions bronzed. Copper and brass coated with this bronzing, and heated to 480° Fahr., acquire a matt grey exterior, which is somewhat reddish, and not permanent until covered with a thin coat of varnish, when it resembles the so-called oxidised metal. We may add that sylvic acid is one of the constituents of ordinary resin or colophonium, and differs from pinic acid in being soluble only in hot alcohol, from which it crystallises in colourless plates. To prepare sylvic acid, the resin is first treated with cold alcohol to dissolve the pinic acid; the residue is dissolved in hot alcohol, and allowed to crystallise. Carbonate or acetate of silver dissolves in sylvic acid, forming sylvate of silver.—*English Mechanic.*

Iron for Gilding and Silvering directly.—The following is a method given for producing iron which will take a direct deposit of gold and silver:—To a ton of iron add 12 kilogrammes of nickel and ½ kilogramme of manganese. Objects formed from this iron only require to be simply washed with milk of lime, and then placed in baths composed as follows:—For gold; water 100 kilogrammes, bicarbonate of soda 800 grammes, pyrophosphate of soda 200 grammes, chloride of gold 16 grammes, cyanide of sodium 65 grammes, hydrocyanic acid 2 drops. For silver; water 100 kilogrammes, bicarbonate of soda 2 kilogrammes, chloride or nitrate of silver 130 grammes, cyanide of potassium 210 grammes, hydrocyanic acid, 10 drops.—*Iron.*

Gilding.—Place in a plate leaf-gold, add a little honey, stir the two carefully together with a glass stopper, the lower end of which is very flat. Throw the resulting paste into a glass of water mixed with a little alcohol, wash it and leave it to settle. Decant the liquid and wash the deposit again. Repeat the same operation until the result is a fine, pure, and brilliant powder of gold. This powder, mixed with common salt and powdered cream of tartar, and stirred up in water, serves for gilding.

Another Method.—Boutet de Monvel.—Dissolve in aqua regia 1 grm. of fine gold, previously rolled out very thin, in a porcelain capsule, heat on the sand-bath and concentrate till it is the colour of blood. Add a half litre of distilled water, hot, in which have been dissolved 4 grms. of white cyanide of potassium. Stir with a glass rod, and filter the liquid through unsized paper. To gild with this liquid, it is heated a little above luke-warmness, and the articles to be gilt are immersed in it and supported upon a piece of very clean zinc.—*Les Mondes; Chemical News.*

Copper Amalgam which adheres to Glass or Porcelain.—To produce this, take from twenty to thirty parts of copper in powder produced from the oxide, either by means of hydrogen or by precipitation of the sulphate with the aid of zinc, mix this with sulphuric acid and with seven parts of mercury, and mix all together with great care. The acid must then be washed away with hot water, and the amalgam be allowed to dry. At the end of ten or twelve hours the mass will be sufficiently hard to take a brilliant polish. The amalgam becomes soft with heat, but does not contract from the effect of cold.—*Iron.*

New Mode of making Varnish.—Maximilian Zingler has taken out a patent for dissolving camphor in bisulphide of carbon, mixing the solution with powdered gum copal or other hard gum, and afterwards adding either camphorated or methylated spirit, or both. After the materials have been thoroughly agitated until the whole of the gum is dissolved, the process is complete, and the product is a spirit varnish. Oil varnish is produced by dissolving linseed or other drying oil in camphorated or in methylated spirits, or in a mixture of these; and this compound is mixed with the spirit varnish above described. With these spirit and oil varnishes can be mixed other gums or resins.

Ancient Printing Inks.—It has been found by Dr. R. C. Tichborne that the printing-ink employed in works published during the sixteenth and seventeenth centuries differs from modern printing-ink in being soluble in ammonia. Carbon appears to have formed, from the first, the basis of printing-ink; and, consequently, all printed matter resists the action of acids and bleaching agents. But some of the early specimens of printing are so easily affected by alkalies, that the characters float off the paper when placed in a weak solution of ammonia.

Black Stains for Wood.—There are two kinds:—(1) The ordinary black stain for different kinds of wood; (2) the black ebony stain for certain woods which approach nearest to ebony in hardness and weight. The ordinary black-wood stain is obtained by boiling together blue Brazil wood, powdered gall-apples, and alum, in soft water, until it becomes black. This liquid is then filtered, and the objects painted with a new brush before the decoction has cooled, and this repeated until the wood appears of a fine black colour. It is then coated with the following liquid:—A mixture of iron filings, vitriol, and vinegar is heated (without boiling), and left a few days to settle. If the wood is black enough, yet for the sake of durability it must be further coated with a solution of alum and nitric acid, mixed with a little verdigris; then a decoction of gall-apples and logwood dyes are used to give it a deep black.

A decoction may be made of brown Brazil wood with alum in rain water, without gall-apples; the wood is left standing in it for some days in a moderately warm place, and to it merely iron filings in strong vinegar are added, and both are boiled with the wood over a gentle fire. For this purpose soft pear-wood is chosen, which is preferable to all others for black staining.

For the fine black ebony stain, apple, pear, and hazel-wood are the best woods to use; when stained black they are most complete imitations of the natural ebony. For the stain, 14oz. of gall-apples. 3½oz. of rasped logwood, 1¾oz. of vitriol, and 1¾oz. of distilled verdigris are boiled together with water in a well-glazed pot, the decoction filtered while it is warm, and the wood coated with repeated hot layers of it. For a second coating, a mixture of 3½oz. of pure iron filings, dissolved in ¾ of a litre of strong wine vinegar, is warmed, and when cool the wood already blackened is coated two or three times with it, allowing it to dry between each coat. For articles which are to be thoroughly saturated, a mixture of 1¾oz. of sal-ammoniac, with a sufficient quantity of steel-filings, is to be placed in a suitable vessel, strong vinegar poured upon it, and left for fourteen days in a gently-heated oven. A strong lye is now put into a good pot, to which is added coarsely bruised gall-apples and blue Brazil shavings, and exposed for the same time as the former to the gentle heat of an oven, which will then yield a good liquid. The pearwood are now laid in the first named stain, boiled for a few hours, and left in for three days longer; they are then placed in the second stain, and treated as in the first. If the articles are not then thoroughly saturated, they may be once more placed in the first bath, and then in the second.—*English Mechanic.*

Walnut Stain for Wood.—The wood, previously thoroughly dried and warmed, is coated once or twice with a stain composed of 1 part, by weight, of extract of walnut peel, dissolved in 6 parts of soft water by heating it to boiling, and stirring. The wood thus treated, when half dry, is brushed with a solution of one part, by weight, of bichromate of potash in 5 parts of boiling water, and is then allowed to dry thoroughly, and is to be rubbed and polished as usual. Red beech and alder, under this treatment, assume a most deceptive resemblance to American walnut. The colour is fixed in the wood to a depth of one or two lines.

Paint as an Engineering Material.—Ernest Spon (Society of Engineers).—The author described the composition and characteristics of the pigments usually employed by engineers. White lead should be of good quality and unmixed with substances which may impair its brightness. It is usually adulterated with chalk, sulphate of lead, and sulphate of barium, the latter being the least objectionable. Zinc white is dry under the brush, but takes longer in completely drying. Red lead is durable and dries well, but should chemical action commence, it blisters and is reduced to the metallic condition. Antimony vermillion is suggested by the author as a substitute for red lead. Black paints from the residual products of coal and shale oil manufacture, and oxide of iron paints, are generally used for ironwork, for which purpose they are peculiarly suited. Referring to the oils used in painting, the author stated that linseed oil was by far the most important, and that its characteristics deserved careful study. It improves greatly by age, and ought to be kept at least six months after it has been expressed before being used. It may be made a drier by simply boiling, or by the addition of certain foreign substances. Nut oil and poppy oil are far inferior in strength, tenacity, and drying qualities to linseed oil, and are used to adulterate the latter. Used under proper supervision no better protection can be found for iron structures than oxide of iron paints. The real value of any paint depends entirely upon the quality of the oil, the quality and composition of the pigment, and the care bestowed on the manufacture; and the superiority of the most esteemed paints is due to these causes rather than to any unknown process or material employed in their preparation.

Restoration of Maclise's Stereo-Chrome Pictures.—The greater portion of the surface of the great water-glass picture in the Royal Gallery at Westminster, representing "The Meeting of Wellington and Blucher after Waterloo," has until recently been obscured by a film of silica. At the beginning of his labours, Maclise fancied it was hardly possible to apply too much of the silicate solution. He was accustomed to shed what may be called a thick dew of this liquor over the parts of the picture which were finished, employing for the purpose a syringe of peculiar construction. Long before the "Wellington and Blucher" was finished, Maclise found out his mistake in applying so much of the silicate solution. A grey bloom, exactly like that appearance which, when occurring on varnish, painters call "chill," was discoverable on those parts where the syringe had been most freely employed. This bloom grew denser, and more opaque, as time went on, until it had obscured a large portion of the design. Maclise hoped this effect would be temporary, but he hoped against the evidence of his eyes, for the injury was enlarged rather than diminished in extent, and increased in density. Thus warned, he used little of the solution on the parts of the work which were the last painted, and, in "The Death of Nelson," he applied hardly any of the same as a fixative, and used as little as possible as a vehicle for his pigments. Quite recently, the Government determined to try what could be done to remove the excess of the solution, the effects of which we have described. The process is a strictly mechanical one, the result of a chemical experiment intended to dissolve the silica being by no means encouraging. The bloom, or film of silica, has been removed by simply being crushed on the surface of the picture. The gain to the arts thus secured is great, and the public is deeply indebted to Mr. Richmond, under whose direction the restoration has been effected.

Mr. Richmond states that the "efflorescence" was largely mixed with London dirt, and was of a rust colour, though on the "Nelson" picture, where it was but just appearing, it was quite white. "It was extremely tenacious, and not to be removed by merely washing or rubbing, which spread but did not remove it. Warm water with spirits of wine was more effectual for this purpose; but by far the best mode was found to be beating it with slings of linen and wash-leather, with pads of cotton-wool confined in them, and this with all the force that a man could give to a side stroke throwing off at each blow whatever it had displaced." The *rationale* of the case seems to be, that as the silicate solution had come to the surface, and formed a crude semi-opaque glass there, it was right to use mechanical means for the removal of the objectionable film. The bags were used with force sufficient to crush the glass and brush it away. The "Nelson" picture, being painted on a ground differing from that of the "Wellington," needed more tender treatment, but of the same kind.

Extract of Indigo.—*Chemical News.*—To make what is generally called "sour extract of indigo," mix 5 lbs. of best Bengal indigo in 30 lbs. of strong oil of vitriol. Let it stand five days; then put it into a tub and add 40 gallons of boiling water to it; then filter while hot through strong felt cloth. The filters are usually made this way:—A frame like a table-top, 8 yards long, 2 yards wide. This frame is divided into four filters. Pieces of wood across are put on the top and made to fit the holes (the shape of bowls, with small holes perforated in them); then the felt cloth is put on the top, and the liquid is put on the filter and filtered through. The sediment at the top is used to colour pottery moulds; that which runs through is put in a tub, and 40 lbs. of common salt added. Digest for six hours; then put on the filters again for four or five days. That which drains through runs away into the sewers; that on the top of the filters is the extract. For these proportions the extract should weigh 80 lbs. This is "sour extract of indigo" of commerce.

Free Extract.—To make free extract of indigo, put 100 lbs. of the sour extract in a tub, 12 gallons of water as well. Neutralise the acid in the extract with strong soda-ash liquor until it is free from any sour taste; then put on the filters for six days. It should weigh 100 lbs. when it comes off, and is then the "free extract of indigo" of commerce.—*Anonymous.*

P. Hubert (*Chem. News*).—Extract of indigo is sodic sulphindigotate, precipitated from a sulphuric solution of indigo by means of soda, crystals, and common salt. The product, after being washed more or less perfectly, often still contains a greenish matter, which is visible if a little of the extract is spread out on filter-paper. To assay a sample, two grms. are dried in a stove. The loss in weight shows the quantity of water present. The residue is ignited, and weighed to find the mineral matter. The amount of indigo is shown by the difference. The extracts of commerce are divided into single, double, and treble, according to their strength. The mean composition is :—

	Water.	Indigo.	Salts.
Single extract .	89·0	4·96	5·7
Double extract .	85·0	10·20	4·8
Treble extract .	73·7	12·40	13·9

Red Sanders.—Sanders-wood, despite its cheapness, is not much used in dyeing. The red matter is accompanied by a brown colour, which must be completely eliminated —a process not unattended with difficulty. The principles found in sanders are—(1) A bitter, brown attractive matter, sparingly soluble in cold water, but readily soluble at a boil. (2) A red matter, santaline; insoluble in water, soluble in alcohol, strong boiling acetic acid, caustic alkalies, and hot alkaline carbonates. It undergoes a change if exposed to the air in a moist state, and is oxidised, especially in presence of alkalies. (3) Santalidin, one of the oxidation-products of santaline, is less insoluble in water than santaline, but dissolves more freely in the other solvents. The powdered wood, exhausted in boiling water to remove the brown matter, is digested in a cold clear solution of chloride of lime as long as this becomes coloured. When this is done, it is carefully washed in cold water, and the dye-bath is prepared. A hot, but not boiling, solution of carbonate of soda is prepared, into which is put the wood contained in a linen bag, and the pan is tightly covered. Heat is applied without bringing it to a boil. When the bath has acquired a bright red colour with a violet tint, it is ready for use. The goods (woollen, cotton, or linen), mordanted in an acid bath, are plunged into the sanders beck till they have the wished for shade, and are then returned to the acid beck. Shades are thus obtained not inferior to madder work in brightness and solidity.—*Muster Zeitung.*

[We copied this process from the note-book of a friend sixteen years ago, and are therefore much interested to find that it has been rediscovered.]—*Chemical News.*

Colouring Matters from Aromatic Oxy Compounds and Nitrous Acid. — C. Liebermann (*Chemical News*). *Phenol Colouring Matter.* — 5 grms. of phenol were mixed with an equal volume of concentrated sulphuric acid and well cooled, to prevent the formation of phenol-parasulphuric acid. The amount of the re-agent required (sulphuric acid mixed with 5 per cent. nitrite of potash) was 20 grms. This was added, with agitation, in such portions that the temperature rose permanently to 40° to 50° C. without becoming higher. The solution was at first brown, then a fine blue. The operation, with the quantities indicated, lasted fifteen minutes. At last there was a faint disengagement of gas. On cooling, the solution was poured with constant stirring into a large amount of cold water, filtered, concentrated in a porcelain vessel, and dried in the exsiccator. The substance thus treated can be dried at 130° C., without undergoing any change. It is a brown powder, readily soluble in alcohol. In alkalies it dissolves with a royal-blue colour. Its composition is $C_{18}H_{15}NO_2$.

Orcin Colour.—10 grms. orcin, 10

grms. sulphuric acid, 40 grms. of the re-agent. The solution must become a fine purple red. When poured into an excess of water it yields a pure orange-red precipitate. The alkaline solution is purple with scarlet fluorescence. After washing for several days it is dissolved in alcohol, filtered and evaporated. It forms a splendid cantharides-like mass. Other colouring matters are obtained at the same time, varying in solubility.

Thymol Colour.—10 grms. thymol in fine powder, 10 grms. sulphuric acid, 40 grms. of the re-agent. In this case the re-agent must be added immediately after the mixture with sulphuric acid. The solution is first green, and then blue; the disengagement of gas must be avoided. The double volume of sulphuric acid is then added, and the whole allowed to stand for some hours. It is then precipitated by being poured into an excess of water, filtered, and washed perfectly. A violet resinous mass, soluble in alcohol, with a fine violet-red colour.

Manufacture of Anthrachinon, $C_{14}H_8O_2$.—The conversion of anthracen into anthrachinon is generally effected by means of bichromate of potash and sulphuric acid. Some manufacturers add a little nitric acid towards the end of the re-action. The anthracen and the bichromate are intimately mixed, and the sulphuric acid, diluted, is added by degrees. On the large scale the operation is performed in vats lined with lead, in which steam is passed. The addition of acetic acid is an improvement. When it is used the proportion of sulphuric acid must be modified. On the small scale the following proportions are recommended:—1 part anthracen is mixed with 2½ parts of bichromate of potash, 4 parts of pyroligneous acid are added, and after heating a time 6 parts of sulphuric acid, previously diluted with double its volume of water, are gradually added. The mixture is heated in the water-bath till the re-action is at an end. The yield is almost equal to what theory requires.

The anthrachinon generally requires to be purified. This is effected by dissolving the crude product in sulphuric acid in cast-iron vessels, and heating until the evolution of sulphurous acid ceases. It is then precipitated with excess of water, collected, well washed, pressed, and dried in a stove at 50° C. It is then a greenish-grey impalpable powder.—*Chemical News.*

Nitrate of Methyl.—C. Girard (*Soc. Chim. de Paris*).—Nitrate of methyl, which was discovered in 1835 by MM. Dumas and Peligot, now occupies a very important position in dyeing. Since 1862 it has superseded methylic iodide in most tinctorial producing re-actions. Dumas and Peligot, in their researches on methylic alcohol and its ethereal compounds, pointed out the facility with which this body ignites and explodes if its vapour is superheated. In consequence of the recent explosions in Germany and in France, C. Girard has endeavoured to reduce its explosive properties by the admixture of other bodies (as is the case with nitro-glycerin). He finds that many bodies, including the ethylic, methylic, and amylic alcohols, aceton, benzin, toluen, &c., under certain circumstances completely prevent the superheated vapour of methylic nitrate from detonating. A mixture of 2 to 3 parts of these bodies with 1 of methylic nitrate does not give rise to explosions, even when burned in large quantities. The author finds, also, that nitrate of methyl, like nitro-glycerin, can be made to detonate by percussion. A piece of blotting-paper, steeped in methylic nitrate, laid upon an anvil, and struck heavily with a hammer, produces an explosion as violent as that given by nitro-glycerin under the same conditions. But if diluted with twice its weight of wood spirit it does not detonate when struck. With certain pulverulent and porous solids, such as tripoli, it forms dynamites similar to those obtained from nitro-glycerin.

The Production of Aniline Colours without the use of Arsenic Acid (*Chemical News*).—Coupier, of Paris, was the first to succeed in producing fuchsine by the action, at a suitable temperature, of hydrochloric acid and iron in small quantities on pure aniline and nitrotoluol. Though Coupier's experiments were confirmed by Schützenberger, the process was not applied industrially before 1872, when Meister Lucius, and Brüning, of Hoechst, Germany, succeeded in working it on a large scale. This firm, however, only manufacture a part of their colours by this method, as they still supply the market with dyes containing arsenic.

More recently, the Gesellschaft für Anilin Fabrikation, of Berlin, have erected new works, where no arsenic acid is used in the preparation of colours. Not only fuchsine (rubine), but all the colours derived from it which are manufactured by this company are warranted to be produced without the employment of arsenic, and to be entirely free from this poisonous re-agent.

The Berlin Company are working Coupier's process with several important modifications, and produce from 200 to 300 kilogs. of fuchsine per diem. Some specimens of fuchsine and other colours manufactured by this company appear to be products of unrivalled beauty, purity, and strength. The fuchsine is stated to be not only purer, but stronger than that made by the aid of arsenic acid, and is the pure hydrochlorate of rosaniline. The rosaniline base, from its great purity, is admirably adapted for the preparation of aniline blue; and is largely used by other manufacturers of analine colours.

Being free from arsenic, these dyes are not only fitted for colouring sweetmeats, liqueurs, syrups, and pharmaceutical preparations of every description, but may be used for many other industrial purposes where poisonous colours would be more or less dangerous, as in the staining of paper, paper-hangings, toys, &c.

It is to be desired that other manufacturers of these dyes should adopt the new method, and relinquish the old arsenic acid process, which, apart from the inconveniences it has caused both manufacturers and consumers, has led to many lamentable accidents.

Constituents of Madder.—M. Rosenstiehl (*Ann. Chim. et Phys*).—It is generally believed that these four distinct principles are present in madder—alizarin, purpurin, pseudo-purpurin, and hydrated purpurin. Rosenstiehl considers purpurin and hydrated purpurin are derived from pseudo-purpurin, and that there are only two distinct colouring principles in madder—namely, alizarin and pseudo-purpurin.

Purpurin.—De Lalande (*Bull. de Mulhouse*) has succeeded in artificially forming purpurin by the oxidation of alizarin. A mixture of concentrated sulphuric acid and artificial alizarin, with arsenic acid, or other oxidizing agent, is heated to 150° or 160° C., and the product thrown into a large volume of water; the precipitate, when well washed, is dissolved in a solution of alum, and on addition of an acid the purpurin separates in dense flocks.

Aniline Inks.—C. H. Viedt (*Chemical News*).—For a red ink the author recommends a solution of 1 part of "diamond fuchsine" (we should say of Brooke, Simpson, and Spiller's rosein) in 150 to 200 parts of boiling water. For a blue he dissolves 1 part of bleu de Paris in

200 to 250 of water. For a violet, 1 part of a Hofmann's violet (blue shade) in 300 of water. A beautiful green ink is made by dissolving 1 part of iodine green in 100 to 110 parts of boiling water. The yellow aniline inks are not recommended. These inks have the advantages of drying quickly, and of never clogging.

Mordants for Dyeing Cotton Aniline Colours.—M. Ch. Girard (*Reimann's Farber Zeitung*).—The mordants used for dyeing aniline blue are:—For diphenylamin blues, mordant the cotton in a solution of tannin at 3 per cent., and pass directly into a solution of alum neutralised with carbonate of soda, then dye directly in the aqueous solution of the blue; brighten, wring and dry. For alkaline blues, of which the sulpho-conjugated salts are sodic or ammonic compounds, we take likewise an aqueous solution of tannin containing 3 per cent. of the weight of the cotton; keep at a boil for a quarter of an hour, wring and dry. Then pass the cotton into a bath containing 1½ kilo. alum, 250 grms. tartar emetic, 750 grms. soda crystals, and 250 grms. tartaric acid. These ingredients are dissolved separately, and finally the colour is added. The bath is heated from 65° to 70° C., the cotton is entered and worked while the temperature is allowed to sink. The bath serves continuously, more mordant being added as it becomes exhausted. Heavy shades are dyed first, then mediums, and then pale shades. To dye cotton with saffranin and night-green, the cotton is first passed into a solution of bichloride or oxymuriate of tin marking 2° B., wrung, passed into a tannin bath, wrung, and then passed into the dye-beck.

Aniline Black.—Hitherto it has been considered impossible to remove or discharge aniline black. G. Witz (*Reimann's Farber Zeitung*), however, has shown it to be possible. He treats the aniline black with an acidulated solution of permanganate of potash, when peroxide of manganese is deposited upon the fibre. This is then treated with a solution of oxalic acid, which removes the manganese, and leaves the tissue perfectly white. The solution of permanganate may be thickened with infusorial silica (kieselguhr), and printed upon the tissue, so that a white design can be produced upon an aniline black ground. The peroxide of manganese can also be produced by other methods, *e.g.*, by successive treatment with salts of manganese and caustic soda.

Japanese Bronzes.—E. J. Maumené (*Comptes Rendus*).—The composition of the specimens examined was as follows:—

	I.	II.	III.	IV.
Copper	86·38	80·91	88·70	92·07
Tin	1·94	7·55	2·58	1·04
Antimony	1·61	0·44	0·10	—
Lead	5·68	5·33	3·54	—
Zinc	3·36	3·08	3·71	2·65
Iron	0·67	1·43	1·07	3·64
Manganese	—	trace	—	—
Silica	0·10	0·16	0·09	0·04
Sulphur	—	0·31	—	—
Loss	0·26	0·79	0·21	0·56
	100·00	100·00	100·00	100·00

These bronzes were probably formed by the direct use of copper pyrites and antimonial galena, mixed with blende.

Purification of Tin.—The principle of Pattinson's process for the separation of alloyed silver and lead depends on the separation by crystallisation of the one body before the other, at the moment of partial solidification. This principle may be extended and applied to the separation of other metals whose degree of fusibility may be different. It may be taken as a general fact that foreign metals will be held suspended in a crystalline condition in the liquid mass of any metal which has a lower point of fusion than themselves, provided that the temperature of the liquid bath at the time be lower than the melting point of the foreign metals. The foreign crystallised metals can then be separated mechanically from the liquid bath by filtering. If such a process could be carried out with practical success, the saving effected in the purification of many metals, in place of the present methods, would be very large, and prove a great boon to our metallurgical industries.

M. Curter, has sought to apply this principle to the purification of Bohemian tin, to enable it to compete successfully with the English or Australian qualities. He uses leaves or sheets of very thin white iron, measuring about 60 millimetres by 4 millimetres ; 500 of these sheets are driven tightly into an iron frame, by means of two wedges, and this frame is fixed in the open bottom of a graphite crucible. These leaves form an effective filtèr, the liquid tin being able to penetrate between the thin sheets, whilst the smallest crystal of foreign metals is excluded.

The tin which was to be filtered is melted first in another crucible, and then allowed to cool until a thin coating of crystals has formed on the surface. After skimming back this skin, the liquid metal already becoming thick is poured into the filtering crucible. The liquid metal then percolates slowly through the capillary interstices of the plates, leaving behind a thick deposit, in which is fonnd iron, arsenic, and copper concentrated to a high degree and mixed with a little tin. The metal which filters through is almost chemically pure tin. In this way Bohemian tin can be perfectly purified in an exceedingly simple and inexpensive manner. Instead of the filter described as above, a mass of wrought or cast iron shavings, or borings, submitted to a high pressure in the bottom of a cylindrical vessel might be employed.—*Iron.*

Tin in Powder.—To prepare tin for tinning brass, copper, and iron :—Melt the metal in a crucible which has previously been slightly warmed, and at the moment the metal begins to set, and when it is very brittle, pound it up rapidly, and when quite cold pass it through a sieve to remove any large particles that may remain. — *Mining and Monetary Gazette.*

Sparks from Phosphor Bronze and Gun Metal.—A number of experiments to determine the comparative liability of copper, ordinary bronze (gun-metal), and phosphor-bronze to emit sparks when subjected to sharp friction or percussion, have recently been carried out in the Royal Gunpowder Factory, Waltham Abbey, in the presence of Colonel Younghusband, Major Majendie, Major Morgan, &c.

During each experiment the gas was extinguished, leaving the room in total darkness, so that the least spark could be readily extinguished.

The results obtained show that copper, gun-metal, and phosphor-bronze are all liable to emit sparks, or, as it is commonly called, "strike fire," when subjected to a certain description and degree of friction, the degree of liability appearing to vary with the different alloys and frictional surfaces, and, to some extent, with the construction and consequent rigidity of the article employed. The harder descriptions of phosphor-bronze emit sparks less readily than the softer samples, and less readily than ordinary bronze or even than copper.

The great value of these experiments consists in the positive evidence which they furnish as to the somewhat unexpected readiness with which, under certain conditions, sparks, and even a stream of sparks, more or less intense and continuous, may be obtained by friction from such metals as copper, gun-metal, and phosphor-bronze. This result can hardly fail to possess a practical interest for manufacturers of gunpowder and other explosives, and for persons who are called upon to deal with and handle these substances. At the same time these experiments bear ample testimony to the very great superiority of copper, gun-metal and phosphor-bronze to iron and steel in regard to the liability to "strike fire." The numerals distinguish the samples of phosphor-bronze, No. 2 being the softest and No. 8 the hardest.

A "free grit" stone, of the same description as is used for sharpening small tools and razors, 6 inches diameter, revolving 1220 revolutions per minute, travelling 2079 feet per minute, was used for these experiments, the material experimented with being in each case applied firmly to the revolving stone and held against it for about half a minute. The first experiment was with No. 2 phosphor-bronze, which occasioned sparks, and sometimes a stream of them. A thin gun-metal knife gave a few sparks, but no cont.inous stream; a gun-metal lever of stouter section and altogether harder than the knife, gave numerous sparks and at times a slight stream; a gun-metal ingot, for making bolts, &c., good casting, gave few sparks, but chiefly a continuous feeble stream: a similar ingot, but a rotten casting, gave an uninterrupted stream of sparks. With No. 4 phosphor-bronze, some very strong sparks were obtained, and at times almost a succession, but generally rather of the nature of a prolonged spark. With No. 7 phosphor-bronze, one or two strong sparks were obtained, but no indication of a continuous stream. (This is the alloy usually employed for the tools and fittings of gunpowder works where phosphor-bronze is used.) With No. 8 phosphor-bronze, which is so hard that it can be used to chisel hard beech, only one faint spark was obtained.

Scheerer's Process for Eliminating Phosphorus from Iron.—A very superior bar iron can be made from phosphoretted cast iron by this method at practically no increase of cost. The process consists in the use of a fused mixture of chloride of calcium and common salt in equal proportions, which is intimately mixed with the molten iron in the puddling furnace, either by adding it gradually in 2 lb. water-tight packages, or placing the whole quantity required upon the bed of the furnace at first—in either case working it very thoroughly with the metal. The puddling process is said to be generally so much shortened that the consequent diminution in the waste of iron almost equals the cost of the materials added. The quantity of the mixed chlorides required is about three times that of the phosphorus present in the iron. The action of other chlorides is stated to have been found very disadvantageous.—*Iron.*

Carbon in Iron.—M. Boussingault (*Comptes Rendus*) finds that carbon exists in carburetted iron in various proportions. Steel contains 7 to 10 1000th parts when hard, 10 to 15 soft. Pig-iron contains 2 to 4 100ths, and sometimes even 5 100ths. The quantity is difficult to settle, as it can only be ascertained in analysis by the difference with manganese, silicium, phosphorus, sulphur, and chromium. The average of the results is 4·4c. When grey the iron has given up its carbon in the form of graphite; but M. Boussingault found no sensible difference in the quantity of carbon in grey and white pig. In all cases, if the real combination of iron with carbon be admitted, it takes place then—5 equivalents of iron for 1 of carbon. Whatever be the temperature it is impossible, says M. Boussingault, to make more than 5 per cent. of carbon enter the iron; this is the limit.

Steel Forging Process.—Garnaut and Seigfield.—The steel to be worked is heated to redness, it is then sprinkled with powdered salt, while in this state it is worked nearly to the required shape, the salt being from time to time renewed. Next, a mixture containing equal parts of sodium chloride, sulphate of copper, sal ammoniac, and carbonate of potassium with half-a-pint of nitre is sprinkled on the steel, the steel is heated afresh, and the sprinkling is continued till a sufficient degree of refinement throughout the whole mass has been attained, and the steel has been worked into the required shape. The steel is a third time heated slowly till it is of a cherry-red colour, and at once plunged into a bath containing a mixture of 3·7 litres pure water, 42·4 grammes alum, and the same quantity of potassium carbonate, of copper sulphate, and 28·3 grammes nitre with 169·8 grammes sodium chloride. The right to use this process has been bought by the U. S. Government.

Solder for Brazing Steel.—The following solder will braze steel, and may be found very useful in case of a valve, stem or other light portion breaking when it is important that the engine should continue work for some time longer:—Silver, 19 parts; copper, 1 part; brass, 2 parts. If practicable, charcoal dust should be strewed over the melted metal of the crucible.—*Iron.*

Novel Method of Welding Steel to Iron.—If the following process, than which nothing can be more simple, be found to be attended with the same results in general practice as are claimed to have been achieved in experiments, a great industrial problem will have been solved. The two surfaces to be welded are slightly wetted, and powdered with a mixture of one part of dried borax, one part of fine iron filings, and a quarter part of prussiate of potash. The pieces of iron and steel are then tightly bound together, either with iron wire or by other means, when all that remains to be done to obtain a perfect weld is to heat them to a temperature of from 350 to 400 deg. (Fahr.) and subject them to blows from a steam hammer, or pass them between rolls.—*Iron.*

Smooth and Brilliant Castings.—M. Collignon says that a saving of 80 per cent. is made by substituting for the sifted coal and charcoal used with green sand for small iron castings a careful mixture of one part of tar with twenty of green sand. Castings produced from moulds with such a mixture are smooth and bright, because the tar prevents the metal adhering to the sand, and also the formation of blisters. Such a mixture likewise aids greatly in the production of large castings, as the tar absorbs the humidity of the sand.

GEOLOGY.

Address of Dr. Wright, President of the Geological Section, British Association.—*Geological and Palæontological Character of the Country around Bristol.*

Geology is the history of the earth; for it attempts to construct a table of phenomena, physical and chemical, organic and inorganic, which have succeeded each other from the past to the present, and on the terrestrial surface traces of its origin and progress are preserved.

That phase which we see to-day is only the most recent of its eventful history, and although the last, is not the final one, as the physical forces that are ever in action among its different parts are slowly and steadily producing new combinations, which in time will effect mutations in its structure, change its physiography, and remodel the whole.

There are ten periods represented by the rocks of the neighbourhood of Bristol, from the oldest Silurian of Tortworth to the Alluvium of Bristol itself. The localities may be grouped into six districts:—

1. Tortworth. 4. Bristol.
2. Mendip Hills. 5. Dundry.
3. Radstock. 6. Bridgewater.

The Silurian in Tortwith district has long been classical ground to the geologist, but the true age and relation of the transition strata were not understood until Murchison's work was published. An old sandstone which abounds in fossils is the dominant rock, and is called Caradoc, or Upper Llandovery Sandstone. The Wenlock limestone and the Ludlow rock, which is exposed at low water on the west bank of the Severn at Purton Passage, are the other Silurian members in this group. These are succeeded by a red sandstone of the Devonian group, with the whitish-grey flags in its upper parts of which Tortworth Court is built.

Also we get a well-developed bone-bed at the base of the carboniferous rocks, and above the coal-measures a curious conglomerate. This formation is composed principally of rounded and angular fragments of limestone, exceeding the size of the head, with fragments of quartz and greenstone, cemented together with a calcareous paste, which is generally magnesian.

The Mendip Hills extend nearly due east and west for thirty miles, with an average breadth of six miles, and constitute the southern base of the Bristol coalfield. They consist chiefly of old red sandstone, carboniferous limestone, and trias. This last is represented by a magnesian conglomerate, flanking the hills, and in places capping their summits.

Old red sandstone forms the oldest stratified rock, and is, strictly speaking, the axis of the Mendip Hills. This nucleus is surrounded, and in parts overlain, by carboniferous limestone, which conforms with it both in dip and strike. The carboniferous limestone is grandly developed, and constitutes the great mass of the chain. On the northern flank of the Mendips, but highly contorted, are the well-known coal-beds of Holcombe, &c. There is no reason why we should not conclude that the coals of the northern side once extended across the Mendips, and now lie deeply buried along the south part of the range. Numerous islands of carboniferous limestone, surrounded by triassic rocks, occur at Wells and other places, and the entire range of the Mendips is surrounded by a limestone conglomerate. This conglomerate is composed entirely of fragments of the older rocks composing the hills, and is the result of the denuding action of the sea which deposited the Keuper beds. This marine denudation took place when the entire area occupied by the Mendips and coal-basin underwent depression, the dolomitic conglomerate and sandstones accumulating *pro rata* with the depression and consequent destruction of the rocks offered for resistance. This conglomerate, the "overlie" of the coal-miners of the Bristol basin, although visible only upon the Palæozoic rocks surrounding the coal-bearing area, is nevertheless spread over them, and beneath the new red sandstones that occupy nearly the entire area from Tortworth to the southern flanks of the Mendips, its presence being marked by the marls and sandstones of the Keuper, the lias limestones, and in other places the oolitic rocks that lie within the coal-basin, especially along its south-east border from Bath to Wells. We have no physical evidence more convincing of denudation, elevation, and depression over large areas of the earth's surface, than that which we can witness easily and study advantageously in the Mendip Hills; for this conglomerate rock here defines the limits between Mesozoic and Palæozoic times: the highly inclined old red sandstone forms the nucleus of the chain, the carboniferous rocks resting upon it; and the coal-measures in conformable succession to the latter were all indurated, metamorphosed, elevated, and thrown into folds long prior to the time when, under slow depression, destruction, and denudation, the dolomitic conglomerate was laid down by the triassic sea—the resultant of wave-forces along a coast-lime which was then the Mendip range, its shingle and boulders being slowly cemented by a magnesio-calcareous paste derived from the wasting beds of the great limestone series.

There is, moreover, evidence of a rhoetic sea which surrounded and covered the Mendips, in some cherty and sandy deposits overlying all the older rocks, and passing upwards into the lias beds, which in this district are found in fragmentary portions.

Two dykes have been observed in the district, one seven miles in length, coincident with the axis of the Mendips, the other at Bleadon. The age of the dykes is subsequent to that of the coal-measures, the whole of the Palæozoic rocks being disturbed alike, and lying at one general angle of inclination, while the secondary rocks are not affected by these Palæozoic changes.

Although more or less connected throughout, the coal-fields adjoining Bristol consist of three well-defined areas, called the Gloucestershire, Radstock, and Nailsea basins, each of which has its own distinctive features. Of these three areas Radstock basin is the most extensive, both geographically and sectionally, a great portion of its thickness being yet entirely undeveloped.

A very slight change in the geological circumstances of the past would have left us in entire ignorance of the existence of a coal field so far south as Bristol; and this reflection induces the hope that in other parts of the country (at present believed to be without coal, or, if present, to lie at such a depth from the surface that it cannot be worked) it may yet be discovered at a moderate depth.

Another feature of the Radstock coal-measure is their great thickness, which Mr. M'Murtrie estimates at 8,000 feet. From this we may infer that, however limited the area in Somersetshire of which we have at present positive knowledge, we are very far indeed from the edge of that infinitely more extensive area which the coal-measures of the South of England originally occupied, and within which outlying basins may still be found.

It is abundantly evident that the Bristol coal-field was originally connected with that of the Forest of Dean and South Wales, with which it has many characters in common, although it differs in other respects.

In all we find the same arrangement of the different strata, namely:—1st, an upper division of productive coal-measures; 2nd, a central mass of pennant sandstone; and, 3rd, beneath, a lower division of productive coal-measures resting upon, 4th, the millstone grit. Hitherto it has been found impossible to correlate the seams of coal; but they present many points of general correspondence in the districts referred to; and the information obtained leads to the conclusion that their greatest sectional development occurs between Radstock and Bristol, according to the following estimate of the thickness of the strata, number of seams, and thickness of coal-seams:—

STRATA AND COAL-SEAMS.

Division of strata.	Sectional thickness.	Number of Coal-seams.	Thickness of Coal-seams.	
			Feet.	Inches.
Upper Coal Measures.	2,600	16	26	10
Pennant Sandstone	2,750	4	5	10
Lower Coal Measures.	2,800	26	66	6
	8,150	46	97	26

This great sectional thickness is attended, however, with serious disadvantages; for although, according to the report of the Royal Coal Commission, the Bristol coal-field was estimated to contain 6,104 millions of tons of coals, a large portion of it lies at an unworkable depth.

In many of the collieries seams of from 10 to 12 inches in thickness are extensively worked, thus setting a good example of economy of one of the most precious natural productions to other parts of England, where veins of similar thickness are left behind as worthless.

The Bristol district is contained in a circle of eight miles' radius from the Guildhall. There are exposures of the old red sandstone and the other old beds already mentioned beside higher beds of lias and oolite. The carboniferous limestone is a great marine formation, and is formed of the sediments of an extensive and wide-spreading sea; the beautiful scenery so characteristic of the Avon, Severn, and Wye is in a great measure due to the development of this rock in these regions. One of the grandest sections of all the beds of the carboniferous limestone is that exposed in the gorge of the Avon near Clifton, where it is seen resting on the old red sandstone, and overlain by the millstone grit.

Last in order, as latest in point of time, we come to the Dundry district, which displays the oolitic formations. Having considered the stratigraphical relation of the rocks in the Bristol district, I desire now to say a few words on the organic remains found imbedded in these strata. The science of Palæontology (*palaios*, old; *onta*, beings) forms an immense field of observation, and one that widens more and more every year.

It is now established, 1st, that the stratified rocks containing organic remains admit of a division into four great groups, representing four great periods of time :—the Palæozoic or Ancient; the Mesozoic or Middle; the Cainozoic or Tertiary; and the Quaternary or Modern periods. 2nd. That each period is distinguished by its own hieroglyphic characters, which are graven on the rocks in definite and determinable characters. 3rd. That these hieroglyphics are the fossil remains or imprints of animals that lived in the water in which the sediments were formed in successive layers on the earth's crust, and are only found in the rocks they distinguish, so that it is possible to determine the age and position of the strata from which they have been collected, or, in other words, identify strata by organic remains; and by this key we are enabled to read the pages of the Rock-book, study the history of extinct forms of life, and determine their distribution in time and space.

Let us apply these principles to the subject we have in hand. The Palæozoic period comprises the history of the Cambro-Silurian, Devonian, Carboniferous, and Permian ages; and if we attentively examine the fossils of this period we shall see that all the organisms belonging to one age are entirely distinct from those belonging to the others. You will find, for example, in the case of the Silurian age, some beautiful corals, crinoids, and cephalopods, with a remarkable assemblage of crustacea, the representative of an extinct family, the trilobitidæ, which are so highly characteristic of this age that the rocks may be called trilobitic.

The Devonian age succeeds the Silurian; and among the corals and shells we observe a striking resemblance to those of the Silurian on the one side and the Carboniferous limestone on the other; and when closely examined we find that many are generally, and all are specifically distinct from both: besides this, we discover that a new group of organisms of a different and higher type of structure are now introduced for the first time, namely, those remarkable forms of the ichthyic class the fishes of the old red sandstone, and whose singular forms with their bony armour and osseous scales remind us of the remarkable fishes *Lepidosteus* and *Polypterus*, from North American, African, and Australian rivers of our time. The hieroglyphics, therefore, engraven on the strata of the second age are visibly different from those on the first.

The Carboniferous succeeds the Devonian: the fine specimens of the anthozoa show clearly that this portion of the section was formed in a tropical sea, and that the limestone is the product of the living energies of polyps, of the family Favositidæ, Cyathophylidæ, &c. The trilobites, which formed so remarkable a feature in the fauna of the Silurian sea, are now represented by *Phillipsia*, a dwarfed genus of the family.

The life of the carboniferous limestone proves that it was a great marine formation accumulated during a long lapse of time out of the exuviæ and sediments of many generations of mollusca, echinodermata, and actinozoa, the reef-building corals having contributed largely to the thickness of the coral beds, and the wasted reefs of former generations having been used up again and again in the formation of the oolitic beds which succeeded the reef-building periods.

The coal-measures present a remarkable contrast to the coral sea of the carboniferous era. The ferns (*Sigillaria*, *lepidodendra*) and other arborescent acrogens of the coal-seams grew and flourished in low islands; and their remains were accumulated under conditions very different from those in which the thick-bedded limestones of the Avon section were formed.

With the close of Palæozoic time mighty changes took place. Volcanic agency was intense and active, flexing, contorting, and upheaving the older beds. These displacements in our area are well exemplified in the unconformable position of the dolomitic conglomerate and new red sandstone of the Bristol district.

The dolomitic conglomerate contains the bones of dinosaurian reptiles.

We know very little of the life of the trias in the district under consideration, beyond the reptilian remains first noticed here, until we come to the close of this age, when we find upper grey marls of the Keuper overlain by and passing into a series of black shales and limestones known as the *Avicula contorta* or rhœtic beds, which comprise the famous bone-bed of Aust Cliff known to all geologists. It is the teeth of *Ceratodus*, or horned teeth, that have made Aust Cliff famous; and more than 400 different forms have been described. When these horned teeth, so called from the prominences they exhibit, were first described by Agassiz, the living species of this genus was not known; it is now ascertained that it lives in the Mary, Dawson, and other rivers of Queensland, and is called by the natives "barramanda." The *Ceratodus* is very nearly allied to the *Lepidosiren*, is cartilaginous, a vegetable-eater, and, like the *Lepidosiren*, lives in muddy creeks; during the hot season it buries itself in the mud, whence it is dug up by the natives, its retreat being discovered by the air-hole through which it breathes; its nostrils are placed in the inside of the roof of the mouth.

The lias, which succeeds the *Avicula contorta* beds, presents a remarkable contrast to them, and shows how much the life-conditions of every age depend on the physical agents that surround it. Two groups of animals appeared in great force in the liassic sea—ammonites and reptiles.

The ammonites attained a large size; and the middle and upper divisions of the same formations were all characterised by different species that marked horizons of life in these divisions. Associated with the ammonites, a large assemblage of other mollusca are found, and a profusion of belemnites and large *Nautili*.

The reptiles were very large, *Ichthyosaurus* and *Plesiosaurus* were the dominant forms; and Pterodactyles with expanded wings performed the part of birds on the dry land of that era; so that the air, the estuary, and the ocean had each separate forms of reptile life in the Lias age. Another change of conditions introduces us to new forms in the lower jurassic sea. A large number of species of conchifera and gasteropoda crowd the shelly beds of the inferior oolite; and new forms of ammonites appertaining to groups entirely different from those of the lias are found in abundance in Dundry Hill. In addition to the mollusca we find many beautiful forms of echinodermata, and a large collection of reef-building corals in the upper beds of the hill.

The jurassic rocks were accumulated as sediments or shore-deposits under many changes of condition; and the idea of a slowly-subsiding bed of the coralline sea gives us, perhaps, the nearest approach to what appears to have prevailed.

The jurassic waters were studded with coral-reefs, extending over an area equal to that of Europe, as they stretch through England diagonally from Yorkshire to Dorsetshire, through France from the coast of Normandy to the shores of the Mediterranean, forming besides a chain winding obliquely through the Ardennes in the north to Charente-Inférieure in the south, including Savoy, the Hautes-Alpes and Basses-

Alpes, the Jura, the Franche-comté, the Jura Chain of Switzerland throughout its entire length from Schaffhausen on the Rhine to Cobourg in Saxony, and along the range of the Swabian Alps and Franconian Jura. Throughout all this widely-extended oolitic region, coralline strata were accumulating through countless ages by the living energies of jurassic polyps, as all the madreporic limestone beds in these formations are due to the life-energies of different species of these creatures; and were we to venture to estimate the lapse of time occupied in the deposit of the coral oolites by what we know of the life-history of some living species, we should find good reason for concluding that the jurassic age must have been one of long duration. It is not the mere coralline structure *per se* that is due to polyp-life, but the entire mass of oolitic limestones are the products of the same vital force; for there could be no doubt in the mind of any competent observer who carefully examined such a rock, that it was a mass of coral secreted by a jurassic polyp, and that the oolitic limestone which surrounds the coral stem is the product of a portion of a wasted reef which had been broken up, ground into mud, and constituted the paste that had coated particles on the shore, and formed by the roll of the waves the globules which were afterwards cemented by calcareous waters, and the whole transformed into the rock we call oolitic limestone.

The reefs that remain are merely fragments of those which had been; and those that have disappeared furnished the calcareous material out of which the oolites of subsequent formations have been built up.

In these remarks I have carefully avoided any allusion to the origin of species, because geology suggests no theory of natural causes, and palæontology affords no support to the hypothesis which seeks by a system of evolution to derive all the varied forms of organic life from pre-existing organisms of a lower type. As far as I have been able to read the records of the rocks, I confess I have failed to discover any lineal series among the vast assemblage of extinct species which might form a basis and lend reliable biological support to such a theory. Instead of a gradation upwards in certain groups and classes of fossil animals, we find, on the contrary, that their first representatives are not the lowest, but often highly organised types of the class to which they belong. This is well illustrated in the corals, crinoids, asteriadæ, mollusca and crustacea of the Silurian age, and which make up the beginnings of life in the Palæzoic period. The fishes of the old red sandstone, we have already seen, occupy a respectable position among the pisces; and the reptiles of the trias are not the lowest forms of their class, but highly organised dinosauria. *Ichthyosaurus*, *Plesiosaurus*, *Pterodactylus*, *Teleosaurus*, and *Megalosaurus* stand out in bold relief from the mesozoic strata as remarkable types of animal life that were specially organised and marvellously adapted to fulfil important conditions of existence in the reptilian age; they afford, I submit, conclusive evidence of special work of the Great Designing Mind which pervades all creation, organic and inorganic. In a word, palæontology brings us face to face with the Creator, and shows us plainly how in all that marvellous past there always has existed the most complete and perfect relation between external nature and the structure and duration of the organic forms which gave life and activity to each succeeding age.

Palæontology likewise discloses to our feeble understanding some of those methods by which the Infinite works through natural forces to accomplish and maintain His creative design, and thereby teaches us that there has been a glorious scheme, and a gradual accomplishment of purpose through unmeasured periods of time; but palæontology affords no solution of the problem of creation, whether of kinds, of matter, or of species of life, beyond this, that although countless ages have rolled away since the denizens of the Silurian beach lived, and moved, and had their being, the same biological laws that governed their life, assigned them their position in the world's story, and limited their duration in time and space, are identical with those which are expressed in the morphology and distribution of the countless organisms which live on the earth's surface at the present time; and this fact realises in a material form the truth and force of those assuring words, that the Great Author of all things, in these His works, is the same yesterday, to-day, and for ever.

Dawsonite.—(*Academy*).—It is worth recording that Dr. Harrington, chemist to the Geological Survey of Canada, has recently described a new mineral-species which presents a remarkable chemical constitution, inasmuch as it appears from the analyses to be a hydrous carbonate of alumina, lime, and soda. The existence of an artificial carbonate of alumina is extremely doubtful, but it should not be forgotten that many years ago a mineral from Hove, near Brighton, was described by Messrs. J. H. and G. Gladstone, under the name of Hovite, and that these chemists then suggested that their specimen might be a carbonate of alumina and lime. The Canadian mineral may have a similar constitution, or it may be merely a compound of hydrate of alumina, with the carbonates of lime and soda. This new species was found at M'Gill College, Montreal, and has received the name of Dawsonite, after the distinguished Principal of the College.

Water of Artesian Wells of Grenelle.—M. Gérardin (*Comptes Rendus*) finds that there is no oxygen present in the water from the lower sandstone of this locality, nor from the Rilly gravel beneath the clay, nor from the Soissonais gravel. Neither was this gas discovered in the water from the artesian well at Gonesse. M. Gérardin concludes that water obtained from subterranean depths does not contain oxygen if kept from contact with the atmosphere. This precaution is essential, for in contact with the air it dissolves several cubic centimetres of oxygen. The author has often found in the interior of the ascension tubes long white opaline filamentary algæ. These algæ present the curious property that they remain white in solar light as long as the water is deprived of oxygen; but they become green the instant the water is the least aërated. Their sensibility to the action of oxygen is most delicate. The action of the algæ serves to confirm the chemical test with hyposulphite of soda.

The Rate of Erosion at Niagara.—T. Belt.—It is generally supposed that the entire gorge from Queenstown to the Falls, a distance of seven miles, has been excavated by the present river since the Glacial period. Sir Charles Lyell estimated that the river is cutting its way back at the rate of about one foot per annum, but Mr. Belt believes that the retrocession does not proceed at more than one-tenth of this rate. He maintains, too, that the gorge from the whirlpool to the Falls was cut out in pre-glacial times, and that the present river has excavated only that portion of the gorge which is worn out in the softer beds between the whirlpool and Queenstown; its work above that point having been confined to clearing out the bed of the old pre-glacial river in the harder rocks. Mr. Belt believes that the facts connected with Niagara lend support to his views, which refer the appearance of the Glacial epoch to a more recent period than that usually assumed.—*Quarterly Journal of Science.*

Great Salt Lake.—G. K. Gilbert (*Geolog. Rep., Lieut. Wheeler, U.S.N.*).—What is now Great Salt Lake must at one time have been much higher and its area much greater than it is at present. Former levels are marked by a series of conspicuous shore-lines carried on the adjacent mountain slopes to a height of more than 900 feet. When the waters rose to the uppermost beach they must have covered an area of about 18,000 square miles, eleven times that of the present lake, and a trifle less than that of Lake Huron; the average depth was 450 feet, and the volume of water nearly 400 times greater than now. The lake was diversified by numerous rocky islands and promontories, and its water was fresh. The flooding of the Great Salt Lake valley, Mr. Gilbert believes, marked a temporary change of climate, and was contemporary with the general glaciation of the northern portion of N. America, and with the formation of the numerous local glaciers of western mountain systems; he considers it a phenomenon of the Glacial epoch. While the general climatal change that caused or accompanied that epoch (depression of temperature, carrying with it decrease of evaporation, if not increase of precipitation) may be adduced as the cause of the inundation of Utah, Mr. Gilbert sees no reason to suppose that the relative humidities of the various positions of the N. American continent were greatly changed; and this consideration will aid in accounting, he thinks, for the curious fact that the ice in the eastern seaboard stretched unbroken past the fortieth parallel, while under the same latitude in the Cordilleras no glaciers formed below 9,000 feet.

A Descent into Elden Hole, Derbyshire.—Rooke Pennington (Lit. Phil. Soc., Manchester).—Near the road from Buxton to Castleton, and about four miles from the latter place, stands Elden Hill, in the side of which is Elden Hole, a perpendicular chasm in the rock, and, like many such apertures, reputed to be bottomless. At a distance of 180 feet from the top a landing-place was reached, although not a very secure one, as it was inclined at an angle of about 45°. Thence a cavern ran downwards towards the south or south-east; the floor was entirely covered with loose fragments of limestone, probably extending to a considerable thickness. There was quite sufficient light at this point to enable one to sketch or read. The party then scrambled, or rather slipped, into the cavern for some few yards, during which they descended a considerable distance: it was of a tunnel-like shape; then it suddenly expanded into a magnificent hall about 100 feet across and about 70 feet high. The floor of this hall sloped like the tunnel, and like it was covered with *débris.* At the lower side they were about 60 feet below their landing-place, and therefore about 240 feet beneath the surface. The entire roof and walls of this cavern were covered with splendid stalagmitic deposits. From the roof were hung fine stalactites, whilst the sides were covered with almost every conceivable form of deposited carbonate of lime. In some places it was smooth and white as marble, in other places like frosted silver, whilst the rougher portions of the rock were clothed with all sorts of fantastic shapes glistening with moisture. From this cavern no opening of any length or depth was found save the one by which the party had entered it.

There can be no doubt, the author believes, that this chasm has been formed by the chemical action of carbonic acid in water, and that it has attacked this particular spot either from the unusual softness of the rock originally situated here, or because there was here a joint or shrinkage in the strata. There is nothing, however, in the position of Elden Hole to lead one to suppose that any stream has ever flowed through it; no signs of such a state of things appear anywhere around. It is not related to any valley or ravine, or to any running water, and there is, as observed, an absence of any well-defined exit for water at the bottom. No mechanical action of a flowing stream can therefore have assisted the process of enlargement. The author thinks it must be due to the gradual silent solvent properties of rain-water falling on the surface, and escaping through jointings and insignificant channels in the hard rocks below. Whether the excavation took place from above or below is uncertain.

Kent's Cavern.—W. Pengelly.—In the south-western end of the Long Arcade, there are two deposits; the newer one contains the ordinary pleistocene cave mammalia, with flint implements; this is overlain by granular stalagmite. Up to the last few years this was the only cave-earth known; but recent researches have revealed the existence of a much older bed, separated from the newer one by a floor of crystalline stalagmite. This old breccia contains flint tools of a much ruder form than those in the bed above, associated with the remains of the bear. During the last year the remains of the cave lion and of the fox have also been found here.

Victoria Cave.—The great interest taken in this cave lies in the long succession of events represented by its contents. The collections already made illustrate the occupation of the country, and of the cave at intervals, by the early English, Roman, and Celtic populations. Then, further back by many ages, they show the remains of people who used the newer type of stone implements. In beds of yet earlier age, the exploration has shown the occupation of Yorkshire by the grizzly bear and the reindeer, in times immediately succeeding, and perhaps preceding, the development of the great ice sheet in the north of England. The series of bones obtained during the past year is exceedingly fine, and altogether the work is one of great promise, but it is now stopped for want of funds. Its strongest claim for further exploration and most interesting result is the existence, in the lowest beds of the cave, of the remains of man, with the great cave-bear, the hyæna, elephant, rhinoceros, bison, &c. And these are covered, both at the entrance of the cave and within, by glacial beds, which afford the strongest evidence that man lived in the district before the advance of the great ice-sheet over the North of England.—*Athenæum.*

Forest Bed in the Thames Banks.—(*Nature.*)—An interesting geological discovery has been recently made during excavations for a new tidal basin at the Surrey Commercial Docks. On penetrating some six feet below the surface, the workmen everywhere came across a subterranean forest bed, consisting of peat with trunks of trees, for the most part still standing erect. All are of the species still inhabiting Britain; the oak, alder, and willow are apparently most abundant. The trees are not mineralised, but retain their vegetable character, except that they are thoroughly saturated with water. In the peat are found large bones, which have been determined as those of the great fossil ox (*Bos primigenius*). Fresh-water shells are also found. No doubt is entertained that the bed thus exposed is a continuation of the old buried forest, of wide extent, which has on several recent occasions been brought to the daylight on both sides of the Thames, notably at Walthamstow in the year 1869, in excavating for the East London Waterworks; at Plumstead in 1862–3, in making the southern outfall sewer; and a few weeks since at Westminster, on the site of the new Aquarium and Winter Garden. In each instance the forest-bed is found buried beneath the marsh clay, showing that the land has sunk below the tidal level since the forest flourished.

Thames Deposits.—During the excavations which are being made near the Houses of Parliament for the foundation of the Thames Embankment Extension, some interesting relics have likewise been brought to light. A deposit containing freshwater shells, at a depth of about 32 feet from the surface, and only a few feet above the London clay, has yielded the remains of a bovine animal, probably the Celtic short-horn (*Bos longifrons*), and the bones of a remarkable rodent, a portion of a human skull, and a flint knife.

Zoology of the Thames Valley.—An interesting collection has recently been added to the British Museum. It consists of the Thames Valley series of remains of British elephants, rhinoceri, deer, ox, &c., which have been discovered in the Ilford Marshes, near Stratford, during the last thirty years, and has hitherto formed the unique private collection of Sir Antonio Brady, of Stratford-le-Point. The nature and value of this collection, as now exhibited at the British Museum, will appear from the following facts:—It contains remains of no less than 100 elephants, all of which have been obtained from Ilford. These are referable to two species, viz., Elephas primigenius, the mammoth, and E. antiquus, a more southern form. The skeletons of each species are represented by many fine examples, and the collection of teeth and jaws represents elephants of every age and size, from the sucking calf, with milk molars, to the patriarch of the herd, whose last molars are so worn that they must have become useless for grinding his food. One characteristic of the Ilford elephants is the number of the plates in the last molar tooth, which has never been found to exceed nineteen or twenty, as against the twenty-four and sometimes twenty-eight in other species. The largest tooth is ten inches in length. The rhinoceri of the Thames Valley are represented by eighty-six remains, of three species, distinguished by the character or the absence of the bony nasal septum—viz., Rhinoceros megarhinus, R. leptorhinus, and R. tichorhinus. The British lion, which recent geology shows to have been no myth, is represented by a lower jaw and a phalanx of the left forefoot. The Brady collection also includes the Thames Valley hippopotamus, which is found at Grays, as well as at Ilford. The ruminants, such as the stag, bison, and ox, constitute fully one-half the collection, numbering more than 500 specimens. They include seven specimens of the great Irish elk (Megaceros hibernicus) and fifty of the red deer.

The Submerged Forest of the Orwell.—J. E. Taylor (British Association) showed that a depression of the land, amounting to thirty feet at least, must have taken place since these peat-beds were formed. He believed that this forest-bed, and other similar beds along the eastern coast, represented the last stage of the continental condition of England, before the depression took place which brought the North Sea over the low-lying plains, and so formed the present German Ocean.

Glaciation of North America.—G. K. Gilbert (*Geolog. Rep.* Lieut. Wheeler, U.S.N.).—About White's Peak, in the Schell Range, Nevada, are the terminal moraines of five or six glaciers that ascend to 8,000 feet altitude in lat. 39° 15′. At about the same altitude, and in lat. 39°, are moraines and an alpine lake upon the flanks of Wheeler's Peak, of the Snake Range, Nevada. Old Baldy Peak (N. lat. 38° 18′), near Beaver, Utah, overlooks two terminal moraines, one of which contains a lakelet at an altitude of about 9,000 feet. No traces were seen of a general glaciation, such as the Northern States experienced, and the cumulative negative evidence is of such weight that Mr. Gilbert is of opinion that the glaciers of the region referred to were confined to the higher mountain ridges.

Decadence of the Andes.—The highest points of the chain of the Andes are sinking. In 1745, when measured by La Condamine, Quito was found to be 9,596 feet above the sea. Humboldt, in 1803, found it had fallen to 9,570 feet; Boussingault, in 1831, was astonished to find it was only 9,567 feet: Orton, in 1867, found it reduced to 9,520 feet; while, finally, Reiss and Stubel verified that in 1870 it had shrunk to only 9,356 feet above the sea-level. Quito, therefore, has sunk 240 feet in 125 years.

Geology of the Appalachians.—Prof. Bradley, of Tennessee.—It has long been the tendency of geologists to regard the metamorphic crystalline rocks of the Atlantic coast as certainly pre-Silurian. This has, however, been called in question by the observations of Prof. Dana, which go to prove that the limestones and accompanying schists and quartzites of Western New England are all Silurian, and not Huronian or Laurentian. Prof. Bradley now claims the same for the region he has investigated, that is, the western portion of North Carolina, the eastern part of Tennessee, and much of Georgia and Alabama. The evidence upon which the conclusion is based is stratigraphical, and must be studied in detail to be fully understood. The time at which the uplift and metamorphism of this region took place is considered by Prof. Bradley to have been post-Carboniferous, and it is probably referable to the close of the Palæozoic.—*Nature.*

Undulations in the Chalk in the North of France, and their probable existence under the Straits of Dover.—(British Association).—The proposed Channe Tunnel, according to M. Hébert, must follow a curved course to avoid folds in the chalk. Sir John Hawkshaw, is very positive that a tunnel may be made across entirely through the chalk. He said that he had taken means to ascertain as nearly as practicable what was the state of things at that portion of the Channel, and that he did not think that it accorded with what M. Hébert' views.

Careful measurements had been made and levels taken on each side of the Channel, and the outcrop of the beds in the Channel had been ascertained as accurately as could be done. By getting the levels and so on, and by knowing the depths of the Channel, the outcrops of the various beds were ascertained, and laid down on a geological map. Of course that was not sufficient to satisfy him, but the result of other enquiries was to show the outcrop of the upper and lower chalk formations, and the next process was to get more accurate information on these points. It appeared from the chart that a line from St. Margaret's Bay would be sufficient to enable it to be carried through the lower chalk; and borings were made at

St. Margaret's Bay entirely through the chalk. Also at San Gatte the borings went nearly 600 feet through the chalk, which gave the position of the chalk on each side of the Channel. A well had been sunk at Calais, which had gone through the chalk. That so far indicated certain depths, and afforded a basis for reasoning. After that an examination was made of the region across the Channel. The Channel was examined in 500 places, by an apparatus constructed for the purpose, and the result of that examination verified the previous geoligical inquiries. Where the geological map showed chalk they brought up chalk all across the channel, and where the geological map showed the outcrop of the lower beds, they brought up portions of those beds. There was no greensand near the line of the Channel. Of course, this was so far in corroboration of what had been done before, and he would say at once that if it was necessary in constructing this tunnel to follow a circuitous line, as had been pointed out by M. Hébert, it would not be constructed. It would be constructed only if it could be made in a straight line. It was not to be supposed that the tunnel would be made immediately beneath the bottom of the Channel. The Channel is a very shallow basin, and it is proposed to take the tunnel about 230 feet below the bottom of the Channel, the depth of water being 108 feet, and there was chalk in the line drawn all across the Channel. He was not apprehensive of coming out into other beds, and he should not care much about it if they were below the other beds, because, with 230 feet of solid matter between them, small leakages would not prevent a construction of that kind being made.—*Academy.*

Volcanic Phenomena in Iceland.—(*Nature*).—Outbreaks have occurred since the beginning of the year. In March the Dyngjufjöll was incessantly vomiting fire, the eruption was steadily spreading over the wilderness, and the whole region of the My-vatn Mountains was one blazing fire. So large a district of the surrounding country has been covered with ashes that the farmers have been obliged to remove in order to find pasture for their stock. Early in April a new eruption had broken out in a south-easterly direction from Barfell, more than halfway to the east, between it and the Jokulsa. A party went out from Laxárdal to explore, and on approaching the place of eruption they found the fire rising up from three lava craters, in a line from south to north, which it had piled up around itself on a perfectly level piece of ground. At a distance of fifty to eighty fathoms to the west from the craters a large fissure had formed itself as the fire broke out, and the land had sunk in to the depth of about three fathoms. Into the hollow thus formed the lava had poured at first, but now it flowed in a south-westerly direction from the two southern craters. The northernmost crater had the appearance of being oblong, about 300 fathoms in length; and from this crater the molten red-hot lava was thrown about 200 or 300 feet into the air in one compact column. The top of this column then assumed a palmated appearance, and the lava fell down in small particles, like drops from a jet of water, which, as they became separated from the column, grew gradually darker, and split into many pieces, bursting into lesser and lesser fragments as they cooled. No flames were observed, but the glare proceeded from these columns and the seething lava in the craters. At times the explorers could count twenty to thirty of these columns. No real smoke accompanied the eruption, but a bluish steam, which expanded and whitened in colour as it rose to a greater distance from the crater, and such seemed to be the power of this blue jet of steam that it rose straight into the air for many hundreds of fathoms in despite of a heavy wind blowing.

Volcanic Geology of Iceland.—W. L. Watts (Geologists' Association).—Iceland is situated at the termination of the great volcanic line, skirting the extreme west of the Old World, which has existed since the Cretaceous period certainly, whilst the points of eruption appear to have travelled northwards. As all the rocks are igneous, or igneous derivatives, no stratigraphical arrangement can be made out. Basaltic lava streams are common in the vicinity of Reykjavik, though no active volcano exists in this part of the island, which is in the secondary stage of solfataras and hot springs. These solfataras are mere pits of bluish-white siliceous mud, the result of the decomposition of contiguous tufa. The principal gas exhaled is sulphuretted hydrogen. Their position changes. The hot springs are working out their own destruction by the accumulation of sinter; the composition of this varies in springs within a few yards of each other. The large rifts in the old lava at Thingvalla were attributed to the flowing away of the undercurrent of lava into a yet deeper depression, thus leaving the unsupported crust to sink down in the middle. All the lavas of Hekla observed by the author are basaltic, and contain crystals of felspar and olivine. An ash and cinder cone forms the summit of the mountain. There were four craters; the longest one is an elliptical depression 250 feet deep, at the bottom of which lay snow, though some ashes and clay were still quite hot. The district of Mydals Jökull, containing the terrible volcano Kotlujia, is remarkable for the confused intermixture of aqueous and igneous ejectamenta, producing agglomerates and tufas. Sand and hot water are the principal productions of Kotlujia itself, which has not been known to produce lava, though ancient felsitic lavas were noted at its base. These floods are produced, in addition to the melting of the Jökull, by the bursting of large cavities in which water has accumulated for years. Such a reservoir was noted in a small neighbouring crater, at the bottom of which was a deep pool of turbid water, into which several small streams emptied themselves, but none ran out again. To Vatna Jökull the principal volcanic forces of Iceland seem now to have retreated. This is a vast tract of snow and ice which rests upon a nest of volcanoes, many of which have been in eruption during historical times. The Vatna rises from a series of basaltic platforms. The existence of permanently active volcanoes in the unknown interior of this mass was considered not improbable.

Vatna Jökull (Glacier), Iceland.—The following letter is from Mr. W. L. Watts (*Nature*), in reference to his journey across the Vatna Jökull. (This is the first time the Vatna Jökull has been crossed. The letter is dated July 12, 1875.)

I am happy to say I have crossed the Vatna Jökull. It occupied between fifteen and sixteen days in bad weather. Euriffa is by no means the highest mountain in Iceland; my aneroids registered 1,250 feet above Euriffa's height, subject to their correction upon my return to England.

I feel certain that the Jökulls of Iceland are advancing at a considerable speed. The part of the Vatna Jökull, in the south of Iceland, called Breithamerker Jökull, has advanced about one mile and a half since the 10th of May last, and threatens to cut off all communication in that direction along the shore. I think, however, its rapid advance is not, as the natives believe, owing to volcanic heat in the Vatna Jökull, but that it is caused simply by the vast increase of frozen material upon its cloud and storm-wrapped heights. This accumulation above the height of 5,000 feet goes on both in summer and winter, and below for another thousand feet the waste during the summer months by no means equals the accumulation during the rest of the year. The glacier at the north point, at which I descended, by Kistufell, has advanced about twelve miles since the making of Olsen's map of 1844, diverting the course of Jökull sâ á fjöllum and causing it to rise about twelve miles from where it appears upon the map, *i. e.* about eleven miles N.E. of Kistufell and twelve N.N.W. of Kverker Jökull, instead of at the base of Kistufell. The grand old water-course it has vacated forms an excellent road for several miles. I feel sure that Iceland must slowly but surely in course of time succumb to the same fate as befell the Greenland colonies.

I am now about to proceed to the active volcanoes upon the north of Vatna Jökull. They are situated in the part of the Odalters-braun called Dyngurfjöllum, and as I expect in the Kverker Jökull. I shall have no time to hunt for any more this year, but if time will allow I shall visit the source of the great lava stream of Skaptar Jökull, a mountain I saw from the Vatnar Jökull, situated in its S.W. limb, which I think may repay inspection; and the lignite in the N.W. of Iceland.

'The destruction wrought by the eruptions of last witner is considerable. Several farms have been ruined by pumice and ash. Poor, dirty, interesting Iceland! both fire and water, the latter in all its forms, appear to conspire against it.

Volcanic Eruption in Iceland.—Very Rev. Dean Sigurd Gunnarsson (*Times*).—On Easter Monday, early in the morning, loud rumbling noises were heard to the westward, and apparently travelled towards the north-east, in the direction of the mountain ranges bounding the valley of Fljótsdalshérad to the north. Presently the sounds turned backward along the southern mountains as well. The air was heavy and jet black towards the north and north-east. About nine o'clock whitish-grey scoriaceous sand began to fall from the sky, the particles averaging the size of a grain, but in shape longer. The dark column moved on nearer and nearer, and the darkness rapidly increased, while the scoriaceous hail thickened at the same rate. A full hour before noon candles had to be lighted in the houses, and at noon the darkness was as dense as that of a windowless house; even abroad the fingers of the hand could not be distinguished at the distance of a few inches from the eye. This pitch darkness lasted for about an hour. During the dark all glass windows appeared like mirrors to those inside, reflecting the objects on which the light fell as if they had been covered outside with a coat of quicksilver. For four consecutive hours it was necessary to have lighted candles in the houses. During all that time the ashes and the sand were falling thick and fast. Lightning and claps of thunder were at the same time seen and heard in rapid succession, and the earth and everything seemed to tremble again. The air was charged with electricity to such an extent that pinnacles, and staff-pikes of iron, when turned into the air, and even one's hands when held up, seemed all ablaze. But the thunder differed from ordinary claps in this, that it travelled in rapidly-repeated echoes across the skies. When the darkness wore off the fall of the ashes abated. The dark column now moved inland towards the upper valleys; but, being there met by a counter current of air, it remained at first stationary for a while, and afterwards moved slowly down country again along the valleys, so that once more the daylight was changed into dusk, which was accompanied by the fall of fine ashes. After the fall, the earth was covered with a layer of ashes and scoriæ from 1½ inches to 8 inches deep; coarsest where it lay thickest, in many cases exhibiting pumice boulders twice as large as the fist. In these places the ashes fell hot as embers on the ground. At first the fall of the ashes was accompanied by a foul sulphurous stink, which, however, very soon vanished. When the ashes had any perceptible taste it was that of salt and iron. For three days after the fall, still weather prevailed, and the ashes lay undisturbed on the earth. Before the fall of the ashes the land was snowless and pasture plentiful; but after it not a creature could be let out of doors, and the sheep, if they were let out, would run as if mad in all directions. On the fourth day a pretty stiff south-west gale blew the ashes away from the hillocks and mounds, except the finest part, which remained on the sward, presenting the appearance of a compact scurf. But what good this gale might have done was undone the next day by a wind blowing from north-west. Great distress was caused by the destruction of the pastures.

MINERALOGY.

Formation of Fissures and the Origin of their Mineral Contents.—A. J. Brown.—The conclusions of the author are, that fissures in the earth's crust are formed, in nearly all cases, by earthquake shocks; that they may be filled in one of three ways—by melted injections, by aqueous agencies, or by sublimation; that the minerals are not derived from the immediate walls of the fissure, but from below the zone of sedimentary rocks.

Deposits of Tin Ore at Park of Mines, St. Columb, Cornwall.—Dr. C. Le Neve Forster (British Association).—The ore here occurs in layers parallel to the stratification of the clay slate. Dr. Forster believes that the rock split along the lines of original bedding; and that tin ore, brought up through small north and south fissures, found its way into cavities on both sides of the fissures.

Formation of Metallic Minerals.—M. Daubrée (*Comptes Rendus*).—During the drainage of a well at the hot-springs of Bourbonne-les-Bains (Haute Marne), the muddy bottom was laid bare, and found to contain a number of Roman coins, statuettes, and other objects in bronze, silver, and gold. But immediately below this level the workmen came upon a bed made up of fragments of rock, chiefly sandstone, cemented together by certain metallic sulphides, which, in many cases, were well crystallised. They included examples of copper-pyrites, *Buntkupfererz* or "horse-flesh ore," copper-glance or sulphide of copper, and what was most notable, tetrahedral crystals of a double sulphide of copper and antimony, identical with certain varieties of *Fahlerz*. The minerals appear to have been formed by the reduction of metallic sulphates, through the agency of vegetable matter, and to have been precipitated among the fragments of stone which they have cemented into a breccia. The thermal waters issue from the new red sandstone at a temperature of about 60° C. It can be proved that the formation of these minerals cannot have extended beyond sixteen centuries.

The Sulphur-Beds of the Island of Saba.—Professor Gesner (*Chemical News*).—Our destination was Spring Bay, (where the beds of sulphur bearing gypsum show their greatest outcrop,) and Great Hole, which adjoins it. The men were engaged in removing the overburden, some eight feet of sand and gravel, when we arrived, and in breaking down the crude brimstone from the face of the bed, which is 40 feet in thickness at this point, and extends into the hill under the volcanic cap for an indefinite distance. Going towards Flat Point, which lies between Great Hole and Spring Bay, and descending the cliff a little, one can obtain a view of the face of the vast bed of brimstone, which shows the yellow features in all the places where the overburden has been removed, and in weather-worn places stands out distinctly. At one place a fissure nearly 2 feet in width, lined with yellow crystal so far as we could see, was sounded with a line for forty feet. The mass of the bed is gypsum, bearing sulphur to a greater or less degree, 60 per cent. being the average of sulphur. In many places masses of sulphur quite pure and resembling melted brimstone, poured into irregular moulds, could be had, hundreds of pounds in weight. The fires died out in Saba so long ago that the sulphur-beds are perfectly cold, and no gases arise to interrupt the working of the sulphur quarry, the workmen carrying on their operations as easily as if in a bank of stiff clay. We traced the bed to Flat Point. A wire tramway from the edge of the quarry to Green Key will be the way to transport the sulphur to lighters. I have seen what I believe to be one of the largest, and certainly the richest and most accessible, deposits of brimstone in the world. Analysis of Saba sulphur:—Sulphur, 80·57; silicate and sulphate of lime, 14·90; water, 4·53.

Origin of Torbanite, or Torbane Hill Mineral.—W. Skey, Geol. Survey, New Zealand (*Chemical News*).—In prosecuting some researches on the absorption of petroleum by clay, Mr. Skey obtained a product that strikingly resembled the natural substance. He believes that if petroleum percolated through a bed of clay, the argillaceous matter would abstract certain constituents from the petroleum, and thus produce, if the action were not long continued, an ordinary bituminous shale; but if the process proceeded until the clay were saturated, a mineral substance like torbanite would be obtained. It is not that the clay merely absorbs mechanically some of the constituents of the petroleum, but Mr. Skey believes that a true chemical action is set up, and that the resulting substance is a combination of a hydrocarbon with silicate of aluminium. This conclusion corroborates the view that torbanite is in no sense entitled to be classed as a coal.

Ice in a Silver Mine.—Geologists have been not a little perplexed with the frozen rocks found in some of the silver mines in Clear Creek county, Colorado, America. For instance, there is a silver mine high up on McClellan mountain, called the Stevens mine. The altitude of this mine is 12,500 feet. At the depth of from 60 to 200 feet the crevice matter, consisting of silica, calcite, and ore, together with the surrounding wall-rocks, is found to be in a solid frozen mass. McClellan mountain is one of the highest eastern spurs of the Snowy Range; it has the form a horseshoe, with a bold escarpment of feldspathic rock, nearly 2,000 feet high, which in some places is nearly perpendicular. The Stevens mine is situated in the south-western bed of the great horseshoe; it opens from the north-western. A tunnel has been driven into the mountain on the lode, where the rock is almost perpendicular. Nothing unusual occurred until a distance of some 80 or 90 feet was made; aud then the frozen territory was reached, and has continued for over 200 feet. There are no indications of a thaw, summer or winter; the whole frozen territory is surrounded by hard, massive rock, and the lode itself is as hard and solid as the rock. The miners, being unable to excavate the frozen material by pick or drill, to get out the ore (for it is a rich lode, running argentiferous galena from 5 to 1,200 ounces to the ton), found the only way was to kindle a large wood fire at night against the back end of the tunnel, and then thaw the frozen material, and in the morning take out the disintegrated ore. This has been the mode of mining for more than two years. The tunnel is over 200 feet deep, and there is no diminution of the frost; if anything, it seems rather to be increasing. There is, so far as can be seen, no opening or channel through which the frost could possibly have reached such a depth from the surface. There are other mines in the same vicinity in a like frozen state.

On the above report R. Weiser, of Georgetown, Colorado, remarks:—From what we know of the depth to which frost usually penetrates into the earth, it does not appear probable that it could have reached the depth of 200 feet through the solid rock in the Stevens mine, nor even through the crevice matter of the lode, which, as we have stated, is as hard as the rock itself. The idea, then, of the frost reaching such a depth from the outside being utterly untenable, I can see no other way than to fall back upon the glacial era of the quaternary. Evidences of the Glacial period are found all over the Rocky Mountains. Just above the Stevens mine there are the remains of a moraine nearly a mile long, and half a mile wide. The *débris* of this moraine consists of small square and angular stones, clearly showing that they have not come from any great distance. And just over the range, on the Pacific slope, there are the remains of one of the largest moraines ever seen, consisting of feldspathic boulders of immense size. It is therefore not unreasonable to conclude that it was during that period of intense cold that the frost penetrated so far down into these rocks, and that it has been there ever since, and bids fair to remain for a long time to come.

New South Wales Gold Fields.—(*Nautical Magazine*).—The proclaimed gold-fields, extending with short intervals the entire length of New South Wales, and westward about 200 miles from the coast, comprise an area of nearly 13,656 square miles, and number more than eighty distinct fields. Gold has been found in the gizzards of fowls, and picked up in the streets of Bathurst. It has been brought up from the bottom of the sea off Port Macquaire by the sounding-line of H.M.S. *Herald;* it is distributed amongst the sands of the Shoalhaven shore, and it glitters among the pebbles which are strewn along the beach at the Richmond, so that the whole Pacific coast may be said to yield gold; and it is the opinion of men best informed on the subject that there are vast treasures of the precious metal in the alluvial lands along the remote western boundary of the colony yet untouched.

Gold in Western India.—A. MacGregor, collector of Malabar, reports to the Board of Revenue, at Madras, "that an application under the Waste Land Rules has been made by Mr. Ryan for a block of land situated near Sultan's Battery, which, there is reason to believe, contains a considerable quantity of gold." He further says, "that a gold-bearing quartz reef is known to run from Devala, near the head of the Nellambur Valley, to Sultan's Battery, and thence northwards. Experienced gold miners believe that the ore is present in sufficient quantities to prove remunerative, and one company has been started with the intention of setting up the necessary machinery." The climate is good, and this new El Dorado can be reached in about twenty days by steamer from Southampton, first-class, for about £50, and £35 second-class, either by way of Madras or Bombay. Any part of the Wynaad (the name of this particular locality) is within an easy journey of the Neilgherry Hills.

Welsh Gold.—England has again become a gold-producing country. The Clogan gold mine, near Dolgelly, produced in the week ending April 17th, 37 oz. 3 dwts. of gold, and in that ending April 24th, 36½oz.—*Iron.*

The Minerals of the Philippines.—(*La Revista Minera.*)—The soil and the subsoil of the Philippines are extremely rich, and activity and intelligence alone are wanted to encourage commerce and industry. According to Spanish returns there are four mines of quicksilver known; twenty-three of gold mixed with sand, besides those of free and uncertain exploration; 141 of coal; twenty-three of copper; eleven of iron; three of gold in veins; three of mixed gold and silver in the same condition; and four of lead. Of these the quicksilver mines are in the province of Albay; the coal mines in the provinces of Mindora, Bucalan, South Camarines, Cebú, Tabayas, Albay, and Marianas; the gold-sand mines in Albay; the copper in Luzon and Marbate; iron in Bucalao; gold and silver, in veins, in North Camarines; and lead in Cebú. In view of these and other very favourable circumstances which exist, the recent establishment of a mining department, which has been formed in the Spanish Foreign Ministry, is very opportune, particularly as it has been entrusted to an engineer from whose competence and laboriousness great results are expected.

Peruvian Minerals.—A report from the British consul at Islay states that the inauguration, in 1870, of about 108 miles of railway from the projected port of Mollendo to Arequipa has most beneficially operated on the country. The greatest mineral, vegetable, and pastoral resources of this country are to be found far inland and converging upon the departmental cities of Arequipa, Pano, Cuzco, and Moquegua, hitherto cut off from the Pacific coast by the breadth of an arid and seemingly inhospitable tract 100 miles in extent, stretching westward from the Corderillas.

The two coasting provinces of the Arequipa department, namely, those of Camuna and Islay, are reported to be little better than a parched desert, intersected by seven rivers and some trifling streams, all running westward and south-westward from the Cordilleras to the ocean through the deep ravines which the snow waters have hollowed out across the Pampa and the sandy decline, and in most, if not all, of which fine gold wash is to be found. The mountain territory traversed by the railway forms, so to speak, an irregular basin and mineral receptacle in the chain of the Andes, in different parts of which the precious metals, including platinum and highly-prized jewels, such as the diamond, sapphire, and emerald, exist in fair quantities, and under favourable conditions for exhumation, in a country not more remote from the equator than from 13° to 17° south, and yet tempered by an elevation mostly of 10,000 feet and upwards, and by the vicinity of perpetual snow. It is true that not much heretofore has been made of these resources, and the famous Mina del Manto, near Pano, has been abandoned, even by English adventurers, because they could not transport the machinery they wanted to the spot, and because they were too insecure. Setting aside the secret proceedings of the Indians, which are too occult to be more than alluded to, it is also true that there have been very limited gold workings in the territories of Cavabaya and Pancartambo, besides some desultory washings in the neighbourhood of Cuzco.

As it would appear that the resources of this part of Peru, under the head of gems, have been somewhat neglected, it may be useful to notice the remarkable presence of emerald of the purest water and largest crystals (as also the valued form, rather than species, of the beryl). In the veins and fissures of granitic primitive rocks, and associated with quartz, felspar, and mica slate, this gem is distributed freely in crystals of various dimensions, usually of very fine colour, and often without flaw if carefully abstracted, the test by heat being simple.

Mineral Resources of the Transvaal State.—(*Iron.*)—In the interior of Southern Africa, lying between latitude 21° and 27° south, and longitude 26° and 32° east, there exists a large republic, the Transvaal State, considerably larger in area than France itself, Dutch in government, but rapidly filling on all sides with an English-speaking population. For some years past rumours have been afloat that gold existed in the Northern Transvaal, but it was not until the diamond fields began somewhat to wane and men were looking for some new source of treasure further a-field that discoveries were actually made. Then it was that a stream began to flow across the Vaal River through the South African Republic to the gold districts beyond the little town of Lydenberg, and lying deep down amid the magnificent scenery in which the Drakensburg Mountains break down on to the flat bushy country which extends eastward to Delagoa Bay. First at Mac Mac, and then at Pilgrim's Rest Creek gold of various quantities was found, from large lumps of 113 oz. to smaller gold, and even dust. A white population of some 1,000 persons were soon mining in the neighbourhood, and many hundreds of natives were helping them in their heavy work of removing the enormous stones and rocks from the bed of the creek, beneath which the largest gold was to be found. About the same time as the Lydenberg fields were opened for alluvial working, two rich quartz reefs, one some 200 miles to the north-west of Lydenberg, and the other, some 300 miles further in the same direction, were discovered, and companies formed to work them by gold-crushing machinery. Both are reported to be doing well, and in proof of this more machinery for crushing on a large scale day and night is being brought out from England. To the far north of these gold-fields, and lying towards the Zambesi River, Mr. Baines, the South African traveller, and Herr Carl Mauch, the discoverer of the vast ruins of Zimbabye, or Zimbao, supposed to be the ancient Ophir, have found three more very extensive systems of reefs, which are only waiting their development by European enterprise and capital. Amidst the mountains of the Transvaal an abundance of iron and coal also exists; galena and lead are also found in certain districts, and lately a cobalt mine, in which nickel silver has appeared in some quantity.

Mines of Algeria.—M. Ville (*Iron*).—At the commencement of last year 3,345 men were employed in the Algerian mines, and of these, 2,655 in iron mines. Researches recently made at a great many different points promise a large increase in the number of explorations. Unfortunately for Algeria, no deposits of fuel have been found worth working. The lignites were thought to promise well, but a mine opened in 1871, in Constantine, was abandoned after very imperfect exploration.

The grand staple is iron ore. The Aïr-Markha mine of oxidulated iron ore employs 1,555 men, and yielded in one year 409,538 tons of ore. It is worked open, by means of straight galleries on the flanks of the mamelon of Mokta-el-Haddid. The company has been able to ascertain the existence of deposits of ore over a distance of about 1,200 metres, and the thickness in the centre of the workings is estimated at about 50 metres. The ores obtained are exported to France and the United States. In the same department are many other deposits of ores of different varieties only waiting the means of cheap transport.

Alger and Oran also abound in iron ore, and mines of hæmatites have been opened on the road from Alger to Oran.

The other minerals, beside iron ore, have yet been little worked; in fact, most of the concessions have been abandoned. M. Ville, however, mentions recent researches which promise well, such as the deposits of zinc and lead in the Val-des-Sakhamondi, those of copper now being worked at Monzaias, after having been completely abandoned, and several deposits in the department of Oran, including the lead mine of Gar-Rouban, which is almost inactive, at present, on account of the low price of the ore. In Constantine the works of the lead mine at Oum-Thebout have not been stopped, the copper mine at Aür-Barbar has been re-opened, and two zinc mines opened.

Russian Mines.—The *Golos* gives some interesting details respecting the mining operations and mineral productions of Russia during the year 1874. The State foundries smelted 1,225,000 Russian puds of bronze, 557,000 puds of iron, and 1,000 puds of steel; 89,000 puds weight of articles in bronze were cast, and 508,000 puds weight of ammunition, 9,000 puds weight of steel cannon, and 15,000 puds weight of iron cannon. 15,000 puds of lead and 6,600 puds of zinc were smelted. 7,800 puds weight of iron articles, 10,000 puds weight of sheet iron, and 7,500[1] roubles worth of iron for use in shipbuilding were also made, besides 46,700 side arms, 20,000 blades, and 5,725 gun barrels. The productions of the smelting establishments of the Ural are estimated at about 13,200,000 puds of bronze, 1,017,000 puds of of iron, '69,000 puds of steel, and 100,000 puds of copper. Those round Moscow produced 3,360,000 puds of bronze, and 1,830,000 puds of iron. South Russian produce is estimated at 430,000 puds of bronze and 440,000 puds of iron; that of the Polish Provinces at 1,370,000 puds of bronze, 800,000 puds of iron, and 120,000 puds of zinc. Lastly, the return from the Caucasus is calculated as 44,000 puds of copper. Gold to the amount of 1,806 puds has been extracted during 1874, without reckoning the districts of Altaï and Nerchinsk, which yield an annual average of 165 puds. Coal has been worked with increased progress in every district except that of the Vistula, which is still suffering from the effect of the conflagrations of 1873. The total amount of coal and anthracite raised in 1847 was 83,575,000 puds, the largest portion coming from the government of Catherinoslaw, the district of the Don Cossacks, the neighbourhood of Moscow, and from private mines. The extraction of mineral oils in the Caucasus shows a great increase, and oil wells have lately been discovered in Poland in the government of Kielce.

(A Russian pud is equal to about 36 lb. English weight.)

Oxfordshire Ironstone. — In the county of Oxford large deposits of excellent ore are known to exist, although they have only been worked hitherto on the smallest scale. Preparations are now being made (within sixty miles of the metropolis) for opening up mines. The ore is as rich in metallic iron as the best oolitic ironstone, whilst the absence of phosphoric acid, of which there is little more than a trace, and the presence of manganese will render it very suitable for Bessemer steel making. It also contains about 8 per cent. of lime, which will of course save the expense of so much lime for a flux, whilst neither the alumina nor the silica, the other earthy constituents disclosed in the analysis, are in excessive proportion. The alumina indeed exists in this ore in a proportion sufficient not only to neutralise the silica in the smelting-furnace, but also to enable the ore to bear an admixture with one containing 4 or 5 per cent.

more silica without detriment to the iron produced.—*Iron.*

New Zealand Coal.—Dr. Ferdinand von Hochstetter (*Physical Geog. and Geol., &c., of New Zealand,* Stuttgart: J. G. Cotta).—The author says that for a series of years past, Carboniferous deposits have been known to exist in various portions of the north and south island. In the vicinity of Auckland, Nelson, on Golden Bay, in the Malvern Hills, near Christchurch, small mines have been opened which were as often given up as worthless. Closer investigation has, however, proved that upon North and South islands the coal varies greatly in quality, and is of very different geological ages. It is not only lignite of a comparatively inferior value that is known, but also thick beds of excellent brown coal of a tertiary age, and, moreover, coal of a probably secondary age, which in quality is scarcely second to the best English coal. One coal-field lies upon North Island, twenty miles south of Auckland, in the Drury and Hunua districts.

The coal-bearing strata are situated on the western declivity of the wooded ranges bordering on the plains of Papakura and Drury, in the east and south-east, at a height of from 200 to 300 feet above the level of the sea. The coal, the quality of which in the various portions of the bed in one and the same locality, and also in the various localities observed, suffers but little change, partakes, according to the varying gloss upon the surface of fracture, sometimes rather of the quality of "glance coal," at others, more of "pitch coal." In the interior of North Island, on the north-west slope of the Taupiri and Hakarimata ranges, the same brown-coal formations are found. This coal-field probably surpasses that of Drury in area. A third very extensive field of brown coal is found on the western and south-western borders of the Middle Waikato basin. Dr. J. Haast discovered extensive coal-fields on the Buller and Grey rivers, including a magnificent bed 8 feet thick, at a height of about 1,500 feet above the level of the sea, and extending over an area of eight miles in width and fifteen miles in length. On the Grey rivers on the west coast, four workable seams were found, the main seam being 15 feet 3 inches in thickness. The coal, as to quality and appearance, is said to be comparable with the best English coal. At Preservation Inlet, Otago, a bituminous black coal occurs.

In the province of Otaga the brown-coal formation, on the south-east coast, extends continuously over at least forty-five square miles, forming hills 500 to 1,000 feet in height. The seams of coal vary from 6 to 20 feet in thickness. The total quantity of coal in this district has been estimated at 100,000,000 tons.

Iron and Coal Deposits at Wallerawang, New South Wales.—Prof. A. Liversidge.—Within a circle of some four miles diameter, about 150 miles from Sydney, the author states there are extensive deposits of rich iron ores of good coal and abundance of limestone. It may, therefore, be safely predicted that in a few years Wallerawang will become an important iron-making district.

Coal in Japan.—A letter from Nagasaki states that the Takasima Colliery is producing 300 tons of coal a day, the bulk of which goes to Shanghai, the local mail steamers using the rest. The discovery of coal, not only in the Pekin district, but in other parts of China, and also of iron ore, is likely to lead to important results. Mr. Henderson is now in this country obtaining all the necessary machinery for smelting iron in the Pekin district; and the mandarins are being treated with for the establishment of iron works and opening of coal-mines in other parts.—*Athenæum.*

Chinese Coal (*English Mechanic*).—In Sze-Chuen, coal occupies an area of 100,000 square miles. Starting from the great plain of China on the west, there is a plateau of coal, overlying a limestone formation, extending to Shersi and Kansu for a distance of about two hundred miles. These beds lie horizontally, have an average thickness of 30 feet, and an area of 30,000 miles. According to Baron Richtofer, the coal is of excellent quality.

Indian Coal-Fields.—Walter Ness (South Midland Inst. of Mining Engineers).—Mr. Ness is stationed at Warora, in the Central presidency, and has lately, on behalf of the Government, inspected the Mopanee field in lat. 22° 18′ north, and in long. 78° 18″ west. In the middle of the valley, on the south edge and immediately under the range of hills, was the Mopanee coal-field, in lease to the Narbada Coal and Iron Company.

The field is of considerable extent, and the coal-seams are as thick as they are at Warora, and not very widely separated by intervening measures. The four seams are of an aggregate workable thickness of coal of 39½ feet, and all can be approached and worked into from the face of the hill, at the bottom of which the Seetawara river sweeps past. From the top of the first to the bottom of the last, is not over 160 feet in all. The mines are comparatively dry, the overlaying measures of sandstone forming a good roof. There is a strong conglomerate overlaying the upper measures. All of these appear impervious to water; and the surface is so undulated that the rain is soon run off to the rivers below. There is no fire-damp, which is also the case at Warora. There might be a tendency to spontaneous combustion, but as this only takes place amongst loose coal, it can be guarded against by taking care to leave nothing to burn in the shape of heaps of slack mixed with iron pyrites, which, in forming sulphide of aluminium, generates heat, and, I think, often thereby gets on fire. I fancy these mines will be largely worked yet for locomotive purposes. The Great Indian Peninsular Railway passes thirteen miles off, but has a branch line into the mines. In reference to the quality of these coals, I may state that they are very unlike British coals. All Indian coals are very much alike in this respect, that they contain a lot of ash and generally a good deal of moisture. The coals are leafy, and are easily impregnated with an excess of moisture when in wet positions, so that the coal in a drained field will contain less moisture than one newly opened and wet. At present, a long period is required to get machinery forward, for the roads are now scarcely deserving of the name; but this state of things will soon be numbered in the past. He is getting his machinery put together; a railway will soon be running into the works, and he hopes that by next year the plant will be in working order.

The first seam of coal was reached at a depth of 175 feet, where the coal was 3 feet 6 inches. Before this had been come upon, yellow clay, variegated sandstone, carboniferous clay, variegated sandstone again, and a thin coal shale had to be passed through. At 186 feet coal of no less a thickness than 15 feet was found with shale only between it and the upper seam. Shale, white sandstone, and then shale, followed; and at a depth of 210 feet there was a third seam of coal, 11 feet in thickness. The winding machinery was the ordinary tightened gear on the first motion, with a pair of coupled engines and a drum for a wire rope. The conductors likewise were of wire rope.

Coal in Russia.—General Romanoffski (Russian Tech. Soc., St. Petersburg).—Coal abounds in the Darya country, but mostly in nests containing comparatively small quantities. Of large coal-fields, but few have hitherto been discovered. The most extensive are those of Kokine Sai, near Chodshent, containing 19,000,000 pud at the lowest estimate. Next to them rank the Tartarinoff mines, from which 300,000 pud of the best coal have been already taken, and the annual out-put of which averages 70,000 pud. (The pud or pood is equal to 36 lbs. avoirdupois.) Lead, salt, and other minerals of superior quality have likewise been discovered, and promise a flourishing trade.

Lignite. — The *Sussex Daily News* states a seam of lignite three feet in thickness has been discovered near the top of Furze Hill, Brighton, a fashionable locality. It is only six feet from the surface. Of course it is not true coal.

The Coal Question.—Professor W. S. Jevons (British Association).—His purpose was to compare statistical facts concerning the recent progress of the out-put of coal with various predictions and theories which had been published on the subject in the previous fifteen years. The quantity of coal raised in the year 1873 amounted to 127,000,000 tons, according to the mineral statistics of Mr. Hunt. Professor Hull had questioned the power of the coal-fields to admit of a much greater drain in any one year than 100,000,000 tons, at which rate he believed the supply would be sufficient for eight centuries. Facts now entirely negative the hypothesis of any such fixed limit. Sir William Armstrong, in his presidential address of 1863, put forward his celebrated calculation that the produce of coal was advancing by a uniform annual addition of 2¾ millions of tons, at which rate the coal in the country, as then estimated, would last only 212 years. According to this law of increase the produce in 1873 ought to be 119 millions, which was eight millions less than the truth, the increase in the interval being at least 41 millions instead of 33 millions, as it would be according to Sir W. Armstrong's method of calculation. The average annual addition to the out-put is now nearly 3½ millions of tons instead of 2¾, but the true law could not really be that of arithmetic increase, which, if followed backward, would lead us to zero about the year 1830. The true law of increase was that of a geometrical series with the average annual rate of 3¼ per cent. According to this law it was calculated that the produce of coal in 1871 would be about 117·9 millions. According to Mr. Hunt's statistics it proved to be actually 117,352,028 tons. On the same method of calculation the produce of 1873 would be about 126·3 millions, and the actual quantity raised exceeded this by about 700,000 tons. In spite of the extraordinary rise of the price of coal in the years 1872 and 1873, the law of geometric increase was thus remarkably verified. In the Report of the Royal Commissioners on coal some calculations of Mr. Price Williams were put forward in which the average consumption, apart from exportation, of coal per head of the population was assumed as rising from 3·9636 tons in 1871 to 4·4266 tons in 1881, 4·5784 tons in 1891, and so on to a maximum of 4·6526 tons in 1941. But according to this method the consumption (not including coals exported) of the year 1873, would be nearly six millions less than the truth. Mr. Price Williams believed that the rate of increase of consumption of coal per head had passed its maximum and was declining, whereas the most recent statistics showed that between 1869 and 1873 the advance was more than double that in the interval between 1865 and 1869. It was pointed out that the remarks of the commissioners upon the coal question proceeded from an entire misapprehension of the arguments given in that book. No one asserted that the production of coal in Great Britain ever would rise to the higher quantities given by the geometrical law of increase. The true conclusion drawn was "that we cannot long maintain our present rate of increase of consumption, that we can never advance to the higher amount of consumption supposed; bnt this only means that the check to our progress must become perceptible within a century from the present time." In the year 1872 the price of coal rose in many places to a height of two or three times its previous highest amount. This rise was in some respects exceptional, but was mainly due to the increased demand which, in spite of the ruinous price, advanced five per cent. per annum. The great increase in the number of collieries produced by the extraordinary demand, would no doubt render the price more moderate for some time, but the coal famine of the years 1872-3 might be regarded as the first twinge of the scarcity which must come, and it had taught us that coal had become now the first necessary of life in this kingdom.

Coal Supply of London.—(*Newcastle Daily Chronicle.*)—The coal supply of London has a curious history. Almost from time immemorial it has been subjected to taxation. The duty of 1*s.* 1*d.* per ton now paid was fixed in 1832. In that year the quantity of coals imported into London was 2,139,078 tons. Up to 1869 the highest average price of the best coals was realised in 1837, when it was 24*s.* per ton, while the lowest was 16*s.* 1*d.* per ton, realised in 1851. From 1862, when best coal was sold in London at 17*s.* 7*d.* per ton, up to 1872, when it took a leap to nearly 40*s.* per ton, the price fluctuated between 18*s.* and 24*s.* per ton, and during 1873 as much as 57*s.* per ton was charged by some of the London dealers, when the best coal was sold at 20*s.* per ton at the pit mouth.

As nearly as can be ascertained, the total quantity of coal imported into London in 1873 was 7,883,138 tons. Of this quantity 4,000,000 tons, or 15 per cent. of the total out-put of the country, was sent from Durham It must not be supposed that all the coal sent into London is placed on the Coal Exchange. Of 7,883,138 tons sent into the Metropolis in 1873 not more than 2,218,825, or a little over 28 per cent., passed through the markets. The remainder, for the most part, is consigned to depôts which are under the ownership or management of the owners of the collieries that chiefly make consignments of coal to the metropolis.

Up to the year 1845, when the London and Birmingham Railway began to carry coals, the fuel consumed in London was taken thence by sea or canal. In 1850, the Great Northern began to carry coals to London, and from that year till the present time the rail-borne coals have gradually been increasing in extent until now the sea-borne coals are in a minority. The average cost of freight from the Tyne or the Wear to London has during the last three or four years been no more than 6*s.* per ton. Not a single ton of the inferior coals which are so largely consumed in the immediate neighbourhood of the great coal-fields is imported into London unless by accident, and the "nuts" and "small," which form so considerable a proportion of the fuel consumed in the North, are known in London by reputation only. For many years the best household coal was produced from the high main seam of the Tyne, and bore the designation of Wallsend coal, from the fact that the Wallsend Colliery was the chief source of its production. The same coal was, however, produced from the Percy-main, Walker, Heaton, Willington and other collieries of the Tyne; and since the original Wallsend Colliery was discontinued, a number of years ago, the Hutton coal-seam of the Wear has largely taken the place of the erewhile favourite. Large quantities of coal produced from the collieries of Rainton, Lambton, and others, working the Hutton seam, have been sold in London as Wallsends; and up to the present time this designation continues to be applied to the best coal imported into London

ANTHROPOLOGY.

The Neolithic and Bronze Ages.—Professor W. Boyd Dawkins (Lit. and Phil. Soc., Manchester).—The author calls attention to the fact that the Neolithic peoples were the first herdsmen and farmers of whom we have any trace, and states that to them we owe the introduction into Europe of domestic animals and of cultivated cereals. They were also the first weavers and gardeners. From the southern character of some of the domestic animals such as Sus palustris, and of some of the vegetables such as the Egyptian wheat and silene cretica, it may be inferred that they came from the south, probably from the south-east, from the warmer regions of Central Asia.

With regard to the Bronze Age it is a disputed question as to whether the knowledge of bronze was spread by commerce or by conquest. Probably it was spread by both these means. The art of the Bronze Age can only be traced home to the Etruscans, that mysterious people who are a terror to the philologists, and of whom we know historically that they were powerful by land and sea, that they were famous workers in metal, and possessed of quantities of amber. He therefore thinks it probable that the amber trade with the shores of the Baltic, and the tin trade with Spain and Britain, distributed over a large part of Europe the produce of the Etruscan workshops. On the decay of the Etruscan power, the trade was taken up by the Phœnicians, the great maritine people who possessed no distinctive style of art of their own, but manufactured goods for the various markets, like the manufacturers of Manchester and Birmingham. He does not therefore see how the popular view can be maintained that the art of the Bronze Age was introduced into Northern and Central Europe by the Phœnicians.

The Cemetery of Caranda.—G. Millescamps (Anthropological Society of Paris).—It appears that this site was used for sepulture in the Neolithic Age, and continued at times to be so used by successive peoples down to the Carlovingian period. During this long succession of ages two traditional customs appear to have been preserved; the one being the orientation of the body, the feet being always directed towards the east; and the other, the votive offering of flint implements. From an examination of the locality the author is led to believe that the art of working flint survived to as comparatively late a period as the Merovingian; but whether it was confined to the fabrication of implements to be simply buried with the dead, or extended to the manufacture of tools for every-day use, the author does not venture to determine.

Caverns and Cavern Life of the Ohio Valley.—Prof. Shaler.—The author sums up his researches in the following propositions:—1. The extensive development of caverns in the Ohio Valley is probably a comparatively recent phenomenon, not dating further back than the latest Tertiary period. 2. It is doubtful whether there has been any extensive development of cavern life in this region before these caverns of the subcarboniferous limestone began to be excavated. 3. The general character of this cavern life points to the conclusion that it has been derived from the present fauna. 4. The Glacial period, though it did not extend the ice-sheet over this cavern region, must have so profoundly affected the climatal conditions that the external life could not have held its place here in the shape we now find it, but must have been replaced by some Arctic assemblage of species. Under the circumstances, it is reasonable to suppose that most, if not all, the species found in these caves have been introduced since the Glacial period. 5. We are also warranted by the facts in supposing that there is a continued infusion of "new blood" from the outer species taking place, some of the forms showing the stages of a continual transition from the outer to the inner form.—*Nature.*

Flattened Tibiæ of Pre-historic Man. — Accompanying the stone implements, pottery, and other relics exhumed from the ancient mounds in the State of Michigan, there have been found some human remains which merit attention, if only for the osteological peculiarities which some of them exhibit. These mounds and their contents are described, by Mr. H. Gillman, in the Smithsonian Report. The tibiæ, or shin-bones, found in some of the Michigan tumuli, present that peculiar flattening which was first observed by Prof. Busk in bones from the Gibraltar caves, and afterwards detected by Broca, Boyd Dawkins, and others in bones from several pre-historic caverns. It may be doubted, however, whether all the northern mound-builders had these "platycnemic" shin-bones.

Palæolithic Cave at Thayingen, near Schaffhausen. — Arthur Wm. Waters (Lit. and Phil. Soc., Manchester).—Traces of early inhabitants have been found in this cave, which is called the "kessler loch," or kettle cave, since the gipsy tinkers had often used it. It is situated in the Jura limestone, a few miles from Schaffhausen, but since it is rather a hollow in the rock it scarcely deserves the name of a cave. A full description of the fauna found here will shortly be published: probably the following list, though not complete, will be found correct:—Ursus arctos, canis lagopus, gulo borealis, elephas primigenius, bos primigenius, canis vulpes, lepus variabilis, arctomys marmotta, cervus tarandus and perhaps cervus elephas and equus. This is very similar to the lists from the other caves, and the animals belong to the upper pleistocene group. Nor does the similarity end in Switzerland, for besides the same animals some of the harpoons and other weapons have an extraordinary resemblance to some from the caves of South France, and sufficient to those of some parts of Germany and South England to show that the same race of men had a wide range.

In the later periods the inhabitants of these dwellings were herdsmen and farmers, who cultivated the land, had several domestic animals, followed the chase, erected houses, skilfully worked stones into implements and afterwards used bronze tools, made pottery, spun and wove flax and bast, with which they made clothes and nets; but when we turn to these earlier cave men, whether in Switzerland or elsewhere in Europe, we find that the life they led was altogether different, for they seem to have been a race of hunters and fishers, with probably no domestic animals, no knowledge of how to cultivate land or to erect themselves dwellings, and the stone tools they used were never polished as in the later periods, but merely chips of flints. Yet these men whose civilization stood so low were able with their simple flint tools to execute engravings on bone and horn with fair skill. The main point of interest connected with the Thayingen cave lies in the discovery among the remains of a piece of antler of reindeer with the representation of a reindeer feeding, most faithfully and really artistically carved. There are also two other carvings (of horses) and the execution of one is even much superior to that of the reindeer.

From their implements and mode of life the palæolithic race of men is supposed to be represented by the Esquimaux at the present time, and this receives the strongest support from the fact that these people, whose mode of life is very similar to that of the palæolithic man, are in the habit of ornamenting their bone and horn implements in the same way, and the style of designs has much resemblance to that of the Dordogne.

From the cave near Schaffhausen, harpoons, and the so-called commandostäbe (which have been shown by Professor Boyd Dawkins to be really arrow straighteners), together with needles or bodkins have been found. Prof. Heim argues that the preponderance of animals looking to the left over those looking to the right indicate a probability that the artist drew with the right hand. He concludes by saying, "the race of zoo-artists were in their talents in advance of the means which were at their disposal. In the later races —for example the pile-dwellers— the intellectual capacity and the resources in the midst of which the men grew up are more nearly balanced." He also says "that this was a premature attempt of the human genius, and that no partial inconsistent cultivation of a single talent can be maintained for a long period." This last remark does not seem to be borne out, since the similarity of the Esquimaux and palæolithic man is undoubted, and would rather make us consider how persistent a low civilization may remain when there are few extraneous modifying circumstances.

Cavern de L'Herm, Foix.—Dr. J. B. Noulet (*Cartailhac Matériaux pour l'Historie de l'Homme*).—From the earth of that part of the cave known as the Vestibule, he obtained upwards of 300 fragments of human skeletons, but none helped to show the form of the skull. As many as 106 isolated human teeth were found, of which three only presented traces of caries. Among the objects of human workmanship we may specially refer to a couple of celts wrought in jade or jadeite. It is concluded that the cave was used for sepulchral purposes, and hence the great accumulation of bones.

Salt Cave, Kentucky.—Mr. Putnam.—This cave is difficult of access, but the explorer was repaid for his trouble. In many places pieces of rock had fallen from the roof of the cave, in others there were nearly level spots with traces of the fires once kindled there, and small piles of stones, some built in such a way as to serve for fire-places. By the side of these were bundles of faggots, which may have been intended for firewood, or, possibly, for torches. In some side-passages were discovered footprints, with the impression of a sort of half-sandal, and, not far from these, some cast-off sandals, made of rush leaves, braided like the straw sandals of China, but of a different shape. A piece of cloth was also found there; it was more than a foot square, and regularly and delicately woven, probably from the bark of some tree. This cloth had been dyed with black stripes, and darned in one corner. Beside these things, there were found in this cave branches of the same bark as that of which this cloth was made, a number of pieces of bark, twine, and rope with knots where they had been tied together, arrow-points, &c. Now that such important and tempting discoveries have been made, the explorations will be continued. The things just mentioned have been compared with those found with the mummy discovered some sixty years ago near the Mammoth Cave, and it is plain that they are similar in material, design, and structure. Mr. Putnam considered it highly probable that they all belonged to one race, and that the most nearly civilised of the prehistoric inhabitants of America. This valuable paper will be published in full in the *Proceedings of the Boston Natural History Society*.

Moa Point Bone-Cave, near Sumner.—Dr. Julius Haast (Phil. Inst., Canterbury, New Zealand).—This cave appears to have been originally a hollow in a stream of doleritic lava, afterwards enlarged by action of the sea. When the old moa-hunters landed, with their canoes, in some of the nooks of the rocky shore, this cave offered them a capital shelter; and although it appears to have been occupied at first only occasionally, there is proof of a more regular occupancy at a later date. Outside the cave, cooking-ovens and kitchen-middens have been found, whilst the interior has yielded an interesting assemblage of objects offering an insight into the daily life of the moa-hunter. These consist of stone implements, a few bone-tools and personal ornaments, fragments of canoes, wooden spears, and other objects, which point to a state of civilization apparently not inferior in many respects to that enjoyed by the Maoris when New Zealand was first visited by Europeans. Yet the geological characters of the cave and its deposits show that the physical features of the country must have greatly changed since the days of the hunters who exterminated these gigantic birds. This exploration, therefore, adds another link to the chain of evidence which has led Dr. Haast to oppose the popular notion that the moas became extinct within recent times—say a century or so ago.

Cissbury Camp.—(*Academy*).—On one of the chalk hills to the north of Worthing, in Sussex, are the remains of an ancient camp, well known to archæologists under the name of Cissbury. Within the entrenchment are a large number of depressions or pits, of which about thirty were explored a few years ago by Col. Lane Fox, and described by him in his admirable papers on the Hill-Forts of Sussex. In the course of last summer, one of the pits, which appeared to have been previously undisturbed, was opened by Ernest Willett. (Brighton and Sussex Nat. Hist. Soc.) The interest of these excavations centres in the fact that the shaft, when cleared of the deposits by which it had been filled in, was found to communicate, at a depth of nearly twenty feet, with a series of chambers or galleries, running in all directions through the solid chalk. It is suggested that these levels were driven into the chalk, along a particular layer of flint, in order that the prehistoric flint-using folk, who appear to have established a manufactory of stone implements on this site, might obtain a supply of sound flint, fresh with the "quarry-water" in it, as suitable raw material for their work. Similar flint-mines have been discovered by Canon Greenwell at Grime's Graves, near Brandon, in Norfolk. Among the débris filling the pit at Cissbury, there were found not only flint implements, but certain objects which appear to have been tools used by the neolithic flint-workers in sinking their shafts and driving their headings. One of these implements is formed of the antler of the red-deer, stripped of all its tines, save the brow-tine, and thus admirably adapted to serve at once as a pick and a hammer. There were also found fragments of five shoulder-blades of the Celtic short-horn, or long-faced ox (bos longifrons), which, according to Mr. Willett, may have been used as shovels.

Stone Mining Tools, Alderley Edge.—Professor W. Boyd Dawkins (Lit. and Phil. Soc., Manchester).—The Lower Keuper sandstone at the copper mines at Alderley Edge is impregnated with carbonate of copper, in search of which tunnels have been driven into the base of the hill. In following the ore from the deep upwards the miners had laid bare a considerable portion of the rock. On examining the stones lying about in the hollows it was evident that a large number had been used in mining operations. Thirty-five of these were secured, and are now in the Museum at the Owens College.

These mining tools are divisible into three classes: 1, the hammers with a simple groove round the middle for the retention of the withy which formed the handle; 2, the hammers which besides this groove have one of their ends also grooved for the reception of another withy, and thus were prevented from slipping when a blow was struck; and lastly, there were two implements which probably had been used as wedges.

All these implements were derived from the ice-borne stones of the boulder clay, of which they were merely picked specimens which happened to be useful for the special purpose of mining.

Subsequently many more specimens were obtained. The number which I have examined is considerably over one hundred, belonging to the three types mentioned above.

The rock where the tools were met with was hollowed out irregularly and evidently artificially, and to a depth in some cases of from eight to eleven feet from the surface. And from an examination of the ground it was perfectly obvious that the ancient users of these tools had worked the metalliferous portions from above, without attempting to make galleries. The tools lay buried in the débris which had been thrown into the old surface workings after they had been discontinued, and which presented all the characters of "a wheelbarrow formation," and were found in the greatest abundance near the bottom.

Stone hammers of the kind mentioned above are very widely distributed. They have been found in the ancient copper mines of Anglesea, of Spain and Portugal, and of Lake Superior. With these also the Egyptians worked the turquoise mines of Wady Magarah, in the Sinaitic peninsula. They undoubtedly represent one of the ruder and probably earlier stages in the art of mining. With the solitary exception offered by the turquoise mines at Magarah, they have only been discovered in old copper workings, and they may therefore be inferred to have been used in ancient times mainly for the extraction of that metal.

I will not venture to attempt to assign a date to the mining operations carried on at Alderley, when these implements were in use. In all the ancient mines, worked by the Romans, so far as I know, iron tools have alone been met with. Nor am I aware of any mines, of post-Roman date in Europe, which have been carried on with tools composed of any other material. It would, therefore, seem probable that they are of pre-Roman age, and that they are of the class termed prehistoric by the archæologists.

Nor is it absolutely certain what metal was sought in these surface workings, because ores of copper, cobalt, lead, iron, and manganese are associated together in that spot. If they were in search of copper, the ore must either then have been richer than that which they left behind, or they must have been acquainted with some mode of reducing the small per centage of copper (which averages considerably less than 5 per cent.) from the matrix, of which we are ignorant. This is at present effected by a bath of hydrochloric acid.

These implements imply a ruder phase of the art of mining than has hitherto been known in the neighbourhood of Manchester—a phase which may point back to the Bronze Age, when the necessary copper was eagerly sought throughout the whole of Europe.

People of the Long-Barrow Period.—Prof. Rolleston (Anthopological Institute).—The author began by stating that it was universally acknowledged that the long-barrows were the oldest existing sepulchral monuments in Great Britain, and gave the arguments adduced to support that theory. He then discussed, at great length, the following points: 1. The evidence existing for dividing the long-barrow period into three epochs. In the earliest one the dead were interred unburnt in chambers, *i.e.*, in graves walled with upright flags, and communicating with the exterior by a passage or gallery, or, at any rate, constructed so as to admit of successive interments. In those chambers was found the greatest amount of manganous discolouration. In the second period the dead were still interred unburnt, but in cists, *i.e.*, in closed stone receptacles not intended to be opened, and having no gallery leading to the exterior. The third epoch of the long-barrow period was distinguished, to the regret of the craniographer, by the practice of cremation—a practice which, like that of burial in cists, and with even more probability, may be supposed to link the long and broad barrow periods together. 2. The evidence for accepting what might be called the Ossuary theory for explaining the appearances met with in the long-barrows, rather than the theory of successive interments, as put forward by Prof. Nilsson, or the theory of human sacrifices and and anthropophagy, as put forward by the late Dr. Thurnam. What inclined Prof. Rolleston to the Ossuary theory was the fact that just those bones are found in connection most frequently which would, by virtue of their ligamentous or muscular connections, longest resist the dislocating effects of removal from a provisional to a permanent burial-place. 3. The evidence as to the mode of life prevalent in the long-barrow period which the cranial and other bones of the persons buried or burnt in them furnished.

Anthropology of Prehistoric Peru.—T. J. Hutchinson (Anthropological Institute). — The writer agreed with Mr. Baldwin as to the original South Americans being the oldest people on that continent. The grandeur of colossal works, in the extent of the ancient burial-mounds, was shown by illustrations. A comparison of those examined by the author in Peru was made with those explored by Messrs. Squier and Davis in the valleys of the Ohio and the Mississippi. The prehistoric architecture of Peru, described by Prof. Raimondi in his recent work on the mineral riches of the department of Aucachs, were mentioned as highly interesting; more particularly the tombs cut out of solid blocks of diorite in the valleys where sandstone is the geological character, thus proving the enormous capacity for work of the ancient Peruvians in transporting these stony masses over the Andes. So small was the author's faith in Spanish accounts of South America, that he inclined to the belief in some future explorer finding the mythical "cradle of the Incas" in the National Library at Madrid, instead of in the Lake of Titicaca, to which latter place it is accredited by the Hakluyt Society.

Pile-dwellings of the Bieler See.—By the lowering of the level of the water in the Bieler See unusual facilities have been afforded for a long time past for examining the remains of pile-dwellings in this lake. An official investigation has been undertaken by Herr E. von Fellenberg, of Berne, who has discovered at the station of Schafis, or Chavannes, some extremely interesting remains. No trace of metal has been detected, but, on the other hand, numerous weapons and implements in stone, wood, bone, and horn, have been brought to light; many of the arrow-heads and knives being notable for preserving their original hafts and setting. Among the organic remains, especial mention may be made of a portion of a human skull, which is said to have been worked by the hand of man.

Ethnography of the Cimbri.—Canon Rawlinson (British Association).—After referring to what we know from historical authorities respecting the great Cimbric nation the author discussed the two ethnological theories which have been advanced to explain the origin of the Cimbri—the German and the Celtic theory. In favour of the view that the Cimbri were of German origin an attempt has heen made to explain the etymology of the name by connecting it with Kämpfer, "fighters," or Chempho, "champions." But Canon Rawlinson rejects both these derivations as not concordant with the laws of phonetic change in Latin. A strong presumption in favour of German origin might be drawn from the geographical position of the Cimbri in Jutland, between the Elbe and the Rhine, if it could be shown that Celtic tribes were not mingled with the Germans in this locality. The blue eyes, flaxen hair, and other physical characters of the Cimbri, are not regarded by Prof. Rawlinson as proof of their German affinities. Nor does he lay much stress on the description of their manners and customs, which are said to resemble those of the Germans, especially in the fact that their armies were accompanied to battle by priestesses rather than by priests. After all, we know but little of the customs of the old Germans, and Prof. Rawlinson reminded his hearers that the "Germania" of Tacitus was to be regarded more as a satire upon Imperial Rome than as a serious description of the German people. Julius Cæsar's statement that the Cimbri were Germans is not, according to the Professor, worth much, since it seems doubtful whether Cæsar ever saw one of the Cimbri. As to the alliance of the Cimbri with the Teutones, who were Germans, this evidence is, perhaps, out-weighed by their far closer alliance with the Helvetii, who were Celtic. On the whole, Prof. Rawlinson evidently leant towards the Celtic theory. The name may be satisfactorily identified with that of the Cymry; the names of individual Cimbric chiefs, such as Boiorix, are characteristically Celtic; and all Greek and Roman writers, excepting Cæsar, refer them to a Celtic origin.

Ethnography of Scotland.—Rev. J. Earle (British Association)—The author believes that there is a strong Norwegian element discernible among the Scotch. It is matter of general observation that the Norwegians and the Scotch have many characteristics in common, and Dr. Beddoe has corroborated this by reference to the physical characters of the two peoples. The relationship is supported, too, by historical evidence. Mr. Earle believes that Scotland received those Norsemen who left Southern Norway, whilst the outgoers from the more northerly fiords occupied the Hebrides, which they termed the Southern Isles, or Sudreyjar, a word which survives to the present day in the title of "Sodor and Man." Decidedly Norse features are found in the Lowland dialect, and it is known that Norse superstitions lingered in Scotland down to a very recent date.

Basque Language.—Dr. Paul Broca (*Revue d'Anthropologie*).—Failing to find any affinities of the Basque with other languages, in spite of all that has been written on this subject, he is led to speak of it as autochthonous. The several dialects of the Basque which have been so successfully studied by Prince Lucien Bonaparte, may be fairly grouped together as a single language. Whatever may have been the original extension of the Euskarian languages, it is clear that at the dawn of the historic period they overspread the country extending from the Garonne to the Pillars of Hercules. Yielding before the Roman invasion, they were displaced by the Latin tongues throughout the greater part of the Peninsula, save, in fact, where sheltered by the Pyrenees. But what passed during this time in Aquitania? It is generally supposed that the old Iberian language was preserved south of the Adour, whilst the Latin triumphed elsewhere. Dr. Broca, however, thinks otherwise. He believes that the conditions under which the Basque was preserved in Spain did not rule north of the Pyrenees; that the language was driven out of Southern Aquitania, just as it was elsewhere.; and that it was re-introduced at a later date. It is a matter of history that in the fifth century the powerful Visigoth kings of Spain sought to reduce the Vascons, who had withstood the Roman arms. The struggle went hard against the Vascons, and they lost at one time even their capital, Pamplona. It was then that many of them migrated across the Pyrenees, and established themselves in the valleys of the Soule and the Labourd. At a later date the Vascon warriors endeavoured to regain in France what they had lost in Spain, the French territory being but feebly protected by the Merovingian kings. At length, in 602, Thierry II. ceded to the Vascons all the country between the Adour and the Pyrenees, which henceforth received the name of Vascony or the Basque country. It was this Vascon invasion, according to Dr. Broca, that re-introduced the Basque language into Aquitania. This language, therefore, so far from being the same as that spoken in the same area in pre-historic times, does not date back beyond a few centuries.

It has been shown by Broca that the Basques on the Spanish side of the Pyrenees are dolichocephalic, whilst those on the French side are, for the most part, brachycephalic. Nevertheless, there is a certain proportion of long skulls among the French Basques, and this is attributed to the same influence as that which re-introduced the Basque language; it is, in fact, the effect of the invasions of the fifth and sixth centuries, when the long-headed Spanish Vascons settled among the short-headed people of Aquitania.—*Athenæum.*

The Beothucs and Stone Implements of Newfoundland.—Mr. G. T. B. Lloyd (Anthropological Institute). —The Beothucs have been extinct for several years, but the author has gathered trustworthy information concerning their physique and manners and customs. They appeared to be distinguished from other races of North America in lightness of complexion, the use of trenches in their wigwams for sleeping places, the peculiar form of the canoe, the custom of living in a state of isolation, apart from the white inhabitants of the island, and in their persistent refusal to submit to any attempts to civilise them. Pottery, as an art, was unknown to them, and they appeared to have been unable to domesticate the dog.

Dwarf People of the Western Ghâts.—Mr. Bond managed to procure an interview with a couple of the wild folk who live in the hill jungles of the western Ghâts, to the south-west of the Palanei hills. These two people, a man and a woman, believed themselves to be 100 years old. Mr. Bond supposes the man to be about twenty-five and the woman eighteen years of age. The man is 4 feet 6½ inches in height, 26¼ inches round the chest, and 18½ inches horizontally round the head over the eyebrows. He has a round head, coarse, black, woolly hair, and a dark brown skin. The forehead is low and slightly retreating; the lower part of the face projects like the muzzle of a monkey, and the mouth, which is small and oval, with thick lips, protrudes about an inch beyond his nose: he has short bandy legs, a comparatively long body, and arms that extend almost to his knees: the back just above the buttock is concave, making the stern appear to be much protruded. The hands and fingers are dumpy and always contracted, so that they cannot be made to stretch out quite straight and flat; the palms and fingers are covered with thick skin (more particularly so the tips of the fingers), and the nails are small and imperfect; the feet are broad and thick-skinned all over; the hairs of his moustache are of a greyish white, scanty and coarse like bristles, and he has no beard.

The woman is 4 feet 6½ inches in height, 27 inches round the chest (above the breasts), and 19½ horizontally round the head above the brows; the colour of the skin is sallow, or of a nearly yellow tint; the hair is black, long, and straight, and the features well formed. There is no difference between her appearance and that of the common women of that part of the country. She is pleasant to look at, well developed, and modest. Their only dress is a loose cloth, and they eat flesh, but feed chiefly on roots and honey.

They have no fixed dwelling places, but sleep on any convenient spot, generally between two rocks or caves near which they happen to be benighted. They make a fire and cook what they have collected during the day, and keep the fire burning all night for warmth and to keep away wild animals. They worship certain local divinities of the forest—Rákas or Rákári, and Pé (after whom the hill is named, Pé-malei).

The woman cooks for and waits on the man, eating only after he is satisfied.—General Report of the Operations of the Great Trigonometrical Survey of India, during 1873-74, by Col. J. T. Walker.

Ceylon Weddas.—Bertram F. Hartshorne (British Association).—The author divides the whole tribe into two classes—jungle Weddas and village Weddas. The former retain more distinctly than the latter the essential characteristics of their isolated condition, still depending for their chief means of subsistence upon their bows and arrows, and passing their lives in the vast forests in the eastern parts of Ceylon, without any dwelling-places or system of cultivation. Their skill in the use of the bow and the strength of their left arm were to be noticed, as well as the absence of any stone or flint instruments among them. The influence of the civilised Tamil and Cinghalese races, contiguous to the district which they inhabit, has only in a very slight degree made itself felt, and their state of barbarism is indicated by their practice of producing fire by means of rubbing two sticks together, as well as by an almost entire absence of clothing, and the custom which they observe of habitually refraining from any sort of ablution whatever. Their features are of no unintelligent type, but they wear an expression of extreme unhappiness, and one of their chief peculiarities is that they never laugh. It is probable that this circumstance is due to physiological causes rather than to any physical conformation. Their intellectual capacity is extremely slight, and their power of memory defective; they are utterly unable to count, nor does their language contain any words to denote the numerals; and it is singular that, while their moral notions lead them to regard theft or lying or the striking of one another as an inconceivable wrong, they are devoid of any form of religion, and also, apparently, of any religious sentiment, except in so far as that which may be inferred from their practice of offering a sacrifice to the spirit of one of their fellows immediately after his decease. Their idea of a future state is limited to the belief that they become devils after death, not, however, in the sense of the Buddhist theory of metempsychosis, but simply as one final and irresistible transformation. Their vocabulary largely consists of words derived directly from the Cinghalese, and others which indicate an affinity with Pali or Sanskrit, whilst there remains a considerable residue of doubtful origin. There is, however, an absence of any distinctly Dravidian element, and the language appears to bear no resemblance to that spoken by the Yakkas of Nepaul. The Weddas are the only savage race in existence speaking an Aryan language.

Andamanese.—Dr. G. Dobson (Anthropological Institute). — The author passed in review the various theories that had been propounded by eminent biologists to account for the origin of the Andamanese. He strongly inclined to the views of Mr. Wallace and M. Quatrefages that the Andamanese are Nigritos, or Samanys, from the Malay Peninsula, and is opposed to the theory of their descent from shipwrecked African negroes, on the ground rather of the dissimilarity of their manners and customs than of their physical characteristics. It is impossible, however, to account for the presence of the wild tribes of Southern India or the peculiar Samanys of the interior of the Malay peninsula, surrounded by races with which they have no connexion whatever, except on the hypothesis that they are the few surviving descendants of a woolly-haired people which in ages past occupied lands south of the Himalayas, when the continent of Asia included within its southern limits the Andamans, Nicobars, Sumatra, Java, Borneo, and the Philippine Islands; and that the present inhabitants of the Andamans and the Nigritos of the Philippines are also the remnant of these ancient Nigrito inhabitants of Southern Asia, which have almost disappeared before the invading Aryan and Mongolian races.

The Negro of the Congo, West Africa.—Watson Smith (Lit. and Phil. Soc., Manchester).—These particulars were furnished by Mr. Richard C. Phillips. The parts of the coast are those situated between the towns Chillunga, Landana, Cabenda, Ambrizette, Kinsembo, and Ambriz.

With respect to coast trading:—the articles of barter are chiefly rum, beads, cloth, knives, rings, hatchets, &c. On certain parts of the coast some articles will pass as currency to the exclusion of others; thus, beads are essential in Ambrizette and Kinsembo, being the true money of the country, and in consequence comparatively little spirits are used in these places, while at Loango rum plays a most prominent part. The produce of the country is palm nuts, ivory, coffee.

The African uses most of his rum as money. Suppose a Negro trader receives half a gallon of rum; he will divide this into many portions—drinking some, giving some to his wives (perhaps ten), spending some in palm nuts, cacada, corn, firewood, &c. The rum is preferred, partly on account of its being readily divided without suffering loss of value. The same applies to beads, which are preferred in some localities. The drinking of spirits is thus very much limited by its scarcity, and by its use as currency; yet occasionally drunkenness breaks out and a "big dance" is held. One thing is evident, viz., that a settled and confirmed taste for spirits is being formed among these coast natives.

The Negro is very averse to work, and takes little thought for the future, has little love or hate, is not revengeful, as that would entail trouble or expense, lives unto himself alone. Crafty, cunning, a born swindler, often a confessed rogue, avaricious yet lazy, he generally attaches himself to some one of importance, and does his bidding like a stray cur who follows you home, and of which you take charge. This is not the individual, but the national character.

The social customs are of a very peculiar nature. The women are the slaves of their husbands or the mother's eldest brother. This arrangement is necessary on account of concubinage, which is every woman's portion till she is married, and illegitimacy is a term of which they have no idea. One and all children are alike, the mother's eldest brother having charge of the whole. They seem to get on very well without the domestic strife which one would expect; the wives seem contented and happy. In fact before the manner in which the domestic machinery works can be appreciated, an examination of it is necessary.

The native tongue is very peculiar, but very musical. I fancy it would sound well sung. The sound of one word often determines that of several others in a sentence, as lĭ-īlu-lĕ ămi, chinkutu-chi-ami, molo-mami, where the alliteration is plainly perceived, Ami means "my." One sound will often predominate through a sentence governed by some principal word. It may be considered in the following light: Suppose it to contain several nouns—five or six,—and each gender to depend on the sound of the first syllable, then let the pronouns, adjectives, verbs, all be declined, with the same corresponding generic sounds; thus we get an alliteration, the subject governing all until the object is reached. The inflexions are of the first, not the last syllable. The following are a few specimens of singular and plural with personal pronouns attached, illustrating the theory, which, however, is not invariably carried out:—

Chinkūtū chiāmi *shirt my*	} my shirt.
Binkutu biami *shirts my*	} my shirts.
Li-īlu leami *nose my*	} my nose.
Mātū māmi *eyes my*	} my eyes.
Lūngŏ chiami *ring my*	} my ring. (*No alliteration.*)
Lungö biamī *rings my*	} my rings. (*No alliteration.*)
Mwŏnŏ ami *child my*	} my child.
Bānŏ bami *children my*	} my children.

There are some very interesting forms of verbs, adverbs of negation, &c., phrases, for example—

toto twāmĭ
sleep my

I am asleep, or was asleep at the

time spoken of. They say in answer to the question, "Have you eaten?" "No." In answer to "Have you anything to eat?" they do not say "No," but "Nothing." The phrase "I have not eaten" involves again a different negative. Many phrases are of a double nature, like the French negative in "je *ne* sais *pas*." Altogether it is a highly elaborate tongue, with whose beauties few are acquainted. If rapidly spoken, a sentence seems but one long word, so easily do the syllables flow together. The words themselves seem intricate changes on simple syllables; few double consonants unless at the beginning of a word, then generally of the extraordinary forms in "Mpembo," "Njeiö," "Msītū," "Nkōmbō," and as the preceding word ends in a vowel these readily combine. I do not think a dozen words in the language end in a consonant. The word for a cat is a suggestive one, "wai-ö," pronounced "why-ö."

Origin and Progress of the People of Madagascar.—Rev. J. Mullens (Anthropological Institute).—The Malagasy appear to be a single race: no tribe is to be found secluded in any corner, or in the hill districts, different from the people of the plains or open provinces, such as is met with in India, in Sumatra, and in Borneo, nor is any portion of the people specially degraded. The Malagasy are divided into three tribes, the Betsimisarakas, the Sacalavas, and the Hovas, the latter largely predominating in number and influence. With regard to the origin of the people, the author rejects the theory of Crawford and others, who argued for their African descent. Their language and tribal customs suggest a very different origin. There can hardly be any doubt that the Malay enters largely into the composition of the grammar and vocabulary, and continued researches into the Malay and Malagasy languages give more and more evidence of their resemblances. The conclusion is, that the Malagasy are a Malay people, following Malay customs, some of them possessing Malay eyes, hair, and features, and speaking a Malay tongue at the present time. They are an intelligent people, orderly, well governed, and daily improving, and the author of the paper sees for them the promise of a great and useful future.

Natives of New Guinea.—To the three races of New Guinea already known to inhabit the island—viz., the Papuans on the south, the Arfaks of the mountainous country on the north, and the Malays of the north-west—Captain Moresby (H. M. S. *Basilisk*) has added a fourth by the discovery of another, probably a mixed race of Malays and Papuans, inhabiting the whole of the eastern peninsula of New Guinea in its northern and southern shores, from about 148° longitude to East Cape, which is in 150° 53′ East longitude, and the adjacent archipelago. This race is distinctly Malayan, but differs from the pure Malay in being smaller in stature, coarser in feature, thicker lipped, and having more frizzled hair. They have high cheek bones, their noses are inclined to be aquiline, their eyes dark and beautiful with good eyebrows; many of the men have light hair and a Jewish cast of countenance; they rise to a height of from 5 feet 4 inches to 5 feet 8 inches, and are sinewy though not muscular, slight, graceful, and eel-like in the pliability of their bodies. This race merges into the pure Papuan in the neighbourhood of Cape Possession, where they vary in colour, stature, and feature; and a mixture of habits confirms the idea of a fusion of race. The new race bury their dead in the ground, and build small thatched huts over them. Their houses, like those of the Papuans, are built on piles, and communicate with the ground by means of a pole notched with steps. They are rude but successful cultivators of the ground, using stone mattocks for turning up the soil; they cultivate yams and taro. Cannibalism does not prevail largely among them, though it is not unknown.

They are affectionate to their children, but in some cases were willing to barter them for iron axes. They do not keep their women in the background, but allow them to have a voice in the trading. The men are but slightly tattooed, but the women are tattooed all over in graceful patterns; the women crop their hair short, but the men wear theirs long and frizzled; the men wear a waistcloth only, but the women a short grass petticoat or ti-ti. Unlike the Papuans they possess the art of making pottery. They are better cooks than the Papuans, and boil their food as well as roast and bake it. The Papuans fish only with a hook and line and a barbed spear, but this race make fishing-nets with fibres of a small nettle-like plant. The Papuans use only outrigger canoes, but these have several kinds. They have developed a system of warlike tactics adapted to the weapons they employ, and when Captain Moresby approached them they formed up in two regular lines, the first line armed with missile spears, and the second line with clubs. This is in conformity with the system adopted by all nations similarly armed, and has, no doubt, been arrived at independently as the result of experience. Upon the whole, they must be regarded as a more civilised race than the Papuans. Up to the time of their discovery by the *Basilisk*, they appear to have had little or no acquaintance with white men.—*Academy.*

Cherokee Alphabet.—Colonel E. C. Boudinot (himself a Cherokee; Amer. Geograph. Soc.).—The Cherokees are the only Indians who have an original alphabet for their language. The Creeks and Choctaws use the English characters, but the Cherokees have an alphabet of their own, invented by a Cherokee who could not talk the English language. His name was Sequoyah. This inventive genius—the Cadmus of his race—had none of the lights of science or civilisation to guide him; but conceiving the idea of enabling the Indians to talk on paper, as he one day saw the agent of the United States doing, he shut himself up in his cabin for more than a year, and endured, like many other reformers and inventors, the gibes and jeers of the ignorant and thoughtless, who all pronounced him crazy until he came forth with a perfect alphabet, and established his claim to be ranked among the first inventive minds of the century. He traced the characters of his alphabet on chips and pieces of bark. This alphabet was invented in 1822; it consists of seventy-eight characters, and, strange to say, is most easily learned by children. A newspaper is published in this character called the *Cherokee Advocate.*

Indians of the N.-W. United States.—General Carrington (British Association).—The author thus summed up their character:—"The whole drift of the Indian's life is in the direction of struggle. He has no home in a special sense, and no adaptiveness for town or farm life. Laziness, free from the pressure of war or self-support, is the only element that would give to a quiet life any value. His aspirations confirm a roving tendency, and the matured generation must remain uncivilised. Formerly the Indians waged extensive wars with each other; but various tribes have become so divided and subdivided that concert among themselves for offensive operations upon an extensive scale is impossible. They will not attack unless superior in numbers, nor risk life heedlessly. The Indian comes, as the hornet comes, in clouds or singly, yet never trying to sting until his ascendency is assured, and his own exposure the slightest. The Sioux warrior thus bred for fight is instinct with the spirit of war. In ambush and decoy he is splendid; in horsemanship, perfect; in strategy, wise; in battle, wary, and careful of life; in victory, jubilant; in vengeance, terrible and fiendish!"

French Boy Living with Savages.—According to statements which recently appeared in the *Times*, a Frenchman, named Narcisse Pierre Peltier, about thirty years of age, has been rescued from the Macadama tribe on Night Island, off the north-east coast of Queensland, where he was left, when a cabin-boy, 17 years ago, by a party of shipwrecked sailors. Having been kindly treated by the natives, he completely fell in with their customs, and is said to have quitted them with reluctance. Like the rest of the tribe, he had had his chest and arms scored with broken bottle-glass, and the lobe of his right ear distended and pierced for reception of a wooden ornament. When first captured he could hardly recall a word of French, but he rapidly recovered the use of his mother tongue, not only in speaking but even in reading and writing. Much information respecting the Macadamas has been obtained from Peltier, and a vocabulary of about a hundred words has been taken down from his dictation.

Height and Weight of Boys aged Fourteen in Town and Country Schools.—Mr. F. Galton (Anthropological Institute). — The principal results showed the comparative heights and weights of those boys who were fourteen on their last birthday in two groups of public schools, the one group of country schools, and the other of town schools. It appeared that boys of fourteen in the country group were about 1¼ inch taller and 7 lb. heavier than those in the town group; also, that the difference of height was due in about equal degrees to retardation and to total suppression of growth.

A Variable Character in the Hand of Man.—Dr. Ecker (*Archiv für Anthropologie*).—Which is the longer, the index-finger or the ring-finger, in the human hand? So much difference prevails in answering this question that Dr. Ecker has been led to examine the subject with some care. In the gorilla, and the other anthropoid apes which he examined, the index-finger is shorter than the ring-finger. Among negroes this is also the case, but with negresses the index-finger is, in some cases, the longer. Among Europeans such differences obtain that no general statement can be fairly made, but it is notable that in women the index-finger is the longer more frequently than in men.

Language and Race.—Rev. A. H. Sayce (Anthropological Institute).—The author holds that the fallacy of language as a sure and certain test of race is one to which few modern philologists would commit themselves. There is no assertion which can be more readily confronted with history, or, when so confronted, more clearly be demonstrated to be false. Society implies language, race does not; hence while it may be asserted that language is the test of social contact, it may be asserted with equal precision that it is not a test of race. Language can tell us nothing of race. It does not even raise a presumption that the speakers of the same language are all of the same origin. It is only necessary to look at the great States of Europe, with their mingled races and common dialects, to discover that language shows only that they had all come under the same social influences. Race in philology and race in physiology mean very different things.

The Comparative Psychology of Man.—Herbert Spencer (Anthropological Institute). — The author commenced by showing the necessity for division of labour in a systematic study of psychology, and proceeded to map out the subject into divisions and subdivisions, and to indicate the manner in which its various branches might be investigated. The main divisions were—mental mass and complexity, the rate of development, plasticity, variability, impulsiveness, difference of sex, the sexual sentiment, imitation, quality of thought, peculiar aptitudes, with their many subdivisions. Mental effects of mixture, and the inquiry how far the conquest of race by race has been instrumental in advancing civilisation, would also come within the scope of comparative psychology.

Measure of Sensation.—Th. Ribot.—The author employs three methods of experiment: the method of smallest perceptible differences; the method of true and false instances; and the method of mean errors. These are thus explained: "Suppose we have two weights, A and B, to compare. If their difference is very slight, it may not be perceived, and they may be pronounced equal. If the difference *d* is gradually increased, it will at last become appreciable," and the sensitiveness of the person experimented upon is estimated by the weight of *d* when this occurs. "The second method consists in taking two weights with a slight difference, so that an error in judgment is possible. Sometimes one and sometimes the other will be pronounced the heavier, and in comparing the results of many trials there will be a certain number of decisions true, and a certain number false. As the difference between the two weights is augmented, the number of true decisions will increase at the expense of the false ones."

The third method consists in taking a normal weight A, ascertained by a balance, and then trying to determine by a judgment from sensation the value of another weight B, which looks equal to A. Usually the second weight differs from the first by a quantity, *a*, which is small in proportion as the sensitiveness of the operator is great. The trial is repeated a great many times, and the mean results ascertained.

In experimenting on the sensation of weight, the hand is stretched upon a table, and a certain weight placed on it, the subject of the trial being blind-folded. Minute additions to the weight are then successively made, and the subject asked if any difference is felt. If not, more is added until the difference is noticed, and the trials repeated many times. By this method it is found that there is a constant relation between the original weight, and the additional weight, whatever may be the amount of the former. If, for example, for 1 gramme an additional weight of $\frac{1}{3}$ gramme is required, for one ounce it will be $\frac{1}{3}$ oz., for one pound $\frac{1}{3}$ lb., &c. The mean of a great number of experiments gives one-third as the relation between the two weights, so that "whatever pressure may be on the skin, no augmentation or diminution will be felt if it does not amount to one-third of the primitive weight."

Muscular effort in raising weights gives more easily appreciable results, and the average sensitiveness is found to be about five times as great as in the preceding cases, a difference of $\frac{6}{100}$ being noticeable. This number applies to all weights, so that 6 grammes must be added to 100 grammes, 60 to 1,000, and so on, to make the difference felt. Sensitiveness to light is determined by the help of a photometer. Any given luminous excitation of the eye must be augmented by $\frac{1}{100}$ for the change to be perceptible.

In testing sensitiveness to sound, two balls of the same size, A and B, have a small tablet placed between them. They are suspended by strings of the same length, and a graduated circle marks the extent to which they are elevated before being allowed to fall upon the tablet and occasion a sound which will be proportional to the height from which they descend. Producing sounds of different intensities afforded the result that any given sound must be augmented one-third to be distinguished from the preceding one.

With regard to weight, various parts of the skin differ in sensitiveness; the most sensitive, as the forehead, temples, eyelids, and the back of the hand, can appreciate one-fifth-hundredth of a gramme, the palms, body, and legs, one-twentieth of a gramme, and nails one gramme.

The minimum of perceptible sound results from letting a cork ball weighing one milligramme fall from the height of one millimètre on a plate of glass when the ear of the listener is 91 millimètres off.

The internal light of the eye, having a lasting cause in chemical processes of nutrition, or muscular motion, renders it difficult to discover the minimum of light that can be recognised. Measuring light by the intensity of its shadows, and using a screen of black velvet, Volckman found the light of the eye represented by the effect of an ordinary candle about 9 feet distant.

With regard to heat, the human skin at its normal temperature, 18°·4 C., appears capable of appreciating a change of about one-eighth of a Centigrade degree.—*Academy.*

Subjective Phenomena of Taste.—Dr. Stone (Physical Society).—The author stated that experiments he had recently made led him to consider whether there might be "complementary taste," just as there is "complementary sight." He described the following experiments as examples of the kind of phenomenon. If water be placed in the mouth after the back of the tongue has been moistened with moderately dilute nitric acid, the water will have a distinctly saccharine taste. Or if the wires from a 10-cell Grove's battery be covered with moist sponge, and placed one on the forehead and the other at the back of the neck, an impression is produced which is exactly similar to that resulting from the insertion of the tongue between a silver and a copper coin, the edges of which are in contact. Dr. Stone showed that the induced current usually employed for medical purposes has not this effect, and he considered the results curious, as, so far as we know, they can hardly be the result of chemical action. Mr. Roberts mentioned an instance in which sudden alarm had been followed by the peculiar taste which results from the introduction of two coins into the mouth, to which allusion has already been made.

Sleep.—Our existing knowledge about the physiology of sleep does not go much beyond the fact that the phenomenon in question is invariably associated with a comparatively bloodless condition of the brain. Pflüger attempts to take us a step further by constructing an elaborate hypothesis of a physico-chemical order (*Pflüger's Archiv*, x. 8, 9). Starting from the view that the functional activity of any organ, and more especially of a nerve-centre, depends upon a dissociation of living matter, which is itself only a modified form of albumin, the author goes on to speculate that the chemical potential energy which is used up in the formation of every molecule of carbonic acid is transformed into heat. In other words, the atoms of which this molecule consists are thrown into a state of very active vibration. These intramolecular explosions are propagated in all directions along the nerves to the muscular and glandular systems, which are in structural continuity with the nerve-centres. Frogs, deprived of oxygen, are thrown into a state of apparent death, precisely similar to sleep; from this they may be roused by a fresh supply of oxygenated blood. A certain proportion of intramolecular oxygen in the nerve-centres is thus essential to the waking state, since it enables a given number of explosions to occur in a unit of time at a given temperature. But, during the waking state, the energy of chemical affinity is used up much faster than the intramolecular oxygen of the grey matter of the brain can be replaced; consequently the formation of carbonic acid steadily diminishes; and when the number of explosions per unit of time sinks below a certain minimum, sleep ensues. The entire energy of the brain is never really used up; but it sinks to a point at which, in the absence of all external stimuli, it is incapable of maintaining functional activity. This theory may be so developed as to explain most of the phenomena of ordinary sleep, such as its periodicity, &c. The author likewise attempts to bring the winter sleep of hybernating mammals, and the summer sleep of tropical amphibia, into harmony with it.—*Academy.*

Temperature of the Human Body during Mountain-Climbing.—(*Nature*).—Dr. Marcet and M. Lortet state that:—1. The temperature of the body, as a rule, falls during the act of ascending an incline.

2. During the time of the "mountain sickness," which so frequently accompanies the ascent of lofty heights, the body-temperature falls in a very marked manner.

Dr. Forel differs from the above observers. He states:—As to the effect of an uncomplicated assent, a considerable rise in temperature (2°·5 Fahr.) accompanies a rapid ascent of about an hour's duration.

Even in conditions of great fatigue, the human body rises in temperature upon the muscular effort of ascending a height. It is impossible to determine if the elevation of animal heat due to the movement of ascension diminishes in proportion to the increase of the muscular fatigue.

Next, as to the influence of an empty stomach on the temperature curve. On himself, Dr. Forel proves that a fast of twelve or even twenty-four hours is no obstacle whatever to the rise of temperature which attends the muscular effort of ascending a hill.

By collecting and comparing the temperature-curves produced in ascending and descending inclines, he found that the body-temperature is raised more by a descent than by an ascent. From twenty-one experiments, the average rise in temperature attending the act of ascending is found to be 2·412° F., whereas the mean of seven descents is found to be 2·772° F. The difference, 0·36° F., is small, it is true. Thus a certain amount of heat is transformed into mechanical work during the act of ascent, a certain quantity being returned to the organism from without, under the opposite condition.

Dr. Forel ascended Mont Rosa in July, 1873 (15,217 feet), and, notwithstanding that he suffered from mountain sickness, the body-temperature never showed any tendency to fall throughout, and was 101·5° F. on his reaching the highest point.

Influence of Sea and Mountain Air on the System.—Prof. Beneke, of Marburg (*Deutsche Ar-*

chiv für Klinische Medicin).—The author has ascertained that bodies part with their heat more rapidly on the sea coasts than on mountain heights. His conclusions from his investigations are that irritable, nervous, excitable people will find themselves better in mountain air; but that persons with good digestion, who have been overworked, will be most benefited by a sojourn at the sea-side.

NATURAL HISTORY.

Wolf of Northern India.—E. Bonaira (*Nature*).—This year (1874-75) I examined fourteen batches or litters of wolf-cubs between December 18 and February 1. Judging from the apparent ages of the different litters, I should fix the breeding time of the wolf from about the middle of October to about the end of December. But the majority are bred in December, as out of the fourteen batches I could approximately fix the birth of eleven of them in some date of December. On the 29th of December a full-grown she-wolf, in milk, was brought to me, with seven cubs, which appeared to be about a week old. She had ten teats. The eyes and ears of the cubs were closed; their ears were drooping; their general superficial colour was sooty brown, with an under colour, that is, at the roots of the hairs, of dirty light tan. The latter colour was more marked on the head and flanks, while the sootiness was more decided on the hinder part of the body. They all had a milk-white chest-spot varying in size. Six of them had white hairs at the tips of their tails.

All those I examined, of about the same age, had similar characters. When the eyes of young wolves open, and they begin to crawl, about the third week, their general colour is a dirty light tan, washed with soot. As they grow, their ears become erect, their general colour a uniform light tan, with only the tips of the hairs dark, the tail being the darkest part of the animal. After the sixth week or so, the white chest-spot emerges into the light fawn colour of the remainder of the chest, and a dark collar on the under part of the neck becomes visible. This collar looks as if dark grey ashes were brushed across the greyish white of the neck. All those I examined which looked older than four or five weeks had this collar. But it disappears again as the wolf gains its adult colouring, becoming merged into the uniform creamy white of the neck and chest. Out of seventy-nine wolf-cubs which I examined, all but one had a white chest-spot, varying in size from a few hairs to a patch the size of a rupee. Fourteen of them had white tips to their tails, varying in size. Seventeen of them had white tips to one or more of their feet. These white marks leave no doubt about the close relationship between the wolf and the domestic dog.

Sense of Humour in Animals.—G. J. Romanes (*Nature*).—Several years ago I use to watch carefully the young orang outang at the Zoological Gardens, and I am quite sure that she manifested a sense of the ludicrous. One example will suffice. Her feeding-tin was of a somewhat peculiar shape, and when it was empty she used sometimes to invert it upon her head. The tin then presented a comical resemblance to a bonnet, and as its wearer would generally favour the spectators with a broad grin at the time of putting it on, she never failed to raise a laugh from them. Her success in this respect was evidently attended with no small gratification on her part.

I once had a Skye terrier which, like all of his kind, was very intelligent. When in good humour he had several tricks, which I know to have been self-taught, and the sole object of which was evidently to excite laughter. For instance, while lying upon one side and violently grinning, he would hold one leg in his mouth. Under such circumstances nothing pleased him so much as having his joke duly appreciated, while if no notice was taken of him he would become sulky. On the other hand, nothing that could happen displeased him so much as being laughed at when he did not intend to be ridiculous. Mr. Darwin says:—"Several observers have stated that monkeys certainly dislike being laughed at." There can be little or no doubt that this is true of monkeys; but I never knew of a really good case among dogs save this one, and here the signs of dislike were unequivocal. To give one instance. He used to be very fond of catching flies upon the window-panes, and if ridiculed when unsuccessful, was evidently much annoyed. On one occasion, in order to see what he would do, I purposely laughed immoderately every time he failed. It so happened that he did so several times in succession—partly, I believe, in consequence of my laughing—and eventually became so distressed that he positively pretended to catch the fly, going through all the appropriate actions with his lips and tongue, and afterwards rubbing the ground with his neck as if to kill the victim: he then looked up at me with a triumphant air of success. So well was the whole process simulated, that I should have been quite deceived, had I not seen that the fly was still upon the window. Accordingly I drew his attention to this fact, as well as to the absence of anything upon the floor; and when he saw that his hypocrisy had been detected, he slunk away under some furniture, evidently very much ashamed of himself.

Tree-Kangaroo.—(*Athenæum*).—In New Guinea there are two species of tree-kangaroos, peculiar from having the fore limbs long, and specially adapted for climbing. These are also peculiar in that the hair on the nape of the neck, instead of being directed downwards, as in the true kangaroos and most animals, turns forwards towards the head. Their front crushing teeth or premolars are abnormally large. In the New Guinea kangaroo (*dorcopsis mulleri*), the fur of the neck and the front molar teeth agree exactly with those of the tree-kangaroos, and not with the Filander, or the continental species.

Quite recently, M. L. M. D'Albertis obtained from a sailor of H. M. S. *Basilisk* a small kangaroo, which he sent to the Zoological Society's Gardens. It was obtained from that little-known region, the south-east end of New Guinea. The cold of the past winter was too much for the little creature, and its death has given the Prosector to the Zoological Society an opportunity of studying its anatomy, which makes it evident that it belongs to the same genus as the New Guinea species, from the north-west corner, described by Quoi and Gaimard, and that it must be termed *Dorcopsis luctuosa*, *Halmaturus luctuosus*, having been the name employed by D'Albertis in his original description.

In one point, namely, in the possession of a species of true kangaroo, the island of Aru more resembles Australia than it does New Guinea, which, with Mysol, is remarkable for containing no kangaroos, but a group of kangaroo-like animals, that fall into two divisions of generic importance, the tree-kangaroos (*Dendrolagus*) and those which cannot be otherwise expressed than by the indirect term, the Ground-tree-kangaroos (*Dorcopsis*). Each division has just been shown to contain two species.

Modes of Occurrence of Moa Bones in New Zealand.—Dr. Hector (British Association).—The author said he used the term Moa in preference to that of Dinornis, because the bones of the New Zealand birds were now divided among so many genera. He demonstrated most conclusively that the knowledge of their former existence was not communicated to the Maoris by the Europeans, who deduced their structure from their remains, but, on the contrary, was imparted to the latter by the former. He believed there was no hope of ever finding the birds alive, for he himself had been over the whole of the islands very thoroughly without seeing them. He found that the country occupied by primeval forests before the advent of Europeans was that in which moa bones did not occur. His deduction was that they lived in the open and low scrub, in which they could walk. In all this region the moa bones were extremely abundant in the South Island, all over the ground; but these bones were very rarely found in collections, for they were usually decomposed and split and warped. In the enormous extent of sub-Alpine country in the South Island, which was covered by only a light vegetation, large quantities of well-preserved moa remains had been recently found, associated with remains of natives. It appeared that the natives had pressed up the country for the purpose of capturing, killing, and eating the moas; and as the natives could not follow them through the sharp bayonet-grass and other underscrub, they seemed to have got at them by setting portions of it on fire, which collected the animals together, often killed them, and accounted for so many of their bones being accumulated in particular spots. The second chief mode of occurrence of moa bones was in the turbary deposits and desiccated swamps, occurring in almost all the valleys leading to the east coast. One notable deposit was at Glenmark, where the remains of a terrace at a higher level had been cut through by the stream, leaving a large turbary deposit on the shoulders of the hill on both sides. Here were found a great number of moa bones, without any associated Maori implements. They occurred mixed together, and above, below, and among great accumulations of drift-wood, which were ten or twelve feet deep over many acres. The bones dug out of that deposit indicated at least 1,700 individuals, which had either been carried down and smothered in floods or which had died naturally and been carried down by the water. Similar deposits occurred in caves, and in turbary deposits on the coast, which were exposed below high-water mark, showing that there had been comparatively modern submersion. There seemed to have been an uninterrupted submergence of New Zealand since the time when the moas were first developed in such large numbers; and there had been no considerable re-emergence of the land since then. Another mode of occurrence of moa bones was wherever the country was favourable for Maori camps, on the sheltered grassy plots and links, or among the sand-hills near. They were associated with their cooking-hollows, and with stone implements, which, however Neolithic in aspect, were similar to those used now by Maoris. It had been said that the oldest moa remains were those associated with the ancient moraines of the upper valleys, but these were the great natural roads up which it was very likely that some moas would travel and leave their remains there. In caves the moa bones were found resting on the stalactitic shelves, perhaps cemented by a little carbonate of lime. They were hardly ever found on the lower surfaces of the caves; and he believed they had mostly gained access to the caves by falling through the upper chasms. He had evidence that sheep in modern days fell through in the same way, and their bones were found similarly situated in the caves. The earliest traces of the moas that had been found were footprints at Poverty Bay, occurring in a soft pumice sandstone, within six or eight inches of the upper surface. Many blocks had been procured with these undoubted footprints. The lower surface of each depression was formed of very fine micaceous sand, but it was filled up with much coarser green quartzose sand. After the birds had passed, the impression had been filled up by blown sand.

The Moa.—In the *Greymouth Weekly Argus*, New Zealand, lately appeared a letter signed, "R. K. M. Smythe, Browning's Pass, Otago," describing, in a very detailed manner, the capture of two living moas (*Dinornis gigantea*), a female, eight feet high, and a young one three feet shorter. The writer finishes his account of their capture by remarking that he has little doubt that he will be able to bring them both alive to Christchurch. Though it is extremely improbable that the genus Dinornis is not extinct, nevertheless there is quite a possibility that living representatives still survive. We possess feathers which are in a state of preservation sufficiently good for Mr. Dallas to determine that, like those of the cassowary and emu, they possessed an aftershaft of a large size; and at the same time tradition, and the condition in which the bones are found, retaining much of their animal matter, tend to show how lately the bird formed part of the existing fauna of the country. If the letter is genuine, it cannot be long before ornithologists, of whom there are several of no mean repute in New Zealand, will be able to satisfy themselves on the subject.

It is well known that the cassowaries are inhabitants of the Austro-Malay archipelago, New Guinea being the head-quarters of the genus. There is one species, however, which inhabits Australia, a living specimen of which has, for the first time, reached the gardens of the Zoological Society.—*Athenæum.*

The Moas of New Zealand.—(*Nature*).—Rumours have reached us from New Zealand to the effect that two living specimens of the colossal struthious birds, the moas, have been captured in the province of Otago. That the genus Dinornis, to which they belong, has been extinct for some time is the general impression; nevertheless, there are many reasons for the belief that it is not long since individuals of that ostrich-like group peopled parts of New Zealand. In 1870 Dr. Haast discovered kitchen-middens made up of fragments of moas of different species, mixed up with bones of seals, dogs, and gulls, together with pieces of chalcedony, agate, &c., which evidently indicate that these gigantic birds were contemporaneous with the ancient human inhabitants of the islands. A human skeleton having been found with a Dinornis egg between its arms is also evidence in the same direction, as is the recent discovery of the neck of one of these birds with the muscles and integuments preserved.

Several portions of the external covering of the bird have also been discovered, along with bones, which show signs of recent interment. Beside feathers, the complete skeleton in the museum at York has the integument of the feet partly preserved, from which it is evident that the toes were covered with numerous small hexagonal scales. A specimen was sent by Dr. Haast to Prof. Alphonse Milne-Edwards, which is to be seen in the Museum of Natural History at Paris. This specimen was obtained at Knobly

Range, Otago, and belongs to the species Dinornis ingens. The tarsus, as well as the toes, were nearly entirely covered with small horny imbricate scales. Likewise the hind toe, or hallux, which is not present in either the ostrich, rea, emu, cassowary, nor in some species of moas, was articulated to the metatarsal segment of the limb a little above the level of the other toes. Those species of Dinornis which possess the hind toe, Prof. Owen includes in the genus Palapteryx.

Amongst the struthious birds, the moas agree most with the Apteryx, in the presence (occasionally) of a fourth toe; and in their geographical distribution. They resemble the cassowaries and the emus most in the structure of their feathers; and in the structure of the skull differ from all to an extent which has made Prof. Huxley arrange them as a separate family of the Ratitæ. A knowledge of the anatomy of their perishable parts would be an invaluable assistance in the determination of their true affinities, but it is almost too much to hope that the material for such an investigation will ever present itself.

Great Auk.—A month or so ago, it was quite true that, as stated by Prof. Newton, nine skeletons, together with bones from about forty other individuals, were the only osteological remains of the great auk (*Alca impennis*). Through the energetic zeal of this ornithologist a specimen was brought to this country from a small island near the north-west coast of Newfoundland, which goes by the euphonious name of "the Funks." This island at one time possessed a rich surface soil, rich in organic débris, which has been removed for mercantile purposes. From this the imperfect and dried gare-fowl above mentioned was obtained in 1863, four feet below the surface, and under two feet of ice. It was thought that the guano bed was exhausted, but quite recently a fresh deposit has been discovered, rich in the remains of the great auk. Portions of the skeletons of about fifty individuals have been obtained, and are now in this country. There is no perfect specimen, but sets of bones sufficient to build up several complete skeletons. The remains have evidently been much exposed to the weather and to changes of temperature, being mostly in an imperfect condition. They, nevertheless, will add greatly to our knowledge of the interesting species, so recently extinct, from which they are derived.

The Night-Jar.—H. E. Dresser (*Birds of Europe*). — This bird feeds on moths, beetles, and insects of various kinds, most frequently capturing its prey on the wing, its capacious gape forming an excellent moth or beetle trap. That it eats caterpillars is also certain: but it feeds more especially on the larger insects, such as may-bugs, dung-beetles, large night-flying moths, especially the sphinx moth, and various species of nocturnal insects. It is a very greedy feeder, and in the autumn is often very fat. The night-jar is often to be met with where cattle have been feeding or where they are stalled, or in the immediate vicinity of outlying folds; and hence the popular delusion that it sucks the goats; and from this belief has arisen the common appellation of goat-sucker.

This species has the claw of the middle toe furnished on the side with pectinations forming a sort of close-toothed comb; and the use made of this peculiar appendage has puzzled naturalists not a little. Some observers contend that it is used to clean the bristles at the base of the bill from the fragments of wings of insects which may adhere to them; but this cannot well be the case, as these bristles are large, strong, and placed at some distance apart, whereas the teeth of the claw are thin and very close. Others think that as the bird invariably perches along a branch in a direction parallel with it, and never across the bough like almost all other birds, this pectinated claw may assist it in keeping its perch more firmly than it otherwise would do. Other naturalists, again, contend that it is used to hold large insects with greater security; but it appears that the night-jar almost invariably takes its prey with the mouth and not with the foot; and consequently this supposition falls to the ground. An anonymous writer suggests that the comb-like structure of the claw may be used for disengaging the hooked feet of beetles from the bill, to enable the bird to swallow them; and this may possibly be the case, as the serrations are well calculated to catch the polished limbs of beetles. Anyone who has attempted to confine *Dytisci* or *Scarabæi* in a collecting-box, must be aware of the difficulty in getting their feet free from the edge, to which they hold with the greatest pertinacity, one foot being no sooner pushed in than another is portruded.

Gilbert White (of Selborne) states that he has distinctly seen the night-jar raise its foot to its mouth while hawking for insects on the wing.

Migration of Birds.—W. W. Kiddle (*Nature*).—In crossing the Atlantic last September, when 900 miles distant from the nearest point of Newfoundland, two land birds settled on the ship, and after a short rest resumed their flight to the south-east, without partaking of the food which was scattered in various places for them. By the colour of their plumage and motion on the wing, I believe them to be a species of lark. It may well be asked whence did they come, and whither were they going over that vast space of ocean, with no resting place nearer the continent than the Azores? How were they fed during their long journey, and what guided them on their course? for it is only reasonable to suppose they had come on a bee line from their starting point, and even then their muscular powers must have been severely taxed. It appears to me that naturalists are not in possession of the secret which enables birds of passage to go many days without food at a time when their system must be strained to its extreme limit of endurance.

From the result of close observation, I do not believe that land birds are often, if ever, driven to sea by the force of the wind. Some other cause must influence their movements. At the head of the Gulf of Bothnia, when there has not been a storm for many days, I have seen scores of different species around the ship, amongst them the hawk, the owl, the robin, and many others. Are those who alight and stay by the ship the stragglers from the ranks of the armies which annually migrate, the sick and worn who fall out by the roadside to die, whose end in creation has been fulfilled, and their places ready to be taken by the young and strong? This surmise is strengthened by the fact that no care can preserve the lives of these tired birds in captivity; the hawk and dove alike refuse food, and quickly pine and die.

Birds must possess strong affections, as they are always seen in pairs on these long journeys, which is an additional argument in favour of their voluntary flight over the ocean. It is scarcely possible they could remain together in a gale sufficiently powerful to blow them off the land, and more unreasonable still to imagine that the strength which is able to carry them hundreds of miles without a rest should fail to breast an ordinary gale under the shelter of the land. Such facts as these vouch for the facility with which the most remote islands may increase the number of their species without the agency of man.

Carrier Pigeons.—(*Nature*).—When his Majesty of Spain was nearing Barcelona, a Spanish steamer was sent to meet *Los Navos* on the high seas, and succeeded in doing so at the distance of 150 miles from the seaport. Carrier pigeons were then liberated so as to announce in Barcelona the happy coming of Don Alphonso XII. The experiment appears to have been successful. It is said that carrier pigeons were in use among the old Roman navigators in the time of the Cæsars. The practice was discontinued for centuries, and the question has been asked by some French papers whether it is desirable to revive it for Transatlantic steamers.

Colouring Matter of the Shells of Birds'-Eggs as studied by the Spectrum Method.—H. C. Sorby (Zoological Society).—The author considers that all the different tints are due to a variable mixture of seven well-marked colouring matters. Hitherto the greater part of these had not been found elsewhere. The principal red colouring matter was connected with the hæmoglobin of blood, and the two blue colouring matters were probably related to bile pigments; but in both cases it was only a chemical and physical relationship, and the individual substances were quite distinct, and it seemed as though they were special secretions. There appeared to be no simple connexion between the production of these various egg pigments and the general organization of the birds, unless it were in the case of the tinamous, in the shells of the eggs of many species of which occurs an orange-red substance not met with in any other eggs, unless it were in those of some species of cassowary.

Instinct and Reason.—James Hutchings (*Nature*).—During the spring of this year a pair of blackbirds built a nest on the top of my garden wall. When the young birds were about three parts fledged one of them left the nest and fell into the flower garden. My cat (seven years old, and which has killed scores of small birds) immediately found it, and at the same time a kitten began to pay rather rude attentions to the young blackbird, and would have used it as kittens are wont, but the old cat would not suffer her to touch it. The cause of this was that the old cock blackbird, being aware of the peril of its young, made a great noise and kept flying here and there around the scene of action, crying and scolding with might and main. It then became evident to me that the cat had two or three objects in view, and a purpose to gain. Firstly, not to allow the kitten to touch, or kill, or make off with the young bird. Secondly, to use the young bird as a decoy to entrap the old one. Thirdly, to make the young bird cry sufficiently from fear or pain to induce the parent's affection to overcome its discretion.

During the manœuvres old Tom repeatedly made unsuccessful springs to catch the cock-bird, alternately running to give the kitten a lesson of patience, or self-denial, or impose a fear of punishment. The young bird repeatedly hopped out of sight amongst the flowers and stinted its cries; then anon the cat touched it again and made it flutter about and cry again, which from time to time brought the old bird down with cries of terror, or wrath, or a blending of both emotions, and almost into the very mouth of the cat. It became evident to me that the cat was using the young bird as a decoy to catch the old one. After I had watched some ten or fifteen minutes, it became too painful for me to witness, so I caught the young bird and put it again into its nest, which was about ten feet from the ground.

Walruses and True Seals.—J. W. Clark (Zoological Society).—The external features which distinguish the seals from the sea-lions is that seals have no external ear, the fore limbs are more enclosed in the body, the hands are not used for being applied to the ground, and the fingers have nails, which the sea-lions have not. These distinctions can be seen in the "seal-pond" in the Society's gardens, where there are both sea-lions and seals. In walking on land the seals move by a succession of bumps somewhat slowly, while a sea-lion can run as fast as a man, though in somewhat an ungainly way. Again the seal has the first and fifth digit the longest, while in the sea-lion the "thumb" is the longest. The seal has a broad short head, with a barrel-shaped body. The hind limbs act as a kind of screw propeller, which steer the animal with such exactness that it can pass through narrow apertures with unerring precision. The walrus occupies an intermediate position between the two other groups, and with its bull-shaped neck and two tusks, can never be mistaken. Animal preservers usually try to eradicate the wrinkles in stuffing, but this is wrong, as the skin is very loose and puckered. The feet are on the same plan as the sea-lion's, and there is the same absence of nails. There are no external ears, there are no eyelashes, and the eyes are deeply set. The average length of the tusks may be taken at 26 inches. The walrus is omniverous, and feeds largely on sea-weeds. When the walrus essays climbing on to an ice floe it throws one-third of its body out of the water by a rapid movement of its hind limbs, seizes the ice by its tusks, and pulls itself up. The young are suckled for two years. There has been so reckless a slaughter of walruses that they are rapidly disappearing. At Bear Island there used to be large numbers of walruses, and we have an account of 900 being butchered at once by rapacious hunters who, however, were unable to ship more than a part of the carcases, and from 600 to 700 had to be left, and were eventually lost. In Spitzbergen as many as 1,000 a year are killed. Every part of the animal is of value for one purpose or another. The principal hunting-grounds are Spitzbergen, Nova Zembla, Greenland, Hudson's Bay, Baring Straits, and the Pribyov Islands.

The range of seals is, in the northern hemisphere, on the west coast of North America northwards from California; around Greenland, and from there down part of the east coast of North America; at Spitzbergen, all around Great Britain, in the Mediterranean, and the inland seas of Russia; the sea along the north coast of Europe, along eastwards, and round down the coast of Asia, nearly to Japan. They are also met with on the coast of Africa about Senegal. In the southern hemisphere they occur around the Horn, along the Antartic barrier, and in some of the islands of the South Sea.

Seals are, unless molested, quiet, inoffensive animals, and sleep much. They can ascend fresh-water rivers, and in the Thames have been met with at Putney. Their food is principally crustaceans. The principal hunting-ground is San Tau Mayen. The oil is worth £50 a ton, and the total value of a year's hunting is about £250,000. Some 60 ships are annually engaged in the hunting, of which 20 belong to England. Unless some international arrangements are soon made for a close time for the hunting, or "seal-fishing," as it is commonly called, we shall soon extirpate the whole race of seals. It is urgently important that our Government should take decisive steps in the matter.

The Manatee at the Zoological Gardens (since dead).—The manatees—of which there are two well-defined species, one found in and at the mouths of the rivers on the eastern coast of intertropical America, and the other on the shores of Western and Southern Africa—are large-sized somewhat seal-like herbivorous animals, sometimes reaching 17 feet in length, differing from the seals and resembling the whales in not having any indications of hinder extremities, at the same time that the caudal portion of the body is expanded into a horizontally-flattened tail. In them the contour of the face is peculiar, the whiskered snout being much flattened, like a pointed cone with a considerable portion of the end cut off transversely. The large nostrils are situated within a short distance of one another, at the upper portion of the truncate edge; they are closed by valves during the time that the animal is submerged. The eyes are peculiarly small and inconspicuous. The external ears are wanting. The mouth is small, without front teeth, and is placed low down, the gape being close to the anterior end of the animal. The neck, from its extreme shortness, can scarcely be said to exist as such.

Neglecting the tail, the body, which is very sparsely covered with hair, has the shape of a much elongate barrel, slightly flattened above and below. The skin is very like that of the hippopotamus. Far forward, just behind the head, the two fore-limbs project laterally from below. The elbow is conspicuous, though placed not far from the side, and the fore-arm, together with the hand, form a flat oval flapper devoid of any indications of fingers, except that at the extreme edge rudimentary nails are developed. These arms are used by the animals as claspers, which can be flexed over the chest; employed as locomotor organs at the bottom of the water, or made to assist in the prehension of food. In the female the mammæ are pectoral, and the consequent general configuration has probably led to the fabulous descriptions of the existence of "mermaids."

In shape the tail is unlike that of any other animal, being spatulate. It most resembles that of the beaver, but is a direct continuation backwards of the body, and is covered with an unmodified skin. As in the whales and beavers, the vertebral column forms a bony axis of support for the flattened muscular and fibrous expansion covered with thick cuticle, which forms the propelling mechanism.

The skeleton is of an extremely dense texture and very massive; the skull and ribs more resembling ivory than bone. In the number of the vertebræ which form the neck there is also a peculiarity, not shared even by its ally, the dugong. In all mammalia there are seven cervical vertebræ, in the manatee there are, however, only six. The ribs are dense and broad.

The half-grown female manatee lately in the Zoological Society's Gardens, is the first living specimen which has been seen in this country. It came from the coast of Demerara, and was three weeks on the journey, during which time it was in a big swinging tank constructed to hold it.

Its movements were much less active than those of the seals, and as food it took vegetable marrow and lettuce in preference to anything else.—*Nature*.

Fish in the Mammoth Cave.—F. W. Putnam, U.S., Geological Survey.—Mr. Putnam passed ten days in the cave, and by various contrivances succeeded in obtaining large collections. He was particularly fortunate in catching five specimens of fish of which only one small individual had heretofore been known, and that was obtained several years ago from a well in Lebanon, Tennessee. This fish, which Mr. Putnam had previously described from the Lebanon specimen under the name of *Chologaster Agassizii*, is very different in its habits from the blind fishes of the cave and other subterranean streams, and is of a dark colour. It lives principally on the bottom, and is exceedingly quick in its motions. It belongs to the same family as the two species of blind fishes found in the cave. He also obtained five specimens of four species of fishes that were in every respect identical with those of the Green River, showing that the river fish do at times enter the dark waters of the cave, and when once there apparently thrive as well as the regular inhabitants. A large number of the white blind fishes were also procured from the Mammoth Cave and from other subterranean streams. In one stream the blind fishes were found in such a position as to show that they could go into daylight if they chose, while the fact of finding the *Chologaster* in the waters of the Mammoth Cave, where all is utter darkness, shows that animals with eyes flourish there, and is another proof that colour is not dependent on light. Mr. Putnam found the same array of facts in regard to the crayfish of the cave, one species being white and blind, while another species had large black eyes, and was of various shades of a brown colour. A number of living specimens of all the above-mentioned inhabitants of the waters of the cave were successfully brought to Massachusetts after having been kept in daylight for several weeks, proving that all the blind cave animals do not die on being exposed to light, as has been stated.

Aldabra Tortoises (in the Zoological Gardens).—A Gaultier (*Nature*).—Both these tortoises are natives of Aldabra, though not of the same breed. The larger, the male, has been in the Seychelles for about seventy years; its last proprietor, M. Deny Calais, kept it with the female in a semi-domesticated state on Cerf Island. His weight is about 800 lbs.; the length of the shell is 5 ft. 5 in. (in a straight line), the width, 5 ft. 9 in.; circumference of the shell, 8 ft. 1 in.; circumference of fore leg, 1 ft. 11 in., and of hind leg, 1 ft. 6 in.; length of head and and neck, 1 ft. 9 in.; width of head, 6 in. The female is much smaller, and there is no certainty as regards the time she was brought to the Seychelles. The length of her shell is 3 ft. 4 in.; the width, 3 ft. 10 in.; the circumference, 5 ft. 4 in. She lays thrice every year, in the months of July, August, and September, each time from fifteen to twenty round hard-shelled eggs.

Every one who sees these two tortoises side by side is at once struck by the great difference in form and sculpture of the shell. That of the male is remarkably high, with a rounded outline, each plate being raised into a hummock, and deeply sculptured with concentric furrows along the margins. The female, on the other hand, has a perfectly smooth shell with an oval outline, without either furrows or raised portions. The shell of the male is brownish, that of the female black. The male has also a comparatively longer neck and tail than the female. It is quite possible that these are sexual differences, the males being known to grow to a much larger size than the females. But as Aldabra consists of three islands, separated by channels of the sea which are impassable barriers to animals which may float but cannot swim, it may be presumed that the two animals come from distinct islands, each island of the group being inhabited by a distinct race, as in the Galapagos.

The male shows himself to be annoyed when the female is disturbed, and there is no doubt that he exhibits affection for her, as was especially evident on board the steamer, when he tried to break out of his cage as soon as he got sight of the female, who was transported in a separate cage. The circumstance that the two animals are a pair, increases the chances in favour of their being kept alive for a lengthened period. And they will be well worth all the care we can bestow on them, as it is extremely doubtful whether we shall ever succeed again in obtaining a pair of full-grown examples. The male is without doubt the largest and most powerful individual of its race, far exceeding in size any of the few other individuals kept in the Seychelles. Nor is it likely that in Aldabra itself a similarly large example should have succeeded in evading the search of the numerous crews which have landed there.

The Tock-tay, or Large House Lizard of Eastern Bengal.—This noisy but harmless animal generally finds a lodgment in the bamboo and mat houses of the district that are anywhere near the jungle. It is also fond of living in hollow trees, which give great resonance to its loud and strongly staccatoed cry of "tock-tay." It is of a green tint, mottled over with red spots, and suckered feet like its smaller congener, the tick-tickee, enable it to run under beams and bamboos. Its cry is, however, very different from the gentle "tick-tick" of the small lizard, being sufficient at night to awake the soundest sleeper. He begins with a loud rattle as if to call attention; this is followed by another and more imperative rattle, and, when everybody may be supposed to be listening, he strikes in deliberately with "tock-tay"—a moan—"tock-tay" another moan—"tock-tay"—a last and final moan, with which he winds up, not to be heard again for an interval.

In the way of edibles he is fond of a good crust, and the common dung beetle frequently furnishes him with a *pièce de résistance.* That insensate insect becomes an easy prey, owing to his heedless rattle-dum-clash ways; he is the great extinguisher of lights in native houses, and Europeans are also familiar with his strong sustained drone, varied by intervals of silence when he has dashed against some rafter or projection, or given himself a heavy fall; but he is not to be discouraged, and is soon up and droning about as dismally a ever.

The drone, however, is sometimes suddenly quenched without the consequent thump on the floor, and when this is followed by a crunching sound overhead one may safely infer that it is tock-tay who has been lying in wait for him, and has snapped up his prey.

These lizards may easily be caught during the day by slipping a noose over their necks while they are asleep in an exposed position; and when so caught they snarl, growl, and snap at their captor in a very ferocious way. I have not heard, however, that they are venomous.—C. B., *Nature.*

Congo Snake (*Murænopsis tridactyla*).—Saville Kent (*Nature*).—This singular eel or snake-like animal (from the neighbourhood of New Orleans, now in the Manchester Aquarium) belongs to the true amphibia. It differs from the ordinary eel in possessing no fins, small bead-like eyes, a mere puncture in place of the ordinary gill-operculum, though more especially in having stationed at each extremity of the attenuated body a pair of feeble little legs, each leg being furnished with three slender toes. These legs, though almost rudimentary, are used by the animal, and with more marked effect than might be presupposed, when crawling over the ground at the bottom of its tank. Rising into the midst of the water, it can swim with great rapidity, progressing by rapid undulations of its body from side to side, after the manner of a true snake. The length of this specimen is about two feet six inches; greatest diameter in the centre of the body, one inch and a half, tapering off into an attenuate tail. The colour closely resembles that of an ordinary eel. Along the lateral line is a double row of minute punctures, the orifices, no doubt, of mucous glands similar to those obtaining in true fishes. The animal has to repair to the surface of the water to breathe, but this is at distant intervals, a large quantity of air being drawn through the nostrils into the lung-pouch by a singular inflation of the throat, repeated several times in succession. When taking in its supply of air in shallow water, it does not altogether leave the ground, but raises itself in a semi-erect position until the head touches the surface. With the head just an inch or two below the surface, and standing, as it were, upon its posterior legs, with the anterior pair held out helplessly in the water, is a very favourite attitude with this creature. In its native swamps the Congo Snake is reputed by the black population to be highly venomous, an injustice to the poor creature as great as that done by our own benighted countrymen to the harmless newt or triton of English ponds and streams, and of which it is merely a highly interesting and most extraordinary exotic type.

The Thresher (*Squalus vulpecula*).—W. W. Kiddle (*Nature*).—Off Youghal a gigantic thresher was passed. It was leaping lazily and obliquely from the water, and after attaining its highest altitude, fell heavily on the surface, without making any effort to ease or guide its descent. This fish was not under fourteen feet in length; the belly of a pearly whiteness, and the back marked across with broad black bands. I have never seen this fish north before; but on the whaling grounds of the southern seas it is common. I do not believe it is dangerous to the life of the whale, as is often stated, but am under the impression that the irritation caused by the attacks of the thresher makes the animal vomit up the squid and other small matter on which it feeds. It is not reasonable to suppose that the blows inflicted by so small an instrument as the thresher's tail can have much effect through a foot of blubber. The whale has also many ways of escaping from its puny enemy; he dives to a depth where the thresher cannot follow, and if he could, his power of inflicting injury would be gone, owing to the resistance caused by the water; his speed also enables him to escape at all times. The treaty of offence which is said to exist between the thresher and sword-fish appears to me to be very mythical. When the whale is sick or dying, he is doubtless an object of attack to all the shark species, as they wage war with the whaler for the coveted blubber.

Marine Silk.—R. L. Simmonds (*Waste Products*):—Among the many novelties which industry obtains from the ocean, one of the most curious is the textile fabrics which are made with the byssus of the pinnæ of the Mediterranean—the gin shells or seawings, as they are called. The shells, which are in general very fragile, resemble in form those of the larger species of mussels. This mollusc, like most of its order, has the power of spinning a viscid silk, but not in the same manner, nor for the same end as the caterpillars. The latter seeking for protection during a certain stage of life only, have organs which, during the rest of their existence, are preparing for the end; but the pinna has constant use for this production, which, although like silk, a secretion of certain organs within its body, acts as an anchor, a leg, or a hand, as may be required.

The operation of the worm may truly be called spinning, but that of the mollusc is rather like the work of a wire-drawer, the substance being first cast in a mould, formed by a kind of slit in the tongue, and then drawn out as may be required. Its mechanism is very curious. A considerable number of bivalves possess what is called a byssus, that is, a bundle of more or less delicate filaments issuing from the base of the foot, and by means of which the animal fastens itself to foreign bodies. It employs the foot to guide the filaments to their proper place, and to glue them there; and it can reproduce them when they are cut away. The pinna possesses a machine as incontestably mechanical as that of a wire-drawer's mill. It is provided with an extensile member like a finger, and this contains a glue which the animal protrudes at pleasure by means of a variety of minute perforations in the lip. This glue or gum, having passed through these apertures, becomes threads of almost imperceptible fineness; and these, when joined, compose the silk so much admired by the Sicilians. This byssus forms an important article of commerce, for which purpose considerable numbers of pinnæ are annually fished up in the Mediterranean, from the depth of 20 to 30 feet. An instrument called a "peronico" is used for this purpose: it is a kind of iron fork, with perpendicular prongs, 8 ft. in length, each of them about 6 in. apart, the length of the handle being in proportion to the depth of the water; for, notwithstanding the extreme delicacy of the individual threads, they form such a compact tuft, that considerable strength is necessary in separating the shells from the rocks to which they adhere. The tuft of silk is then broken off and washed with soap and water. It is then dried in the shade, straightened with a large comb, the root cut off, and the remainder carded. By these means a pound of coarse filaments is reduced to about three ounces of fine threads.

This is fabricated into various articles of wearing apparel, such as shawls, stockings, caps, gloves, purses, and waistcoats. The web is of a beautiful yellow brown, resembling the burnished gold hue which adorns the backs of some splendid flies and beetles. A considerable manufactory is established at Palermo.

The Colerado Beetle (*Doryphora decemlineata*).—Dr. Kalender (*Kölnische Zeitung*).—It appears that the insect passes the winter in the ground, but as soon as the potato plants have developed their first shoots the beetle shows itself. The females then deposit their orange-coloured ova, in lumps of ten to twelve, upon the under surfaces of the leaves; the larvæ appear after five to eight days, and begin their destructive work, which lasts two or three weeks, after which period they transform into nymphæ; ten to fourteen days later the young beetles appear; thus one summer can see three or four generations, of which the last one passes the winter in the ground. The insect does not confine its devastations to the potato only, but has also been found to attack the young shoots and leaves of Cirsium lanceolatum, Amaranthus retroflexus, Lisymbrium officinale, Polygonum hydropiper, Solanum nigrum, Chenopodium hybridum and album, and even of Hyoscyamus niger. This variety of plants shows that the insect has great powers of adapting itself to its food, and to this it must be ascribed that it can only with the greatest difficulty be got rid of. The home of the insect was in the Rocky Mountains, U. S.; with the westward progress of agriculture the cultivation of the potato approached the birthplace of the insect, and it transferred its dwelling to the potato fields, which of course were welcome food; thus in a short time it became a general plague. In 1859 it began its eastward progress, and has now reached the coast of the Atlantic; whether it will cross this ocean and begin its devastations in Ireland remains to be seen; much may, however, be done to prevent its appearance in Europe. The means used for its destruction are various; the most successful one has been the so-called Schweinfurt green (arseno-acetate of copper). This is mixed with flour and water, and the plants are sprinkled with the mixture. Although highly poisonous to animal life, the Schweinfurt green does not poison the soil, as it is perfectly insoluble in water, and the destruction of the noxious insect is almost complete.

Lieut. Carpenter, in the "Report of the Zoological Collections made by him in Colorado during the Summer of 1873," states that not a single specimen of the potato beetle was to be found to the west of the Rocky Mountains, though he believed it would be ultimately spread over that region through the agency of the seed, as the insect was of too sluggish a nature to be capable of spreading itself so rapidly by its own instinct; and his belief in this was further sustained by its continued absence from the Salt Lake basin, occasioned by the cheapness of vegetables in the Mormon settlement, rendering the importation of potatoes from Colorado unnecessary. Mr. Bates believes the distribution of the beetle depends more upon climatic conditions. The native home of the insect was on the eastern plateaux of the Rocky Mountains; and the climate of the Pacific coast being more like that of the west coasts of Europe, their faunas also bore a greater resemblance. He believes the absence of the insect from the west of the Rocky Mountains to be caused by the difference of climate, and the same cause might be expected to prevent the establishment of the insect in countries like Britain, where the moisture of the atmosphere would, probably, be fatal to it.

Ants.—A young lady, more practically philosophic than Æsop or La Fontaine, has actually started an establishment for the preservation and the propagation of the ant species in France. The fair mistress of the institution is described as of rather "terrible" aspect. Although clad in a suit of buff, like the archeresses of olden time, she is not quite safely guarded against the attacks of her ungracious *protégés*, who have managed to bite her face and hands until they are tanned to the texture of parchment. The consequence of these continued attacks has, so the *Soir* affirms, been to render her skin insensible to the most furious assailant. She lives day and night in the midst of her numerous wards, and employs large numbers of emissaries to collect fresh sacks of them from the great forests in or near France. It is not, of course, a mere disinterested affection which has suggested to her these strange proceedings. She keeps only the ants which are "good layers," and sells their eggs at a high profit to the breeders of pheasants, whose taste for that article of food amounts almost to a madness. Until lately human ingenuity has been more usually exercised in inventing methods for the destruction of ants. But as we grow wiser we grow more humane. The police of Paris have removed the ant-house of the inventress to a respectable distance from the town. But she has already established her reputation and a custom which bids fair to make her fortune.—*Globe.*

Rocky Mountain Locust (*Caloptenus spretus*).—C. V. Riley (Entomological Society).—This insect causes an immense amount of devastation; in a short period it devours almost every living plant, leaving nothing but the leaves of the forest trees, and converting a fruitful country into an absolute desert. From a knowledge of the habits of the insect, and believing in its inability to exist in a moist climate, he predicted that its ravages would not extend beyond a certain line, and he had seen these predictions fulfilled. Having noticed that hogs and poultry grew excessively fat from devouring locusts, and considering that the use of them as food for man would tend to relieve some of the distress occasioned in the devastated districts, he had caused a number of them to be prepared in various ways, and they were found to be well suited for food, especially in the form of soup.

Silkworm Culture. — Duseigneur-Kléber (*Nature*).—The author observes :—That the red or black mulberry produces more vigorous worms than the white; that the old notion of selecting bright-coloured cocoons for breeding has given place to the belief that dull yellow are the best; that while the worms are making the cocoons, the ventilation of the buildings, too often neglected, is even more important than warmth.

M. Duseigneur-Kléber has paid much attention to the method of work performed by the worms in the construction of their cocoons. A healthy worm (in disease they act irregularly) selects a suitable spot for its operations, where there is space for its whole body to move about, supporting itself generally by its two last feet only. Having carefully arranged from twig to twig the outline of its work, its movements quicken, and at the end of three hours the first outer layers of its nest are complete, and the sphere of operations is then limited. At the end of five or six hours the exact form of the cocoon is indicated, still remaining diaphanous and rarely coloured yellow. So far it is easy to watch the worm at work, and it is seen that it holds itself in a semicircle, or curved like an S. After a little more work the cocoon loses its transparency, and begins to be coloured. The author, however, by methodically cutting into cocoons continued his observations, and found that the worms never stopped to repair the damages thus caused, but, going on uninterruptedly, the layers formed within the cut layer rapidly covered the aperture. Remaining attached by its hind legs, a worm forms its layers in the shape of an 8, changing its position from time to time, generally moving but a short distance, though sometimes turning completely round and continuing on the opposite side of the cocoon. He calculates that, varying according to race, there are from thirty to forty different layers in a cocoon, and the time occupied in its construction is from three and a half to four days. Whatever may be the condition of the outer layers, the innermost coat formed is of the finest thread, and the end towards which the head is turned is the tenderest, thus providing a soft and elastic cradle for its metamorphosis.

The silk-rearing districts are, besides France, Italy, the Austrian Empire, China, and Japan, the following less known localities :—California, Mexico, Guatemala, Peru, Brazil, Chili, the Argentine Republic, Algeria, and Armenia. In South America, especially, increased attention is being paid to silk production, and it gives promise of becoming a very important industry.

British Wild Flowers and Insects (Abstract of a Lecture by Sir John Lubbock, Bart.).—Sprengel pointed out the close relations which existed between flowers and insects, and the service rendered by the latter in transferring to pollen from the stamen to the pistil; but Darwin was the first to perceive that the importance of this consisted, not merely in the transference of the pollen from one organ to another, but from one plant to another. Everyone, indeed, knows how important flowers are to insects; that bees, butterflies, &c., derive the main part of their nourishment from flowers, but comparatively few are aware, on the other hand, how much the flowers themselves are dependent on insects. Yet it is not too much to say that if flowers are very useful to insects, insects, on the other hand, are in many cases absolutely necessary to flowers: that if insects have been in some respects modified and adapted with a view to the acquirement of honey and pollen, flowers, on the other hand, owe their scent and colours, nay, their very existence, in their present form, to insects. Thus, the lines and bands by which so many flowers are ornamented have reference to the position of the honey; and it may be observed that these honey-guides are absent in night flowers, where they of course would not show, and would therefore be useless; as, for instance, in Lychnis vespertina, or Silene nutans. Night flowers, moreover, are generally pale; for instance, Lychnis vespertina is white, while Lychnis diurna, which flowers by day, is red.

In illustration of the great influence which insects exercise over plants may be instanced those cases in which within a single genus we meet with species having large, and others with small flowers, as, for instance, in Epilobium and Geranium; in which case the large flowers are those most dependent upon insects.

Of course these conclusions implied that insects were capable of distinguishing colours. Sir John Lubbock placed some honey on a slip of glass, and put the glass on blue paper, and when the bee had made several journeys, and thus become accustomed to the blue colour, he placed some honey in the same manner on orange paper. Then during one of the absences of the bee he transposed the two colours, leaving the honey itself in the same place as before. The bee returned as usual to the place where she had been accustomed to find the honey; but though it was still there she did not alight, but paused for a moment, and then dashed straight to the blue paper. No one, he said, who saw this bee at that moment could have had the slightest doubt of her power of distinguishing blue from orange. Again, having accustomed a bee to come to honey on blue paper, he ranged other supplies of honey on paper of other colours, yellow, orange, red, green, black, and white, then he continually transposed the coloured paper, leaving the honey on the same spots, but the bee always flew to the blue paper wherever it might be.

A large number of common flowers are beautifully adapted to secure and profit by the visits of insects, the berberry, heath, dead-nettle, salvia, sweet pea, daisy, cypripedium being striking examples.

The sleep of flowers is also possibly connected with their relation to insects. By keeping flowers in the dark they can be induced to sleep all day, while in other cases they may be kept awake all night by means of artificial light. In short, the observations commenced by Sprengel have shown that insects, and especially bees, have an importance in relation to flowers which had been previously unsuspected. To them we owe the beauties of our gardens, the sweetness of our fields. To them, flowers are indebted for their scent and colour, nay, their very existence in its present form. Not only have the brilliant colours, the sweet scent, and the honey of flowers been gradually developed by the unconscious agency of insects, but the very arrangement of the colours—the circular bands and radiating lines, the form, size, and position of the petals, the arrangement of the stamens and pistil—all have reference to the visits of insects, and are disposed in such a manner as to ensure the great object which these visits are destined to effect. For it is obvious that any blossom differing from the form and size best adapted to secure the due transference of the pollen would be less likely to be fertilized than others; while, on the other hand, those which were rich in honey, which were the sweetest and the most conspicuous, would most attract the attention and secure the visits of insects; and thus, just as our gardeners, by selecting seed from the most beautiful varieties, have done so much to adorn our gardens, so have insects, by fertilizing the largest and most brilliant flowers, unconsciously, but not less effectually, contributed to the beauty of our woods and fields.—*Royal Institution Proceedings.*

Insectivorous Plants.—Charles Darwin—J. Murray, 1875: (*Nature*). See Frontispiece.

For the last fifteen years Mr. Darwin has been steadily and quietly at work, collecting materials and recording long series of observations on "carnivorous plants"; and now at length has given us their results, completely and finally settling some of the points that have been most in controversy, and raising others which suggest some surprising conclusions.

Rather more than one-half of the volume is devoted to the most abundant and readily obtainable of these predatory plants, the common sundew (*Drosera rotundifolia*).

Commencing with a description of the well-known leaves and their glandular appendages, or "tentacles," as he terms them, Mr. Darwin has arrived at the conclusion that the upper part of these latter are glandular hairs or mere epidermal formations (trichomes), but that their lower portion, which alone is capable of movement, consists of a prolongation of the leaf; the spiral vessels being extended from this to the uppermost part. It is not sufficient that the substance which excites the movements of the tentacles should merely rest on the viscid fluid excreted from the glands; it must be in actual contact with the gland itself. While it is the glands or knobs at the extremities of the tentacles, and a very small part of the upper portion of the pedicels, which alone are sensitive or irritable, the actual inflection takes place only in the lowermost portion of the pedicel, causing a bending of the tentacle; and the irritation is conducted from the tentacle actually excited to the neighbouring ones, or to all those on the leaf, in such a manner as to cause them to bend towards the object which produces the excitement. When exciting particles were affixed on glands at two different portions of a leaf of drosera, the result was that all the tentacles near each of these two points were directed towards them, "so that two wheels were formed on the disc of the same leaf, the pedicels of the tentacles forming the spokes, and the glands united in a mass" over the irritated tentacle which represented the axle; the precision with which each tentacle pointed to the irritating particle was wonderful. What makes this result the more extraordinary is that "some of the tentacles on the disc, which would have been directed to the centre had the leaf been immersed in an exciting fluid (as in Fig. 1), were now inflected in an exactly opposite direction, viz., towards the circumference. These tentacles, therefore, had deviated as much as 180° from the direction which they would have assumed if their own glands had been stimulated, and which may be considered as the normal one. We might imagine that we were looking at a lowly organised animal seizing prey with its arms. Fig. 1 displays the leaf of Drosera rotundifolia as it appears when immersed in a solution of phosphate of ammonia, one part to 87,500 of water. Fig. 2 shows the leaf with the tentacles on one side seizing a piece of meat placed in the disc.

When pieces of raw meat were stuck on needles and fixed as close as possible to the leaves, but without actual contact, no effect whatever was produced.

The minuteness of the solid particles which produced sensible inflection was a matter of great surprise. Particles perfectly inappreciable by the most sensitive parts of the human body, as the tip of the tongue—a fragment of cotton weighing $\frac{1}{8000}$, and of hair weighing $\frac{1}{78000}$ of a grain—caused the tentacles with which they were in contact to bend. It is extremely doubtful whether any nerve in the human body, even if in an inflamed condition, would be in any way affected by such a particle supported in a dense fluid, and slowly brought in contact with the nerve; yet the cells of the glands of drosera are thus excited to transmit a motor impulse to a distant point, inducing movement. The only substance which appears to be altogether without effect in producing inflection is rain-water in drops; a singular exception paralleled by the case of certain climbing plants whose excessively sensitive tendrils are irritable to every sort of object which touches them except rain-drops.

The inflection of the base of the tentacle is accompanied by a change in the molecular condition of the protoplasmic contents of the cells of the gland and of those lying immediately beneath it; though the two phenomena are not necessarily connected with one another. If the tentacles of a young but mature leaf that has never been excited or become inflected, are examined, the cells forming the pedicels are seen to be filled with a homogeneous purple fluid, the walls being lined with a layer of colourless circulating protoplasm. If a tentacle is examined some hours after the gland has been excited by repeated touches, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, the purple matter is found to be aggregated into masses of various shapes suspended in a nearly or quite colourless fluid. This change commences within the glands, and travels gradually down the tentacles; and the aggregated masses of coloured protoplasm are perpetually changing their form, separating, and again uniting. Shortly after the tentacles have re-expanded in consequence of the removal of the exciting substance, these little coloured masses are all re-dissolved, and the purple fluid within the cells becomes as transparent as it was at first. This process of aggregation is independent of the inflection of the tentacles and of increased secretion from the glands; it commences within the glands, and is transmitted from cell to cell down the whole length of the tentacles, being arrested for a short time at each transverse cell-wall. The most remarkable part of the phenomenon is that even in those tentacles which are inflected, not by the direct irritation of their glands, but by an irritation conducted from other glands on the leaf, this aggregation of the protoplasm still commences in the cells of the gland itself.

Some who admit the reality of the phenomena now described, have still doubted the digestive power ascribed to the leaves of the sundew, believing that the apparent absorption of the organic substances in contact with the glands is due rather to their natural decay. Mr. Darwin states that the action of the secretion from the glands on all albuminous substances —for it is by these only among fluids that inflection of the tentacles is excited—is precisely the same as that of the gastric juice of animals. The secretion of the unexcited glands is neutral to test-papers; after irritation for a sufficiently long period it is distinctly acid. A very careful analysis by Prof. Frankland of the acid thus produced indicated that it was probably propionic, possibly mixed with acetic and butyric acids; and the fluid, when acidified by sulphuric acid, emitted a powerful odour similar to that of pepsin. If an alkali is added to the fluid, the process of digestion is stopped, but immediately recommences as soon as the alkali is neutralised by weak hydrochloric acid. It is one of the many extraordinary facts connected with this subject that the tentacles of the leaves of drosera retain their power of inflection and digestion long after the separation of the leaves from their parent plant.

As might naturally be expected, salts of ammonia are among the substances which have the most powerful effect on the leaves of drosera. From a most carefully conducted series of experiments from which every possible source of error seems to have been eliminated, it appears that the absorption by a gland of as little as $\frac{1}{268800}$ of a grain of carbonate of ammonia (this salt producing no effect when absorbed through the root) is sufficient to excite inflection and aggregation of the protoplasm. With nitrate of ammonia a similar effect is produced by the $\frac{1}{691200}$ of a grain; while the incredibly small quantity of $\frac{1}{10760000}$ of a grain of phosphate of ammonia produces a like effect. In both the experiments the air surrounding the plant was more or less humid, and the effect was much more intense in the one where the air was the dampest, indicating apparently that the inflection was due to the absorption of the extremely soluble gas by the moisture which was in contact with the tentacles. This would also afford an explanation of the curious fact, that some of the closely adjoining tentacles on the same leaf were much, and some apparently not in the least, affected, if we suppose that they were clothed with larger and smaller amounts of moisture.

With organic fluids the aggregation of the protoplasm and inflexion of the tentacles furnish a most delicate and unerring test of the presence of nitrogen. Benzoic acid, even when so weak as to be scarcely acid to the taste, acts with great rapidity and is highly poisonous to drosera, although it is without marked effect on the animal economy. The poison of the cobra, on the other hand, so deadly to all animals, is not at all poisonous to drosera, although it causes strong and rapid inflexion of the tentacles, and soon discharges all colour from the glands.

The last point of investigation was the mode of transmission and nature of the conducting tissue of the motor impulse from one tentacle to another. In order to be conveyed from one tentacle to another, the impulse has to be transmitted down nearly the whole length of the pedicel; and it appears to be conveyed from any single gland or small group of glands through the blade to the other tentacles more readily and effectually in a longitudinal than in a transverse direction. It can be shown that impulses proceeding from a number of glands strengthen one another, spread further, and act on a larger number of tentacles than the impulse from any single gland. The phenomenon already alluded to, of the aggregation of the protoplasm in a tentacle incited indirectly by the irritation of other glands on the leaf, this aggregation advancing not upwards, but downwards, in each tentacle, partakes of the nature of those actions which in the nervous systems of animals are called reflex. This is the only known instance of the existence of such a phenomenon in the vegetable kingdom. The transmission of the motor impulse in the sensitive leaves of mimosa is in a precisely opposite direction, travelling upwards from the base to the apex of those pinnæ which are indirectly irritated in consequence of the direct irritation of other pinnæ of the same leaf.

In the Venus's Fly-trap, *dionæa muscipula* (fig. 3, leaf viewed laterally in its expanded state), the sensibility or irritability resides in three hairs, or filaments, on each half of the upper surface of the leaf; while the function of absorption appears to belong only to a number of small purplish glands which thickly cover the whole of the upper face. These glands have also the power of secretion; but only when excited by the absorption of nitrogenous matter. The filaments are sensitive both to sudden impact and to contact with other substances, except water; the lobes of the leaf closing together, in the former case very suddenly, in the latter more slowly. If the leaf has closed in consequence of sudden impact or of the contact of non-nitrogenous matter, the two lobes remain concave, enclosing a considerable cavity; shortly re-open, in perhaps twenty-four hours; and are at once again irritable. When, however, the irritating foreign substance contains soluble nitrogenous matter, the lobes of the leaf become gradually pressed closely together, and remain closed for a period of many (from nine to twenty-four) days; and when they again open, if they ever do so, are at first scarcely sensitive to renewed irritation. The absorption of nitrogenous matter by the glands is accompanied by an aggregation of the protoplasm in the cells of the filaments, similar to that observed in drosera, but this result does not follow the simple irritation of the filaments. A series of experiments appears to prove the existence of an actual process of digestion in dionæa, the closed leaf forming a temporary stomach, within which the acid secretion is poured out. The plant seems to be subject to dyspepsia, which is even fatal when it has indulged too freely in the pleasures of the table, or rather of the leaf. These observations, however, come from America, where, in its native land, its habits may possibly be more intemperate than in this country. The motor impulse is transmitted to dionæa as in drosera, through the tissue of the leaf.

Aldrovanda, an aquatic, perfectly rootless genus, also belonging to the order droseraceæ, presents phenomena similar to those of dionæa, possessing sensitive hairs which cause the leaf to close, and glands which secrete a digestive fluid and afterwards absorb the digested matter. The order embraces, in addition, only three other genera, Drosophyllum, Roridula, and Byblis, all of which are provided with secreting glands, possessed, in all probability, of similar properties.

When the painful rumour gained circulation, not many months ago, that *pinguicula* must be added to the list of predatory plants, it was received with even greater incredulity than the stories about drosera. The facts are, however, as patent as in the plants already described. The upper surface of the leaf is studded with glandular hairs of two kinds, one with longish stalks, the other nearly sessile, both of which secrete an extremely viscid fluid; and the dull irritability resides in the blade of the leaf itself, which becomes slowly incurved at the margins over substances that excite its sensibility. Fig. 4 shows the margin of the leaf of Pinguicula vulgaris bending over a row of small flies. This movement of the margin of the leaves (not the apex) is caused either by continued pressure from a foreign solid substance, or by the absorption of nitrogenous matter; water or a solution of sugar or gum produces no curvature; and although the latter, if sufficiently dense, excite a copious increased flow of the viscid secretion, this has no acid reaction. The increased secretion, occasioned by contact of nitrogenous solids or liquids with the glands, is, on the contrary, invariably acid, and possesses the power of rapidly dissolving and digesting insects and other nutrient substances. Some vegetable substances containing nitrogen, as some seeds and pollen-grains, are acted on in a similar manner, so that the butterwort is a vegetable as well as an animal feeder. The secretion appears to be again absorbed into the glands, together with the nutrient substance dissolved in it.

Until the publication of the present volume, very little was known about the habits of the singular genus *utricularia* or bladderwort, of which several species are natives of ditches, especially of very foul water, in this country. Fig. 5 shows a branch of Utricularia neglecta, about twice enlarged. The very finely divided leaves bear a number of minute bladders, about one-tenth of an inch in length, the form of which, as Mr. Darwin points out, bears a very singular resemblance to that of a minute Entomostracan Crustacean. Each bladder is furnished near its mouth with two long prolongations, serving as "antennæ," branching into a number of pointed bristles. On each side of the entrance to the bladder are also a number of bristles; and the entrance is itself almost entirely closed by a movable valve (Fig 6), which rests on a rim or collar, dipping deeply into the bladder, and can only open inwards. The surface of the valve is furnished with a number of glands endowed with the power of absorption, but apparently not of secretion. The whole internal surface of the bladder, with the exception of the valve, is covered with a number of minute bodies, consisting of four divergent arms of unequal length and great flexibility; the collar itself being furnished with similar but two-armed bodies.

The use of these bladders is not merely, like the air-bladders of Fucus, to support the plant in the water; they are employed to capture small aquatic insects and other animals, which they do on a large scale. What it is that attracts the animals to enter the bladders is at present unknown; but, having once entered by pressing down the valve, escape is almost impossible; they sometimes get closely wedged between the valve and the collar, and thus miserably perish. But the most mysterious part of the structure of utricularia is that this beautiful and complicated arrangement for capturing prey is not accompanied by any correspondingly perfect arrangement for its digestion. No secretion whatever has been observed to exude from either the glands or the quadrifid processes; pieces of meat and albumen inserted within the bladders remained absolutely unchanged for three days; and it is only when the bodies of the captured animals begin to decay that the products of decomposition are slowly absorbed.

An epiphytic South American species, U. montana, bears bladders of a similar structure in all essential points, which capture a quantity of minute animals. This species is also furnished with a number of small tubers, which appear to serve as reservoirs of water during the dry season. Several other species were examined, including the Brazilian U. nelumbifolia, found only in a very remarkable habitat, floating on the water which collects in the bottom of the leaves of a large tillandsia that inhabits abundantly an arid rocky part of the Organ Mountains at an elevation of about 5,000 feet above the level of the sea. In addition to the ordinary propagation by seed, this plant is said to put out runners which are always found directing themselves towards the nearest tillandsia, when they insert their points into the water and give origin to a new plant, which in its turn sends out another shoot.

The last genus examined belongs also to the Lentibulariaceæ, the Brazilian genlisea. It is also utriculiferous; but the bladders are of a very different nature to those of utricularia, being simply hollow cavities in the very long petiole or narrow part of the lamina of certain leaves specialised for this purpose. The bladders are not more than $\frac{1}{30}$ of an inch in diameter, and are surmounted by a long tube fifteen times as long and only $\frac{1}{100}$ inch in diameter, which branches at the extremity into two arms coiled in a spiral manner. Very little is known of the habits of the plant, of which only dried specimens have been examined in this country. It is probable that insects creep down the long tube into the bladders, where their remains have been found, and there perish; but whether there is any process of digestion is unknown. The escape of insects once captured is prevented, not by a valve, as in utricularia, but by rows of long thin hairs pointing downwards and springing from ridges which project from the inside of the tube. The inside of the utricle and of the neck are furnished in addition with a number of quadrifid processes, to which the function of absorption is ascribed, and which are compared to the "quadrifids" of utricularia.

The novelty of the results arrived at by the author does not lie in the fact of plants being found to feed on organic matter whether animal or vegetable; physiologists have long been familiar with this power in the case of parasites and saprophytes, the former deriving their nourishment entirely from living organic matter, in some cases animal, in others vegetable; the latter from organic matter in a state of decay; but neither having the power of "assimilating," or obtaining their food-materials direct from the atmosphere and the inorganic constituents of the soil. Saprolegnia and cordiceps are as fully entitled to the designation of carnivorous or even insectivorous plants as dionæa or drosera. The difference lies chiefly in the localisation of the power of absorption, which have not been generally considered to reside in the foliar organs. By far the most interesting facts brought out in this volume are the changes from neutral to acid in the nature of the secretion poured out by the glands of drosera on their excitement by contact with soluble nitrogenous substances; and the alleged "reflex" excitement of the tentacles of drosera. It is impossible to foretell to what these discoveries will lead. —*A. W. Bennett.*

Phenomena of Plant Life.—The expansive power of growing vegetable tissue is something marvellous, if the experiments undertaken by Mr. Clark, president of the State Agricultural College of Massachusetts, are perfectly trustworthy. The greatest weight lifted by the pumpkin in the course of its development he states at nearly 2½ tons. At the end of the experiment the soil was carefully washed from the roots of the pumpkin vine, and the entire system of roots spread out upon the floor of a large room and carefully measured. In addition to the main root, roots were formed at each joint or node. The total length of root developed was calculated to be over fifteen miles: and the time the plant was growing, four months. During the greater part of the time, of course, the rate of growth was relatively slow, but the maximum rate was computed at not less than 1000 feet of root per day.

With another plant of the same species, Cucurbita maxima, an experiment was instituted to ascertain the pressure exerted by the rising sap. For this purpose the plant was cut off near the ground, after it had attained a length of 12 feet, and a mercurial gauge attached to the part left in the ground. The maximum force with which the root of the pumpkin exuded the water absorbed by it was equal to a column of water 48·51 feet in height.

Some experiments to determine the channels through which the crude sap rises, and on the diffusion of the elaborated sap, gave interesting results. Mr. Clark says:—"I find that the crude sap imbibed by the root-hairs from the surface of the particles of the soil seems to be taken up in a dry state; that is, it appears to be absorbed molecule by molecule, no fluid water being visible, and carried in this form through all the cellulose membranes between the earth and leaf, by which it is to be digested or exhaled. I do not say this is literally true, but it accords very nearly with what is constantly to be seen in some species of plants. The circulation of the sap in a poplar tree is very dry compared with that of the blood of any animal. Not a drop of moisture will ever flow from the wood of an aspen, so far as I have observed." It was found that an exceedingly small proportion of sap-wood sufficed to convey the necessary supply of crude sap to the foliage, but none would ascend through the bark.

The quantity of sap that flowed from different trees during the season varied greatly in diverse species. Thus the entire flow from the bitter-nut was less than the product of the sugar-maple for a single day; but the iron-wood and the birches surpass the maple in the rapidity and amount of their flowing. A paper-birch, 15 inches in diameter, bled in less than two months over 1486 lbs. of sap; the maximum flow, on the 5th of May, amounting to 63 lbs. 4 oz. The grape bleeds comparatively little as compared with many other things. A very large proportion of the trees experimented upon did not show any tendency to bleed in spring.

Flora of Spitzbergen. — At least 100 species of flowering plants have been observed. Nearly the whole of the vegetation consists of herbaceous perennials, about one-third being grasses, sedges, and rushes. The nearest approach to woody vegetation are the crowberry, two species of willow, and Andromeda tetragona, an Ericaceous under-shrub, neither of which rises more than a few inches above the soil. Taking the families in their natural sequence, we have—1. Ranunculaceæ: six species of ranunculus. 2. Papaveraceæ: Papaver nudicaule, a pretty dwarf yellow-flowered poppy. 3. Cruciferæ: about eighteen species, including Cardamine pratensis, ten species of draba, and one species of scurvy grass, Cochlearia fenestrata, perhaps the only esculent vegetable found in Spitzbergen, and which has proved most valuable to the crews of the vessels that have touched there. 4. Caryophylleæ: about a dozen species, including the following British—Silene acaulis, Arenaria ciliata, A. peploides, and A. rubella. 5. Rosaceæ: four species of Potentilla and Dryas octopetala. 6. Saxifrageæ': Chrysosplendium alternifolium, Saxifraga oppositifolia, nivalis, cernua, cæspitosa, hirculus, aizoides, and four other species not found in Britain. 7. Compositæ: four species, including the dandelion. 8. Campanulaceæ: Campanula uniflora. 9. Ericaceæ; the little shrub mentioned above. 10. Gentianaceæ: Gentiana tenella, discovered by the Rev. Mr. Eaton in 1872. 11. Boraginaceæ: Mertensia maritima. 12. Polemoniaceæ: one species of polemonium. 13. Scrophulariaceæ: Pedicularis hirsuta. 14. Empetraceæ: the empetrum alluded to. 15. Polygoneæ: two British species, Polygonum vivaparum, and Oxyria reniformis; and Kœnigia islandica, which is of annual duration. 16. Salicineæ: the two species of willow given above. The remaining families—(17) Juncaceæ, (18) Cyperaceæ, and (19) Gramineæ—make up the rest, the latter being by far the most numerous, and embracing several British genera and species.

In a broad sense, the Arctic vegetation closely resembles the flora of the higher Alps, but there is less brilliancy and variety of colour in the flowers, yellow and white largely predominating. The plants assume a dense tufted habit of growth, and increase mainly by lateral branches, which take root and in their turn produce offsets. It is possible some or all of them ripen seeds in certain favourable seasons, but the almost total absence of annual plants, and the habit of growth of the perennials, seem to indicate that this very seldom happens.

Botany of the Island of Amsterdam (*Athenæum*).—The following botanical fact associates itself with meteorological phenomena, being probably directly connected with atmospheric currents:—It is a curious fact that the little island of Amsterdam, in the South Indian Ocean, is known to be covered with trees, whilst the island of St. Paul's, only fifty miles to the south, is destitute of even a shrub. Botanists have long been anxious to determine the character of the Amsterdam forest, but the difficulty of effecting a landing on the island has generally prevented the collection of specimens. In the *Journal of the Linnean Society*, Dr. Hooker announces that at length he has received the desired specimens, these having been collected by Commodore Goodenough, who states that they represent the only species of tree growing on the island. Dr. Hooker identifies this with the Phylica arborea of Thouars, a tree which, strangely enough, is found in the remote island of Tristan d'Acunha. It is a curious problem for those who study insular floras to suggest how the same plant can have established itself on these two little specks of land, separated from each other by about five thousand miles of ocean.

Botany of Victoria.—Baron Mueller, government botanist, Victoria, in his last report gives some interesting details of the results of recent explorations in the Upper Yarra, Hume River, and other districts. As might be expected, although the general physical features and the nature of the flora and fauna of most districts are known, every trip adds new species to those previously known. In the forest regions of the Upper Yarra and the southern branches of the Goulburn River measurements were taken of some of the larger trees of Eucalyptus amygdalina var. regnans, the highest being approximately 400 feet, but it is believed that there are higher specimens, which, however, could not be measured on account of the labour of clearing away the dense jungle to get a base line. The magnificent grass, Festuca dives, first discovered in West Gippsland, was found in the same districts. This grass grows from 10 to 12 feet high, or even as much as 17 feet in the rich soil of the fern-tree gullies. In the Hume district an entirely new tree, "probably of medicinal value," Bertya Finlayi, was discovered. Many Tasmanian forms were traced northwards into New South Wales. A list of additions to the genera of Australian plants during the year numbers fifty, and includes Corynocarpus, Carmichaelia, Ilex, Lagerstroemia, Agrimonia, Embothrium (sect. oreocallis), Ulmus (sect. microptlea), Moræa, Areca, Wolffia, and many others equally interesting to the student of the distribution of plants, besides fourteen absolutely new genera.

Plants of the Libyan Desert observed in Rohlf's Expedition.—P. Ascherson (*Botanische Zeitung*).—The greater part show their struggle with local conditions by their half-globular form, and by having either a minimum or a suppression of leaf surface. The leaves are often reduced to fleshy scales, or overgrown with a protection of thick hair. An armature of thorns and prickles is very common; even in the usually harmless family of grasses the collector is likely to be wounded by the sharp points of Aristidia pungens and Villa spicata. Most of the desert plants are destitute of the pleasant hue of green; only Schouwia schimperi and Scopolia mutica decorate themselves with beautiful broad leaves of that colour. These plants also differ from the majority in their bright purple and dark violet flowers. An inconspicuous inflorescence adapted to wind-blown dust is most common. The seeds are mostly small, numerous, and frequently furnished with feathers or wings, which give them a chance of reaching a spot where they can develop. Nearly all possess the property of working up through the sand as it threatens to overwhelm them. The tamarisk especially exhibits this property, and often reaches a height of from three to five mètres in the sand-hills. The group of stemless palms are exceptions to this rule. Their thick leaves keep the sand back, and they are frequently found at the bottom of sand-hollows. The greater part of the wild plants growing in the oases appear dependent upon the cultivation of those spots, and would soon perish if it were abandoned. Most of them seem wanderers from the Mediterranean.

Transference of Plants during War.—In reference to the fact that German plants were found in French soil after the German invasion, we may state that a similar phenomenon has been observed before. Lepidium draba was introduced into England by the English troops who failed in the attempt to land on Walcheren in 1809. The gain from the herb was probably greater than the loss from the war. In 1814 many plants from the Don became acclimatised in the Rhone valley and vicinity of Paris. The most notable improvement on record of any spontaneous flora is perhaps the addition to the Alsatian grasses by the introduction of Algerian species. These plants, although coming from a warm climate, have secured a firm footing in their new home, and rendered fertile a number of places which had remained up to that time barren and fruitless.

Tree Aloes.—Professor Thiselton Dyer (*Nature*).—The tree-aloes of South Africa rank with the most remarkable of vegetable forms, and until quite recently were almost unknown. These species of aloe are probably only really indigenous in South and East Africa, though A. vulgaris is widely spread in the Mediterranean region and elsewhere, but only as a cultivated plant, or an escape from cultivation. A. indica of Royle is doubtless a variety of the preceding, as is also probably A. littoralis of Koenig, found at Cape Comorin, the difference in character being due to altered conditions of situation. In some rocky districts the tree-aloes form the dominating feature of the landscape, giving it a very peculiar appearance. The eastern species occasionally attains a height of 60 feet. There are two species of tree-aloe in South Africa —one endemic on the west coast, and the other confined to the east. That of the west, A. dichotoma, Linn., extends from Walvisch Bay to Clanwilliam. It is well described in Paterson's *Travels in Africa* (1789), but otherwise very little known. The present Governor of the Cape, Sir Henry Barkly, has made great exertions to procure plants for Kew, and two have now arrived in this country, the largest being eight feet in height. The eastern species, A. Barberae, Dyer, was named in honour of Mrs. Barber, who first sent cuttings of it to this country. A. dichotoma attains a height of thirty feet, with a girth of about twelve feet. A. Bainesii, Dyer, turns out to be the same species as A. Barberae, the character of scattered or clustered leaves having broken down in this instance. The specimen named Barberae had its leaves originally arranged in rosettes at the ends of the branches, but as it grew they became distant and scattered. There are still some slight discrepancies to clear up with regard to the flowers.

Gum Copal Trees of Dar-es-Salam, Zanzibar.—Capt. Elton. —The author fully endorses Dr. Kirk's report, published in the *Linnean Society's Journal*, for he was astonished at the immense number and size of these trees, far exceeding anything he had before imagined. The height of an average tree is about sixty feet, and the girth at bottom upwards of four feet. On stripping off the bark, the gum was found deposited in many places between it and the wood in a liquid form. The trees are suffering greatly from the attacks of swarms of ants and other insects, and are being slowly but surely destroyed, piece after piece, branch after branch. They are all festooned with the long intertwined ropes of the india-rubber uiana, the thickly-matted cords of which, pendant from the main limbs and knotted into a sort of rigging, become an easy means of ascent to the natives looking for the resinous deposits on the branches. This india-rubber was worked rather extensively here at one time, but was soon given up as unprofitable, in consequence of the number of slave-lads carried off by leopards.

India-Rubber.—A new source of caoutchouc has been discovered in Burmah. The plant yielding this caoutchouc is the Chavanesia esculenta, a creeper belonging to the natural order Apocyneæ, an order which includes the Borneo rubber plant, *Urceola elastica*, the African rubber plants, *Landolphia* spp., as well as other genera yielding milky juices. The plant, which is common in the Burmese forests, is said to be cultivated by the natives for the sake of its fruit, which has an agreeable acid taste. It comes into season when tamarinds are not procurable, and finds a ready sale at Rangoon, at an anna per bunch of ten fruits. The milk is said to coagulate more readily than that of Ficus elastica, and to be purer and better for most purposes for which rubber is used.

In his last report of the progress and prospects of the cultivation of various useful trees in India, Dr. King speaks of the caoutchouc-yielding trees, and the difficulties attending their cultivation. But his account of the Assam india-rubber tree, *Ficus elastica*, whose large glossy foliage is familiar to almost everybody in this country, excites some surprise. He writes: "The rubber of this country (India) is obtained from fig-trees, most of which (at least in early life) are parasitical [by which he means, of course, epiphytical]. These figs begin life by establishing themselves on the tops of other trees, along the trunks of which they send their twining aërial roots, which ultimately reach the ground. In course of time the supporting trees are killed, but the figs remain and grow, often entirely obliterating their predecessors. It is from the long aërial roots that the rubber is mostly got, and not from the branches. After a few severe tappings a fig ceases to yield rubber from its roots. The number of rubber trees, even in a country like Assam, is limited, and it is easy to foresee their early exhaustion. It is true it is also easy to propagate these figs by cuttings, but plants produced from cuttings put into the soil cannot very well have aërial roots, and may consequently be expected to yield little, if any, rubber. The artificial formation of india-rubber plantations on the summits of tall forest trees is obviously impracticable." Now, it has long been known that these india-rubber trees are epiphytical, but it seems far more probable that the mode of growth referred to simply renders it difficult to extract the caoutchouc until the roots come down within reach, not that they represent the principal seat of its secretion. Indeed, if this really be the case, it seems quite inexplicable, for this secretion pervades the whole system. However, it can be only partially true. The aërial roots of Ficus elastica are not only produced from the epiphytical examples, but also from those growing in the ground. Mr. Mann, and other writers, describe them as running along for a distance of thirty or forty feet on the surface of the soil, and mention the fact that the collectors tap the lower parts of the stem and these trailing roots. Looking into Mr. Mann's report on the same subject, he specially mentions the reckless felling of large trees to obtain the caoutchouc more readily; and in reference to the cultivation of the tree in question, he says that planted trees would yield at half the age a naturally grown tree would, as in the latter case several years elapse before an aërial root can reach the ground and establish itself. Dr. King's argument in favour of growing the Parà caoutchouc, *Hevea brasiliensis*, on this ground must fall through; but as the latter is reported to furnish the best quality of caoutchouc, there is a good reason for attempting its cultivation.—*Nature.*

Alpha Fibre, or Esparto Grass (*Machrochloa tenacissima*, Kth.).—This plant has created more than usual interest of late, owing to the report that the supply was becoming exhausted. In contradiction to this it is satisfactory to note, on the authority of Colonel Playfair, the Consul-General at Algiers, that enormous tracts of land on the high plateaus in all the provinces of Algeria, are covered with the plant. Thus, in the province of Algiers it covers an area of about 2,500,000 acres. In the province of Oran the extent of the Alpha growth is almost unlimited. In the circle of Daïa it is stated to cover a space of about 900,000 acres, while in the subdivision of Mascara there is an immense field for its exploration. In the several divisions of the province of Constantine it is estimated that a total of about 570,000 acres are under growth of this substance. These figures alone show an aggregate of some 3,970,000 acres of Esparto known to exist in Algeria. The difficulty, however, is in the want of proper roads or easy means of transport by which the material could be brought to the sea or a railway station. Colonel Playfair says that practically there is no limit to the supply of alpha procurable from Algiers; all that is required is the establishment of railway communication, and the government of the colony is prepared to sanction the construction of lines, either by French or foreign capitalists, on the most liberal terms. Several companies have been formed for the purchase and exportation of this fibre, which is becoming more sought for in proportion to the increasing demand for paper. The Algerian authorities are quite alive to the necessity of encouraging all such commercial enterprises as may tend to develop this important branch of commerce. The exportation of this fibre for paper-making has increased very rapidly during the past five or six years. In 1869 it amounted to 4000 tons, in 1870 it rose to 32,000 tons, and in 1873 to 45,000 tons, while the past year's produce was expected to reach 60,000 tons. The average price at Oran is about 140 francs per ton.

Jute.—Two species of Corchorus, C. capsularis and C. olitorius, are generally accredited as the sources from whence the fibre well-known as jute, so largely imported for carpet and other descriptions of weaving, is obtained. These plants are chiefly grown in Bengal, but in the Madras Presidency Hibiscus cannabinus and Crotolaria juncea are popularly termed jute; so that some confusion has arisen as regards the identification of the plants yielding jute in India. This question has recently occupied the attention of the Government of Bengal, and from inquiries instituted it appears certain that the true jute (Corchorus) is not found in the Madras Presidency, and that the fibre sent from thence as jute is really referable to Hibiscus and Crotolaria.

The Gombo Plants of the Mallow family have long been known to yield useful fibres as well as mucilage. MM. Bouju Frères (*Comptes Rendus*) state that they have devised a mechanical process of treating the stems of Gombo (*Abelmoschus*, or *Hibiscus esculentus*) so as to afford a pulp which can be converted into good paper—equal, so it is said by M. Landrin, to the best made from rags. The plant grows abundantly in Syria and Egypt, and is cultivated for its edible fruits. The MM. Bouju previously patented methods of using the fibre for cordage and woven fabrics. Gombo paste, sometimes used in medicine, is made from a gummy and mucilaginous substance, extracted from the plant by water, which the French have named gombine. An analysis of gombo gives—

Water	13·82
Gombine	19·50
Cellulose	60·75
Resin	0·93
Mineral matters	4·75
Substances not reckoned	·25
	100·0

The Ramie, or China Grass Plant (*Bœhmeria nivea*).—This plant has excited much interest of late owing to its proposed extended cultivation in India. It seems to thrive in Cayenne, specimens having been shown at a recent exhibition in that colony and compared with plants grown in France. The Cayenne plants, which were grown on a comparatively poor soil, without manure and with little or no attention, were double in size and height to those grown in France. Three successive shoots were produced in one year.

Victoria Regia.—The Botanical Gardens at Ghent contain an aquarium in which is cultivated a Victoria Regia that has attained a large development. The head gardener, M. von Hulle, was recently struck by observing the force that was required to immerse the floating leaves in the water. He saw one of them support a child, and another was not even submerged by the weight of one of the gardeners. He was led to experiment as to the limit of this resistance—loading the surface of one of the largest leaves with bricks. It was found to bear a weight of 346 kilogrammes: that is to say, nearly equal to three men of average stature and corpulence.

Quinine.—As an instance of successful acclimatisation, the introduction of chinchona cultivation into British India is most remarkable. For the plants have not only been transplanted from one quarter of the globe to another, but they have been converted from wild to cultivated products. The beneficial results of bringing quinine and the other febrifuge alkaloids in the chinchona bark within the reach of the people of India certainly cannot be exaggerated. Chinchona cultivation in India was commenced in 1861. In 1874 there were 2,649,033 plants on the Government plantations of the Nilgherry Hills alone; besides private plantations, among which 234,531 plants and 469¼ ounces of seeds have been distributed. In the same year, 91,773 lbs. of bark were supplied to the manufactory, for the preparation of quinine, in a cheap form for use in India, the value of which was 2,294*l.*; and 1,181 cases of East Indian and Ceylon bark were sold in the London market. The tallest chinchona tree on the Nilgherry Hills is now thirty-two feet high, with a girth of 28½ inches.

Florida Cedar.—Steps have been taken to acclimatise the Florida cedar in Bavaria. The superiority of the wood of this tree (*Juniperis Virginiana*) over all other kinds of cedar, is well known, and the demand for the wood in Bavaria, where immense quantities of lead-pencils are made, has induced some manufacturers to take up the question of the acclimatisation of the tree in that country. Seeds have been sown in the Royal Forest, and about 5,000 young plants have been grown on one private estate: the cultivation of the tree is also being attempted in other parts of Germany.

Protection of Vines from Frost.—For this purpose the production of large artificial clouds of smoke is a common appliance in France and Germany. G. Vinard's methods of creating the smoke is easily executed, and has proved successful; it consists in carefully mixing gas-tar with sawdust and old straw, and piling up this mixture into large heaps in the vineyards. The mixture remains easily inflammable, in spite of rain and weather, for more than a fortnight. When required for use, smaller heaps are made from the large ones, of about two feet in diameter, and are distributed in and round the vineyard. If there is little wind these heaps burn freely for about three-and-a-half hours, and produce a very dense smoke. The artificial cloud which thus enwraps the vines considerably decreases the radiation from the ground, and with it counteracts frost, which is greatest towards morning during calm spring nights, and which does so much harm to the plants.

Boxwood.—The wood of Buxus sempervirens, which is almost exclusively used for the best kinds of wood-engraving, has been for some years becoming more and more scarce. Wood of the largest diameter is the produce of the forests of the countries bordering on the Black Sea. Large quantities are produced in the neighbourhood of Poti, from which port the wood is shipped direct to England. The supply, however, from this port is becoming fast exhausted; and it is said, unless the forests of Abkhassia are opened to the trade, it must soon cease altogether. The quantity exported from Poti during the year 1873 amounted to 2,897 tons, of the value of £20,621; besides this, from 5,000 to 7,000 tons of the finest quality annually pass through Constantinople, being brought from Southern Russia, and from some of the Turkish ports of the Black Sea for shipment, chiefly to Liverpool. An inferior and smaller kind of wood supplied from the neighbourhood of Samsoon is also shipped at Constantinople to the extent of about 1,500 tons annually. With regard to the boxwood forest of Turkey, the British Consul at Constantinople reports that they are nearly exhausted, and that very little really good wood can now be obtained from them; in Russia, however, where some little Government care has been bestowed upon forestry, a considerable quantity of choice wood still exists; but even there it can only be obtained at an ever-increasing cost, as the forests near the sea have been denuded of their best trees. The trade is now entirely in English hands, although formerly Greek merchants exclusively exported the wood. In the province of Trebizonde the wood is generally of an inferior quality; nevertheless, from 25,000 to 30,000 cwts. are annually shipped, chiefly to the United Kingdom.—*Nature.*

The Potato Fungus (*Peronospora infestans*) (*Academy*).—One of the most important discoveries of recent times in vegetable microscopy has fallen to the lot of Mr. Worthington Smith, who has been the first to detect, or rather to determine, the resting-spore of peronospora infestans. For this signal service to science the Council of the Royal Horticultural Society have unanimously conferred upon the discoverer the Gold Banksian Medal. It would be difficult to overrate the importance of this last step and final link in our knowledge of the life-history of the potato-fungus, and Mr. Smith may well be envied his good fortune in finding what has baffled the investigations of the most expert fungologists for so many years. Moreover, it is very gratifying at the present moment to be able to claim this honour for our countryman. The following is a brief sketch of the history of enquiries into the nature of the organism attacking the potato-plant. As long ago as 1845 and 1846 Dr. Morren on the Continent, and the Rev. M. J. Berkeley in this country, declared their conviction that the disease was caused by a fungus. Montagne, who was one of the first to investigate the matter, does not appear to have held steadfastly to this view, though he was perfectly aware of the presence of the fungus in diseased haulm. Even at that date nearly as much was known of the life-history of this fungus as we knew previous to Mr. Smith's discovery, and soon the true nature of the conidia and zoospores was settled. Indeed, oospores (resting-spores), were seen and figured by Montagne—who, however, failed to recognise them as such, and gave them the name of artotrogus. Mr. Smith has examined the preparations for the microscope made at the time, and declares the artotrogus of Montagne and Berkeley to be identical with the bodies discovered by himself. The antheridia and oogonia are found on lateral branches of the mycelium within the tissue of the leaf; the former is ·0004, and the latter ·001 of an inch in diameter. The oosphere is fertilised by conjunction with an antheridium, the latter fixing itself to the former by a pollinodium or fecundating tube. This tube penetrates the oosphere, and discharges part of its contents into the protoplasm of the infant resting-spore. The mature oospore, or resting-spore, becomes free, and may lie dormant for some time; but the simple spores and zoospores, which are borne on slender threads protruding from the epidermis of the leaf, simply serve to propagate the fungus during the summer. Now that we know that the resting-spore of peronospora infestans is actually produced in the haulm of the potato, and not exclusively on a different plant, as has been conjectured, there is a better chance of our being able to cope with it. One thing is certain: we cannot be too particular in burning affected haulm and tubers, and fresh ground should be preferred where there is a choice.

"Edible and Poisonous Mushrooms and Toadstools."—John Sadler (Edinburgh Pharm. Soc.).—There are no fewer than 600 genera and 500 species of these fungi; and these are so widely distributed that it is difficult or impossible to say where they are not to be found. The potato disease and vine blight are believed by some to be caused by a certain development of minute fungi, which also attacks at times animals, and even man himself.

It is exceedingly difficult to distinguish between the edible and poisonous fungi. Among those considered poisonous are the fiery-milk, satanical tube, and fly-mushrooms. The effects of partaking of the latter are often very remarkable and sometimes fatal. The great cheerfulness which is first induced is followed by giddiness, and at length by a kind of drunkenness, one of the symptoms of which is that to the eyes of the patient every object becomes immensely larger than it really is. A straw lying on the road, for instance, becomes so formidable an obstruction that a person under the influence of this mushroom would take a running jump in order to clear it.

Only young, fresh, and sound mushrooms are to be gathered; and these should be cooked as soon as possible, and partaken of in moderation. When they become black, though originally edible, they are actually poisonous.

Cultivation of the Oak.—Oak timber is rapidly disappearing from Europe, although half of the area of Sweden, one-fourth that of Norway, one-sixth that of Switzerland, and 780,000 square miles in European Russia are stated to be yet in forest. The consumption of oak in France has doubled during the last fifty years; she requires 15,000,000 cubic feet yearly for wine casks alone, 750,000 cubic feet for building purposes, 600,000 cubic feet for her fleet, and 150,000 cubic feet for railway cars. £800,000 worth of staves were imported in 1826; £5,000,000 worth are now needed. Since losing Alsace and Lorraine, France contains 135,000,000 acres; 20,000,000 of this surface is covered with forest. In Norway the Administration of Forests declares that it is necessary to stop the cutting of timber. Holland and Belgium are nearly denuded of timber, and are large importers. North Germany is rich in forest, but within half a century has begun to cut down young trees. Austria has sold her forests since railways have been introduced. In Italy no forests remain. Spain and Greece are almost absolutely woodless. The southern coasts of the Mediterranean are almost forestless. Wood, for all purposes of construction, is becoming scarcer and dearer in all parts of the United States, yearly. In the Dominion of Canada it is yet abundant, though rather farther to seek. Only in St. Domingo and Central America, on the southern shores, and of their rivers flowing into the Caribbean Sea, and in Guiana and Trinidad, are there virgin forests of good timber remaining, to supply the failure of the forests in Europe and the United States.

Russian Forests.—P. N. Werekha.—The extent of the forests of Russia in Europe is about 442,897,500 acres, or 40 per cent. of the whole area. The forests are very unequally distributed, and internal communication is still very imperfect in many parts of the empire; hence much of this wealth is at present unavailable. Every year, however, the facilities for transport are increased, and there is a corresponding augmentation in the amount realised. The principal trees are the Scotch pine, spruce fir, larch, birch, lime, aspen, and oak. To these may be added for the governments of the South, though relatively playing an unimportant part in commerce, the elm, ash, beech, hornbeam, maple, various poplars and willows, &c. The value of the forest products exported in 1871 amounted to 16,026,553 roubles, of which more than one-third came to this country. In Russia, wood is still either the only or the principal fuel used. The railways consume wood for fuel to the annual value of 7,200,000 roubles. Wooden drinking-vessels, platters and spoons, take the place of pottery and metal in many districts, except in the houses of the rich. The author estimates that 40,000,000 wooden spoons are made every year.

But the most destructive industry, so far as the forests are concerned, is the manufacture of bast mats, bark boots (lapti), cordage, and other articles prepared from the liber or inner bark of the lime, birch, and willow, chiefly of the former tree. It is computed that 100,000,000 pairs of lapti are made annually, each pair requiring the bark of four young trees; thus 400,000,000 trees are cut down every year for shoes! Lime-trees from five to ten years of age, and half-grown birch, are employed for this purpose. Such reckless waste is much to be regretted. Moreover, the pines are tapped for their resin and bled to death in from ten to fifteen years, in the same way as the Landes of Gascony were denuded of their pine-forests during the last century.

The previously almost useless aspen, either for fuel or building, has attained to considerable importance within the last few years as a material for paper-making. There are already ten manufactories actively engaged in the preparation of this paper in Russia, and two in Finland; and as vast reserves of this tree have accumulated in the forests, it is expected to prove a source of great riches for many years to come. Timber, of course, is the most valuable article exported, though resinous products and bast mats bring in a large sum. The Scotch pine, spruce fir, birch (for coach-building), and the oak, are the principal and almost the only timbers exported.

GEOGRAPHY.

The Gold Medals placed at the disposal of the Royal Geographical Society by the Crown were in 1875 awarded as follows: the Founder's Medal to Lieut. Weyprecht, for the enterprise and ability he has displayed in the command of two expeditions to the sea between Spitzbergen and Nova Zembla; for his discovery of new lands in the same sea; and for the scientific observations made during his voyages: The Patron's Medal to M. Julius Payer, for the service he has rendered to geography by his explorations in the Arctic regions; first, as member of the North German Expedition of 1869-70, in East Greenland, and afterwards, as second in command to Lieut. Weyprecht, in the two Austrian Expeditions to the Nova Zembla Sea of 1871 and 1872-4, during the latter of which he led the sledge-party in exploring the coasts of the newly-discovered Franz Josef-Land.

Madagascar.—Joseph Mullens, D.D.—There has hitherto been a great lack of geographical information about the interior of Madagascar. Dr. Mullens and Mr. Pillans have brought home some beautiful specimens of cartography, from which a new map of the country they traversed has been prepared. It is now discovered that the central provinces of Madagascar have been the scene of volcanic phenomena on an enormous scale. The Ankarat mountains, which are visible from the capital, cover a space of 600 square miles. The five central peaks attain a height of from 8,000 to 8,950 feet above the sea. In the neighbourhood of Lake Itasy, 25 miles beyond this extinct volcanic centre, is another extraordinary volcanic region, and here crater after crater is met with. Upwards of forty craters of varying sizes were visited and mapped by the missionaries, and others are supposed to exist beyond to the north. Fifty miles further south are three groups of volcanoes; altogether, in one journey, the travellers saw and counted not less than 100 extinct craters, extending over an arc of 90 miles, without reckoning the Ankarat range.

This volcanic belt is continued northward, and is evidently connected with the system of volcanic peaks which form the islands of Nosibé, Mayotta, and Johanna, &c. The great Comoro is now the active vent, where eruptions on an enormous scale are frequent, while it is not improbable that there is also some connection with the more distant volcanoes at Bourbon and Mauritius. Sir Bartle Frere agrees with Dr. Mullens in considering Madagascar in remote ages to have formed a portion of that great submerged continent which some naturalists believe to have extended hence to the Malay Peninsula, of which a few peaks only now remain at Seychelles, Rodriguez, Mauritius, &c.

Dr. Mullens believes the Malagasy people to be a single race, and that there is no evidence that the original inhabitants were Africans. He divides the Malagasy into three tribes, viz., the Betsimasarakas, the Sakalavas, and the Hovas. He shows the total population to have been considerably over-estimated by former writers, and places it at

2,500,000. The Malagasy are a Malay people following Malay customs, some of them possess Malay eyes, and hair, and features, and all of them speak a Malay tongue at the present hour.

In August, 1865, the mission was organised at the capital; the then reigning queen was a heathen. She was succeeded by the present Ranavalona, at whose coronation all symbols of idolatry were excluded, whilst the Bible was placed conspicuously at her right hand. In February of the following year she was baptized, and on the 8th of September, 1869, the idols of the nation were, by her command, committed to the flames; and this was immediately followed by the destruction of all the village and private idols by their possessors throughout Imerina. The fruit of the seed sown seventy years ago by the London Missionary Society had at length ripened. Such a religious revolution has scarcely been heard of.

The fourth memorial church was opened on March 28th, 1874. The alteration in the Great Palace, by the addition of a verandah of stone pillars, and the stone towers or bastions added to it by Mr. Cameron, has thoroughly destroyed the more picturesque appearance of the timber structure of 1862, and the total absence of the steep-roofed houses, with long cross gable-ends, destroys one of the characteristic features of the city in earlier days. The European-looking church at Ampamarinana, with its campanile tower and wheel-windows of stained glass, and the spire of the Royal Church near the Palace, give the whole place a thoroughly European air, whilst Swiss and English-looking "villas" are springing up everywhere.

Lake Tsad and the White Nile.—Dr. Nachtigall (British Association).—The author has made an examination of the physical character of Lake Tsad, and of the remarkable depressions of the Bahr el Ghazal and of Bodele, which lie east of it; and also has investigated the nature and origin of the Shari river and its branches, which are the main feeders of the Tsad. This lake or basin, covers an area of not less than 10,500 English square miles, or has about the same extent as the island of Sicily. The interior does not consist of open water, two-thirds at least being filled up with islands. Travellers may cross the southern portion of the Tsad in spring and summer without being aware that they have passed through a lake, because the branches which separate the islands are then perfectly fordable by beasts of burden. On the central islands live the savage Budduma, on the eastern the Kuri, and from the north-east shore many of the people of Kanem have passed into the interior of the Tsad, their proper country having been rendered uninhabitable by the Arab robbers. Between the islands the Budduma people navigate their light boats, and prove a constant source of dread to the shore peoples, but carry on some trade at special points in ivory and in natron, which is found in many places on the banks and islands, although the waters of the Tsad are everywhere sweet and fresh. The Bornu people carry this natron westward to the markets even beyond the Niger. The Tsad changes its outline continually; its lowest stage occurs towards the end of June, and it reaches its highest stage in the end of November. There are also lasting movements of change in progress over the greater part of its basin of depression which offer some exceedingly remarkable phenomena.

The northern portion of the Tsad is extending itself gradually in wide bays, some of which are so recent as not yet to have received names from the Arab nomads; and on the western shore the waters have made such advances during the past years as to cause the capital of the kingdom of Bornu to be transplanted from the town of Kuka, which the waters threaten to inundate, to a higher ground farther north. A broad wooded valley stretches east and north-east of the Tsad. Both this valley, called the Bahr el Ghazal, and the valley of the Bodele are said to have been, in no very remote times, filled with water and connected with the Tsad; at the present time the whole of their depressions are scattered with the dorsal bones of fish, and Dr. Nachtigall's barometer observations show that both are considerably below the level of the Tsad. Such being the case, it is a question of the highest interest in physical geography how this great depression became disconnected with the Tsad, and to what causes the drying up of this region are to be ascribed.

Lake Victoria, Nyanza.—Lieut-.Col. C. C. Long (Royal Geographical Society).—Col. Long left Gondokoro on the 24th of April, 1874, charged by Col. Gordon with a friendly mission to the powerful King of Uganda (King Mtesa), and accompanied by two Egyptian soldiers and two servants. The journey occupied fifty-eight days, at the end of which the party was rewarded by the sight the richly-cultivated central district of Uganda, appearing like a great forest of bananas. King Mtesa received the envoy with great friendliness, and ordered thirty of his subjects to be decapitated in honour of the visit. Permission was given Col. Long to descend "Murchison Creek" and view Lake Victoria. The journey from Mtesa's residence occupied three hours, and the party embarked on canoes made of the bark of trees, sewn together. Col. Long sounded the waters of the lake, and found a depth of from 25 to 35 feet. In clear weather the opposite shore was visible, appearing "to an unnautical eye" from twelve to fifteen miles distant; he did not think he could possibly be greatly deceived in this estimate, Speke's numerous islands being really the shore of the opposite side. After much negotiation and opposition, he obtained permission to return to Egyptian territory by water, and on the way, in lat. 1·30, discovered a second lake, or large basin, at least twenty or twenty-five miles wide. He found the Upper Nile from Ripon Falls to Karuma Falls a fine navigable stream large enough for the *Great Eastern*. He finally reported from Gondokoro (October 20) that Col. Gordon would soon have a steamer on Albert Nyanza, and intended also to move one to the Upper Nile above Karuma.

On the Project for Letting the Waters of the Atlantic into the El Juf Depression of the Western Sahara.—Gen. Sir Arthur Cotton (British Association).—This project originated with Mr. M'Kenzie, a young engineer, who is now endeavouring by public subscription to obtain the means for carrying into effect a preliminary survey. The El Juf depression was believed to be an area of great but unknown extent lying below the sea-level in the interval between Timbuctoo, the southern foot of the Atlas, and the west coast opposite the Canary Islands. Its former connexion with the Atlantic was by means of the now dry bed of the Belta, situated on the coast between Cape Juba and Cape Bojador, and great hopes are entertained that, by means of a short canal or opening through a littoral ridge or elevation of no great width, the El Juf may be again filled with water, so as to form a deep gulf or sea admitting of ships, carrying commerce and civilization into the heart of North-western Africa. The depression of the El Juf, according to Sir Arthur, is "mentioned in several papers;"

but the only evidence adduced was that of a Capt. Riley, who was shipwrecked on the coast, and afterwards taken prisoner and carried across the hollow!

Mr. Donald Mackenzie with reference to this scheme lately had an interview with the Lord Mayor. Mr. Mackenzie, whose principal coajutor appears to be Mr. Skertchley, proposes to remove the barrier of sand which now obstructs the mouth of a river opposite the Canaries, and asserts that the waters of the Atlantic will then fill up a tract of the Western Sahara, 126,000 square miles in extent, and enable vessels to get within a short distance of Timbuktu. The Lord Mayor referred to an "eminent" engineer who considered this scheme to be easy of accomplishment. Such an enterprise is utterly impracticable; there exists no evidence whatever which justifies the assertion that the tract known as "El Juf," or the belly of the desert, is depressed below the level of the ocean. Under any circumstances, table-lands of some height separate it from the Atlantic. Nor do we see how the waters of the latter are to get to Timbuktu, or even within a reasonable distance of it, for that town lies 1,200 miles up the Niger, and at a considerable elevation above the sea.

Libyan Desert.—The topographical results of G. Rohlfs's expedition are embodied in a map by W. Jordan, one of the members of the expedition. This map constitutes a most important contribution to African geography. Its value is enhanced by the numerous geological and botanical notes inserted upon it. Limestones of tertiary age and cretaceous rocks predominate, Nubian sandstones being limited to the region south of lat. 250° 30′ north. A vast "sea of sand," which Rohlfs crossed in a N.N.W. direction for a distance of about 400 miles, on his road to Siwah, forms a striking feature of the map. The oasis of Siwah was found to be depressed 95 feet below the level of the Mediterranean; that of Araj, to the south-east of it, lies 246 feet below the sea-level.

The Site of Pisgah.—J. L. Porter (*Athenæum*).—On Friday, the 15th of April, 1874, I left Hesbân, with three companions. We rode across the rich plateau of Moab, in a south-westerly direction, for an hour and a quarter, and then reached the edge of the plateau, where it begins to break down, in rocky irregular slopes, to the great valley of the Jordan. A little below the brow of the descent, about five miles from Heshbon, we passed through ruins covering several acres. They were of the oldest type, and consisted of heaps of large, roughly-hewn stones, massive foundations of houses, with rude caves and excavations in the rocks. I asked our Arab sheikh the name of the place, and he replied Khurbet Siâghah, "the ruin of Siâghah." I had never heard the name before, and the thought at once occurred to me that it might be a corruption of the Hebrew Pisgah. In Arabic there is no P, but the other radical letters of the Hebrew word are retained in Siâghah. That there might be no mistake as to the name, I afterwards asked a shepherd, and he gave me the very same name.

The ruins lie on a gentle declivity, which descends to the wild ravine of Ayûn Mûsa; while, on the south, is a steep ascent to a rounded hill, which projects boldly from the plateau of Moab, and commands an extensive view of Western Palestine. I asked the name of the hill, and the reply of our Arabs was Jebel Siâghah, "Mount Siâghah." The summit of the hill seems to be a little higher than the table-land which extends up to it, rich in soil, and partially cultivated. From the summit one gets the first full view of Jeshimon, or Wilderness of Judæa; and the whole topography appeared to me to correspond exactly with the narrative in Numbers xxiii. and xxiv.

From the ruins of Siâghah I saw, about due west, a rounded peak, connected with the N. W. side of Jebel Siâghah by a low, narrow neck of land. We ascended the peak, and reached the summit in twenty minutes from Siâghah: the distance is thus about a mile. I found here the ruins of an old town covering the summit and sides of the hill. On the top are the remains of a Roman castle, with a large arched tank in the centre, now nearly filled with stones and broken columns. Outside the castle are ruins of an older date. The name of both peak and town is Neba or Nebbeh. The summit of Neba I estimated at about 400 feet lower than Jebel Siâghah, but it (Neba) commands a much fuller view of the Jordan valley, the Dead Sea, and the plain of Jericho. Neba is unquestionably the town Nebo mentioned by Eusebius as six miles from Heshbon, towards Jericho, a position exactly corresponding with that of these ruins. It is evident, too, from the Scripture narrative in Num. xxxii. 3; xxxiii. 47; Deut. xxxii. 49 and xxxiv. 1, that in the time of Moses, Nebo was a town which gave its name to a section of the mountain ridge beside it; and such is the case still.

I paid special attention to the view from Nebo, and compared it with that described in the account of the death of Moses. In the foreground, far below, lies the whole plain of Jericho, with the valley of the Jordan on the northern shore of the Dead Sea, where the Israelites encamped, then called "the plains of Moab." On the north is seen the range of Gilead, as far as its culminating point at Jebel Osha, the ancient Mizpah of Gilead; but all north of that peak, including Hermon, is shut out. On the north-west I saw, through the long vista of the Jordan valley, the heights of Naphtali and southern part of Lebanon. The whole outline of Western Palestine from thence to Hebron is visible, but I could see no part of the Mediterranean.

From Neba I rode, in half-an-hour, down a difficult zigzag path to Ayûn Mûsa, "the fountains of Moses," which spring up under a great cliff in the bottom of the wild glen to which they give their name. From the fountain the peaks of Siâghah and Neba are both visible; and it was most interesting thus to find the names Moses, Pisgah, and Nebo still clinging to this spot. I think it highly probable that the fountains of Moses are identical with Ashdoth Pisgah, "the springs of Pisgah," mentioned in Deut. iii. 17.

Ashkelon. — Professor Pusey lately called attention to the fact that, just as there were a Gaza and a Maiumas Gazæ, or "Gaza by the Sea," so there were, in the sixth century, at least, an Ascalon and a Maiumas Ascalon, each place having then a bishop of its own. He also pointed out that Benjamin of Tudela speaks of the present Ascalon as the new town "built by Ezra the priest on the sea-shore," four parasangs from the former place of the same name. Lieut. Conder has discovered that both places exist still. The ruined Ascalon by the sea-shore has been long known and frequently described. The site just discovered, called Khirbet Ascalon, is in the hills north of Beit Jibrin, near Tell Zakeriyeh. It shows remains of an early Christian church or convent, and a great lintel of stone, with a deeply-cut cross in the centre, resembling somewhat the cross of Malta, lies on the ground. Such lintels are to be found in all that class of ruins which date from the fifth to the seventh century. It is twenty-three miles from the shore, which would seem to agree with the four parasangs measured to Ashdod. Lieut. Conder concludes that the Ashkelon of the Bible, of Herod, and of the Crusaders, are one and the same place, distinguished from an early Christian site of the same name by the title of Ascalon Maiumas. The numerous Crusading fortresses in the great plain, which was the scene of so many conflicts between the English and Saladin, have been pretty nearly all identified in the course of the survey.

Bethabara.—The place where John baptised has recently been identified. Lieutenant Conder points out that the site hitherto generally received, Bethnimrah, is too far south, one condition being that the place must be within two days' journey of Cana and Nazareth. He has examined all the fords of the Jordan (there will be fifty in the new map, against eight in Murray's latest map), and finds one twenty-five miles from Nazareth, which not only seems to answer all the conditions but also preserves the name. It is called Makhâdhet Abâra, the "Ford of the Crossing-over." As Bethabara means the "Town of the Crossing-over," this identity of name might be met with at any of the fords, so that the identification must be supported on other grounds. Besides the condition of distance, the new site, however, is the ford over which the road down the Wady Jalud to Gilead and the Hauran passes. Here the river-bed is more open than at other places, the steep banks of the valley are further retired, and a broad space is left, suitable for the collection of the great crowds which followed John the Baptist.

The Cave of Adullam.—Lieut. Conder points out that the site of the celebrated cave must satisfy certain conditions in which the caves at Khureitûn, the traditional site, and those of the Deir Dubban both appear to fail in one point or other. Adullam was in the Shephelah: it was near Jarmuth and Socoh, between Gath and Bethlehem. It was a natural stronghold. Its site must show the usual indications of an ancient town with rock-cut tombs, good water supply, and roads. It must have at least one habitable cave; and the modern name must contain the essential letters of the Hebrew, especially the Ain. All these conditions seem to be satisfied in the site now called Ayd el Mieh. Ayd el Mieh lies in the upper part of the Wady Sumt (the Valley of Elah). On the western slope of this valley is a place named on Murray's map after a kubbet called the Wely Mudkor. The kubbet itself stands on the north edge of a range which rises 500 feet above a valley, here a mile broad. The sides of the hill are steep and cut into terraces. The kubbet is surrounded by heaps of stones and ruins of indeterminate date. The rock is scarped and quarried. There are wells and stone troughs; there are ancient tombs; and there are roads connecting the place with Hebron, Bethlehem, and Tell es Safiyeh. The name Ayd el Mieh with an Ain preserves all the essential letters of the Hebrew. As for "the cave," there is no single cavern of vast dimensions, and with winding passages, as may be found at Khureitûn, but a series of small caves, smoke-blackened and still inhabited, or used as stables. Lieut. Conder points out that the present troglodytic peasantry carefully avoid living in the large caves, as being damp and feverish, as well as dark, and dreading the bats, scorpions, and flies which infest them. If this identification be accepted, Lieut. Conder argues, that the adventures of David assume a consistency and clearness wanting from the old traditional sites.

The ruins of Beit Jibrin (Betogabra), the Eleuthnopolis of the second and third century, Lieut. Conder proposes to identify with Libnah. The following is the list from Joshua (xv. 42), with their proposed modern names:—

Libnah . .	Beit. Jibrin	. Lieut. Conder.
Ether . . .	Kh. Atr. . . .	"
Ashan . . .	Kh. Hazanah.	"
Jiphtah .	(not yet identified.)	
Ashnah . .	Idnah.	"
Nezib . . .	Kh. Nusib . .	Dr. Robinson.
Keilah . . .	Kh. Kilah . .	"
Achzib . .	Kussah	Lieut. Conder.
Mareshah .	Kh. Merash	. Dr. Robinson.

Lieut. Conder lays down a canon which he considers to be established by his own observations. It is that "the order of occurrence of the names in the topographical lists is a certain indication of relative situation."

He argues that Gath was at Tell es Safiyeh, the Blanchegarde of the Crusaders. From the survey camp at Beit Jibrin 424 names were collected, and 180 square miles surveyed. The majority of the ruins are early Christian, and there is an average of three ruins to every two square miles.

The Turcoman Frontier of Persia.—Capt. the Hon. G. Napier (British Association).—The frontier of Persia, on the side of the Turcoman steppe, is not definitely fixed; the Persians claiming the whole of the valley of the Attrek, *i.e.*, the territory up to the watershed of the tributaries of the right bank of the river, whilst the Russians, who possess an establishment at its embouchure, exercise the right of owners on the lower part of its course. The Attrek is a stream of much importance, flowing along the northern foot of the mountain chain and parallel with its axis; near it is by far the best of the roads which lead from the capital of Persia to its north-eastern provinces, and it has acquired great interest for the geographer and historian since the discovery of an ancient bed of the Oxus, with which it was probably connected. The old bed of this historic stream is far to the south of that which the Russians are now taking so much pains to explore. Branching off from the present course of the river at Chardjui, it trends east as far as the Kurren Tagh, through a break, in which hilly range it passes in a southerly direction, and finally debouches in the Caspian at the mouth of the present Attrek. If we suppose that the Oxus flowed along this bed in classical times, the records of it in ancient authors, almost all of which are at present inexplicable, become capable of easy interpretation.

On the Pamir Plateau and the Upper Waters of the Oxus.—Col. T. E. Gordon (British Association).—The author was placed in command of a party to survey the mountainous region separating Eastern from Western Turkestan. The doubtful points in the geography of the region which he set himself to solve were: the ultimate direction of the Aktásh stream (Ak-su), rising in the Little Pamir and flowing east; the number and position of the lakes; the culminating point and general character of the table-land; the direction of the stream draining the mythical Karakul Lake; and the position of the watershed dividing the waters flowing west into the Aral, and east into the closed basin of Central Tartary. Col. Gordon's party, consisting, besides himself, of Capt. Biddulph, Capt. Trotter, R.E., and Dr. Stoliczka as naturalist, left Yangi-Hissar on their arduous errand on the 21st of March, 1874. Signs of approaching spring were then visible in the plains; but in the elevated regions which they had to traverse, all was locked in snow and ice, as in midwinter. The route lay *viâ* Tashkurgan, before reaching which they crossed three passes at an elevation of 12,850, 13,330, and 14,480 feet respectively. Beyond Tashkurgan they entered the Sirikul Valley, the average breadth of which was about three miles, and which they found peopled by a mixed population of nearly 3,000 souls, speaking the Persian language, and subject to the ruler of Kashgar. It is elevated 10,250 feet above the sea-level; the cultivation consists mainly of beardless barley, legumes, &c., and willows grow thickly along the streams. After extending south for some distance, the valley bends towards the west, and there merges into the "Taghdungbash" Pamir; the drainage of the valley is into the Karkand River. North-east of Sirikul lies the Tagharma plain, twelve miles long by seven miles broad, and this is separated from the Kizil Art by a spur from the mountain ranges; the latter plain is 130 miles long, and is enclosed on the east by a lofty mountain chain. It contains two lakes bearing the name of Karakul, the "Little Karakul" lying in the lower, and the "Great Karakul" in the upper end, the two giving off their drainage in opposite directions. The fact of the two Karakuls having been confounded in the reports of previous travellers had rendered the topography of the Pamir extremely obscure, and the discovery of the duality, with their opposite drainage, was one of the most important results of the expedition. The outlet of the Little Karakul flows eastward towards Kashgar, and that of the Great Karakul south-westward into the Oxus. The march of the party up the Ak-su, on the 4th and 5th of April, was made through snow and against a freezing wind. They learnt that the elevated Great Pamir was rarely passable, on account of snow, before the end of June. The attempt was nevertheless made, and Wood's Lake was reached on the 1st of May; it was found entirely frozen over and covered with snow. According to careful observations made by Capt. Trotter, the lake proved to be 13,900 feet above the sea-level, but mountain peaks near it rise 4,000 or 5,000 feet higher. The watershed lies about eight miles above the head of the lake, whence the fall is gradual to the east; this point, 14,200 feet high, was regarded as the culminating point of the Pamir; hence, to the Aktash Valley, the distance was found to be about fifty-two miles. The animals of the Pamir are the ovis polii, ibex, brown bear, leopard, lynx, wolf, fox, marmot, and hare; all remaining throughout the year. The general result of the survey showed the Pamir to be a great, broad, rounded ridge extending north and south, and crossed by mountain chains, having valleys between them which are open and sloping towards the east, but narrow and with a rapid fall towards the west. The word "Pamir" signifies a wilderness. The party returned *viâ* Tashkurgan to Yarkand, arriving there on the 21st of May.

Ruins of Sigiri.—T. H. Blakesley (Royal Asiatic Society).—The rock of Sigiri, in the north extremity of the Central Provinces of Ceylon, which rises some 500 feet above the surrounding plain, appears in early times to have constituted the citadel of a fortified position, surrounded by earthworks and moats, the sides of which were in some parts rivetted with stone. Two quadrangular areas have been traced out, comprising, together with the rock, a space of about 600 acres, and defended not only by the walls and moats above mentioned, but, on the eastern side, by a large artificial lake, which was doubtless also used for the purposes of agricultural irrigation. Extensive earthworks (bunds) for the diversion of running water into particular channels may be traced in different directions for two or three miles. The locality has been for centuries thickly covered with jungle, and all that now remains of the lake is a swamp, occupying only a portion of its former extent. But there are still to be seen paintings on parts of the surface of the great rock of a very remarkable character, apparently suggesting the existence of close relations between China and Ceylon. The author ascribes the earthworks and some of the bunds at Sigiri to King Kásyapa the Parricide, who lived in the fifth century of our era; and the completion of the water arrangements to Parákrama Báhu, in the middle of the twelfth century. Earlier than either of them, indeed, as early as the first century, B.C., are, in his opinion, the walls of cyclopic masonry, still to be seen at Mapa-gala—a pair of rocks about half-a-mile south of the rock of Sigiri. United with the rocks about the latter, the whole must have constituted a military position of almost unparalleled strength, considering the appliances of Oriental warfare.

Formosa.—From a report of a journey into the interior of Formosa made in the latter part of the year 1873, it appears that the flat portion of the country is almost everywhere cultivated with the greatest care. The principal crops are rice, sugar-cane, and sweet potatoes; and the minor crops, pea-nuts (*Arachis hypogæa*), indigo, and areca palms. The mountain region, though very steep and rugged, was covered with thick tropical forest. Tree-ferns, as well as other ferns, grew luxuriantly; and in places where there was a bit of level ground, Chinese had formed settlements around which they were growing rice, and were clearing patches of the hill-sides for the cultivation of tea. Formosa is the island from whence we obtain our supplies of the camphor of commerce, but in the interior the trees which abound in the forests are said to be left untouched, as the natives do not know how to make camphor. —*Nature.*

New Guinea.—A triangulated survey of the east shores and seas of New Guinea, embracing a space of eighty-five miles of latitude and fifty-five miles of longitude, has been completely finished. It contains, in addition to all the coast line and reefs, &c., being shown, more than 3,000 miles of separately fixed soundings. A running survey has been made on the northern shores of New Guinea, from East Cape to Astrolabe Gulf, an approximate coast line of 700 or 800 miles in extent laid down. It has been proved that a safe channel exists round the east end of New Guinea, by which a new and shorter route than before known is opened up between Australia and China. This passage is not recommended for sailing vessels without a pilot or local knowledge, but as a steam route (and steam is fast becoming the carrying power of the world) it has no drawbacks.

Ashantee.—Messrs. Ramseyer and Kühne (Nisbet & Co.)—Mr. and Mrs. Ramseyer, with their infant, and Mr. Kühne were carried off by the Ashantees. During their journey, they suffered terribly from the length of the marches and from scarcity of food. They were also, when not travelling, frequently secured by fetters. Their misery was increased by the gradual wasting away of the child, who died two months after the capture of the party. A messenger had been sent to the king to announce the serious illness of the child, and to ask for a milch cow. On the day of the child's death, the messenger returned, accompanied by an ambassador, wearing a large round gold plate on his breast. They were followed by two soldier boys, bearing six ells of coloured cloth, a third with a sugar loaf in a brass plate on his head, and a fourth with a stately ram. The king, Coffee Calcalli, sent them greeting, and was grieved to hear of the illness of the child; a milch cow could not be found, but the cloth, he said, would form a bed, and the ram and sugar would be useful; he had also sent some gold dust, in value about nine dollars. Nor was it only the king who showed compassion for the captives in their grief. When the child was dying, the inhabitants of the town where they were detained, constantly came to make inquiries and offer sympathy, while the local queen brought eggs, and tried to comfort them with the assurance that if they saw the King the child would recover. When the heart-stricken parents were praying over their babe's dead body, the people came to the door of the room, and looked sadly and earnestly at the corpse. Surely it is unjust to represent people capable of such manifestations of feeling as utterly wanting in heart and humanity. The death of the child occurred at Totorase, where they halted for ten days. They had, during that time, little to complain of as regarded treatment. From Totorase they were taken to Abankaro, a place nearer the capital, and remained there for six months. There they were joined by M. Bonnat, a French merchant, who had also been captured by the Ashantees in their raid.

At length, on the 5th of December, 1870, after several intermediate changes, the prisoners found themselves in Coomassie.

The royal authority is maintained by a carefully organized system of espionage and the most relentless severity. The King has about a thousand kra, a word which signifies the king's soul. They are put to death when he dies, and are, consequently, extremely careful to watch over his safety. Should one of the kra die during the lifetime of the King, all his money and jewelry go to the monarch. Indeed most of the free people in Coomassie hold office of some sort, and on their death the King seizes their property. A public court is held every Friday for the trial of offenders. If the testimony is deemed insufficient, the accuser takes an oath that his evidence is true. If the accused persists in his innocence, he is forced to chew a piece of odum wood and afterwards to drink a pitcher of water. If he is sick in consequence, he is deemed innocent, and the accuser is put to death. If, on the contrary, no ill effects ensue, the accused is considered guilty, and suffers capital punishment.

The Ashantee code is terribly severe. The offences punished with death are of the most trivial nature. For instance, no one may whistle in Coomassie; no egg must be allowed to fall and break in the streets; no drop of palm oil may be spilt in the streets. Murderers are put to death with the most horrible tortures. On June 5, 1870 (say the writers), a murderer, with his hands bound behind him, a knife through his cheek, and two forks piercing his back, was dragged by a rope past our rooms. Others had been thus tortured already in various ways, the vital parts of the body not being wounded. Commencing at mid-day, the punishment increased in intensity till eight o'clock, when the poor wretch was gashed all over, his arms cut off, and himself compelled to dance for the amusement of the King before being taken to the place of execution. If he could not or would not dance, lighted torches were applied to his wounds; to escape this excessive torture he made the greatest efforts to move, until the drum was beaten and the head cut off. Some victims thus lost several of their limbs, or were pierced by an iron rod through the calves of both legs or other parts; and yet murders were far more frequent here than in the British protectorate.

The King is by no means so uncontrolled a despot as is generally supposed. Nominally absolute, he is, in most important matters, obliged to yield to the will of his council. This council, called Asantee Kotoko, is composed of the King, the Queen, the three first chiefs of the kingdom, and a few of the nobles of Coomassie. It transacts all ordinary business and tries all accused persons. The King may commute the punishment of death, but in some cases he is compelled to accept the decision of the council. In important matters all the chiefs are assembled, but they are sure to vote in accordance with the view of the council, for who would dare to oppose the Kotoko? Had the King been free to act according to his own judgment, it would seem probable that war with the British would never have taken place; but as it was with the Emperor Napoleon in 1870, so it was to a certain extent with Coffee Calcalli. If he wished to retain his crown he must fight. The captives say:—We believe that war had been decided on for months, and had been wished for and planned for years; not by the King, but by his great men, whose influence he could not resist, though his predecessor had made short work with any one attempting to dictate to him.

The Sandwich Islands.—Isabella J. Bird.—These islands lie upwards of 2,000 miles south-west of San Francisco, and consist of fifteen islands, eight only being inhabited. The total area is about 7,000 square miles, and the native population is under 50,000. There are besides upwards of 5,000 foreigners. There is, however, a large native white population, descendants of settlers in the islands; most of the Government offices—for the Sandwich group has a constitutional monarchy—being filled by whites of this class. The islands have for many years been professedly Christian in religion. Their official designation is the "Hawaiian Islands." Their climate for salubrity and general equability is reputed the finest on earth. It is almost absolutely equable, and a man may take his choice between broiling all the year round on the sea level on the leeward side of the islands at a temperature of 80° Fahr., and enjoying the charms of a fireside at an altitude where there is frost every night of the year. The trade winds blow for nine months of the year, and on the windward coasts there is an abundance of rain, and a perennial luxuriance of vegetation.

The largest of the islands is Hawaii—its area is 4,000 square miles—but the capital, Honolulu, is on Oahu. Hawaii Miss Bird calls a huge slag, and the same may be said of most of the other islands; everywhere there are unmistakable signs of the fiercest volcanic outbursts, and every now and again are the inhabitants reminded of the instability of the foundations of their lovely dwelling-place.

Almost all the roots and fruits of the torrid and temperate zones can be grown on the islands, though the flora is far scantier than that of the South Sea groups. The indigenous fauna is small, consisting only of hogs, dogs, goats, and an anomalous bat that flies by day. There are few insects except such as have been imported, and there is no great variety of bird-life.

In Hawaii, as well as in others of the islands, the coast line is everywhere broken by deep "gulches" or ravines, often from 1,000 to 2,000 feet in depth, running for miles into the interior, clothed from top to bottom of their nearly perpendicular sides with almost impenetrable vegetation, and having the narrow valleys below raked by torrent-like rivers, which are often swollen to many hundred yards in breadth.

All the principal islands of the group, being of volcanic origin, are more or less mountainous, ranging in extreme height from 400 feet in Kahoolawe to close on 14,000 in Hawaii, the loftiest island in Oceania. On the island of Hawaii are two active and at least two extinct volcanoes. To the south of the Waimea plains violent volcanic action is everywhere apparent, not only in tufa cones, but in tracts of ashes, scoriæ, and volcanic sand.

Mauna Loa, somewhat to the south of the centre of the island of Hawaii, is the highest active volcano in the world, rising to a height of 13,760 feet. The whole of the south side of Hawaii, down to and below the water's edge, is composed of its slopes, its base being 180 miles in circumference. Its whole bulk above a height of 8,000 feet is one frightful desert, though vegetation, in the form of grey lichens, a little withered grass, and a hardy asplenium, extends 2,000 feet further up. The crater Mokuaweoweo, is six miles in circumference, 11,000 feet long, 8,000 feet wide, with precipitous sides 800 feet deep. The crater appears to be in a state of constant activity, and at times overflows, carrying destruction to the lowest level of the island.

The following description gives a vivid idea of the present condition of the crater:—When the sun had set, and the brief red glow of the tropics had vanished, a new world came into being, and wonder after wonder flashed forth from the previously lifeless crater. Everywhere through its vast expanse appeared glints of fire—fires bright and steady, burning in rows like blast furnaces; fires lone and isolated, unwinking like planets, or twinkling like stars; rows of little fires marking the margin of the lowest level of the crater; fire molten in deep crevasses; fire in wavy lines; fire calm, stationary, and restful; an incandescent lake two miles in length beneath a deceptive crust of darkness, and whose depth one dare not fathom even in thought. Broad in the glare, giving light enough to read by at a distance of three-quarters of a mile, making the moon look as blue as an ordinary English sky, its golden gleam changed to a vivid rose-colour, lighting up the whole of the vast precipices of that part of the crater with a rosy red, bringing out every detail here, throwing cliffs and heights into huge black masses there, rising, falling, never intermitting, leaping in lofty jets with glorious shapes like wheatsheafs, corruscating, reddening, the most glorious thing beneath the moon was the fire-fountain of Mokuaweoweo.

On the east flank of Mauna Loa, about 4,000 feet in height, is the crater of Kilauea, which has the appearance of a great pit on a rolling plain.

But such a pit! It is nine miles in circumference, and its lowest area, which not long ago fell about 300 feet, just as ice on a pond falls when the water below it is withdrawn, covers six square miles. The depth of the crater varies from 800 to 1,100 feet in different years, according as the molten sea below is at flood or ebb.

On the west side of Hawaii is an extinct volcano, Hualulai, 10,000 feet high, which has only slept since 1801, when there was a tremendous eruption from it, which flooded several villages, destroyed many plantations and fish-ponds, filled up a deep bay twenty miles in extent, and formed the present coast.

The largest extinct volcano in the world, Haleakala, is in the centre of the island of Mauai, lying to the north-west of Hawaii. It is 10,000 feet in height; its terminal crater is nineteen miles in circumference, 2,000 feet deep, and contains numerous subsidiary cones, some of which are 800 feet high.

The native population is dying out, at the fearful rate of something like 1,000 per year; so that unless some counteracting circumstances intervene, it must in a very few years become entirely extinct. Cook calculated the population of the islands in 1778 to be about 400,000; now the native population is under 50,000. That the decay is to a considerable extent owing to contact with whites, there is no doubt.

Journey across the Western Interior of Australia.—Col. P. E. Warburton (*Athenæum*).—The efforts made within the last few years to explore the interior of Western Australia have proved unusually successful. Since 1873, Gosse, John Ross, and Ernest Giles have penetrated deep into the western wilderness; and two travellers, John Forrest and Col. P. Egerton Warburton, have succeeded in crossing the whole region intervening between the central telegraph line and the western sea-board.

The expedition originated in the public spirit of two colonists, Messrs. Hughes and Elder, who defrayed its expenses. Its leader, Col. P. Egerton Warburton, was born in 1813, and, after many years' service in India, he settled about 1853, in South Australia, where he was appointed to the command of the colonial police force, and on several occasions was led, by his love of exploration, to push for several hundred miles into unknown parts of the colony.

The expeditionary force left Adelaide on the 21st September, 1872, and reached Alice springs, a telegraph station in the very centre of the continent, on the 3rd of October, having travelled 1,200 miles, At Alice spring the party was detained for over six months. At length on the 15th of April, 1873, they started, accompanied by seventeen camels, to whose services the success of the enterprise is mainly due. For about 145 miles as the crow flies, as far as Mount Wedge (Gosse's Bluff Range), the country was found to be well adapted to stock-breeding. There was abundance of grass and water; and the scenery, in many places, is described as delightful. But beyond this range a change for the worse took place. There were still a few patches of grassland, but springs were met with only at long intervals, and the sandy and scrubby country was lightly dotted here and there with clumps of casuarinas, and covered with the never-failing spinifex. In the beginning of September, the explorers entered upon a great sandy wilderness, formed of sand-ridges, 80 feet high, and 300 yards apart, but clothed with shrubs and flowers, acacias and eucalypti, useful as food for camels, but not fit for man. Water could be procured only by digging, and game was exceedingly scarce. The six months' supply of provisions, owing to the unexpected length of the journey, became exhausted, and the travellers were barely able to sustain life on jerked camel-flesh and roasted acacia-nuts. The discovery of wells proved a matter of difficulty, and Col. Warburton was undoubtedly justified in trying to "catch" natives to serve as guides; but we must leave our readers to decide whether his treatment of a "hideous old hag," whom he secured by "tying her thumbs behind her back, and haltering her by the neck to a tree," and whose "sex alone secured her from punishment," because, in that by no means comfortable position, she set up an incessant howl, was the most judicious means of conciliating the goodwill of the natives.

After a sojourn of two months in this inhospitable region, the party at length reached a tributary to the

Oakover, and with it a more fertile country, though they were still at a distance of 150 miles from the nearest settlement whence provisions could be procured. Colonel Warburton by this time was worn out to such a degree, that during the latter part of his journey he had to be tied at full length on the camel's back; his son was scarcely able to walk; and the rest of the party—two Europeans, two Afghan camel men, and a native lad—had likewise suffered greatly in health. Out of seventeen camels there remained now only three, and unless assistance could be procured speedily, the party was doomed to perish almost within sight of their desired goal. Colonel Warburton decided, under these critical circumstances, that the two strongest men of the party, with two camels should make their way to the nearest station, whilst he, with the remainder, stayed behind at the Oakover in expectation of their speedy return. This was done. After an absence of sixteen days, the hoped-for relief arrived, with an ample supply of provisions and six stout horses, which took the worn-out travellers down to the coast. Colonel Warburton's reception by the colonists was of the most enthusiastic nature, and the perseverance with which he pushed his way across one of the most inhospitable tracts of Australia, the hardships and sufferings which he and his gallant party sustained, entitle him to our sympathy, and to a foremost place amongst Australian explorers.

Australian Exploration to the North of Fowler's Bay.—Details concerning Mr. Giles's investigation of the country lying about 100 miles from the coast-line of the great Australian Bight, have come to hand. The country he examined seems almost useless for pastoral purposes, the greater part of it being dense scrub, "heavy red sand-hills with thick mallee, mulga, acacia, Grevilleas, casuarina, hakea, and spinifex." For 220 miles the greatest suffering was endured from the want of water, the horses all dying, and the party only being saved by his two camels; Mr. Giles speaks of the latter as "wonderful, awe-inspiring, and marvellous creatures." He just touched the edge of Lake Torrens, and from what he has seen he judges that there exists a vast desert of scrub of a triangular form, the base of which is at or near the western shores of the lake, and the sides running north-westerly from the southern foot, and most probably west from the northern cone to an apex at no great distance from his starting-point, Youldeh. It consists of two deserts divided by a strip of open country about thirty miles broad; the western one he has named Richards' Desert, and the eastern one Ross's Desert. His starting-point was Youldeh, 135 miles N.N.W. from Fowler's Bay. At Pyleburg, sixty-four miles from this, is an extraordinary native dam, and a clay tank, with circular wall five feet high around it, the work of the aborigines. Mr. Giles is confident of being able to cross to the settled district of Western Australia.

Mr. Lewis's expedition to Lake Hope, South Australia, has proved successful. Lake Hope he found perfectly dry. Before completing his work, Mr. Lewis proposes endeavouring to discover a route between the south-west portion of Queensland and the north-west of New South Wales, with a view of establishing direct overland communication with the former colony.

Temperature of the North Pacific Ocean.—A *Times* correspondent on board H.M.S. *Challenger*, describing the voyage from Cape York to Hong Kong says:—The results so far are very satisfactory, and the *Challenger* has arrived in port with every store bottle and case in the ship filled up. With regard to the temperature of the eastern seas visited by the *Challenger*, they are, in fact, a chain of sunken lakes or basins, each surrounded and cut off from the neighbouring waters by a shallower rim or border. The water, down to a depth equal to that on the border, is able to circulate freely, and gradually cools as we descend; but the whole mass below, having no means of communicating with the outer waters, remains at the same temperature as that of the water flowing over the floor of the rim; or, in other words, the icy-cold water travelling north along the floor of the ocean from the Antarctic Seas, which is found in all the deep open channels, cannot obtain admission through or over the surrounding rim. Thus, we can now affirm with certainty that the sea immediately east of Torres Straits, although having a depth of 2,450 fathoms, is surrounded by an elevated rim, having no deeper water over any part of it than 1,300 fathoms, all the water below that depth being at a steady temperature of 35°. The Banda Sea, which is 2,800 fathoms deep, is cut off at a depth of 900 fathoms; the Celebes Sea, which is 2,600 fathoms deep, is cut off at a depth of 700 fathoms; the Sulu Sea, which is 2,550 fathoms deep, is cut off at a depth of only 400 fathoms, all the water below that depth being at a temperature of 50°. On the other hand, we find that the Molucca passage is open to at least the depth of 1,200 fathoms, and the China Sea to 1,050 fathoms, the greatest depth yet obtained in them.

From Mindanao by New Guinea and the Admiralty Islands to Japan.—H.M.S. *Challenger.*—The following deep sea soundings were made:—The greatest depth in the section, 2,250 miles long, from the Admiralty Islands to Japan, was found on the 23rd of March in 4,575 fathoms, between the Carolines and Ladrones. This is the deepest trustworthy sounding on record, with the exception of two taken by the *Tuscarora* off the east coast of Japan, in 4,643 and 4,655 fathoms respectively, but no sample of the bottom was procured on either of these occasions. A second sounding gave 4,475 fathoms. The tube of the sounding machine contained an excellent sample of the bottom, which was of a very peculiar character, consisting almost entirely of the siliceous shells of Radiolaria. Three out of four Miller-Casella thermometers sent down to these depths were crushed to pieces by the enormous pressure they had to bear; the fourth withstood the pressure, and registered, when corrected for the pressure, at 1,500 fathoms, the usual temperature for that depth, 34·5° Fahr., so that at that place there is a layer of water at that uniform temperature occupying the bottom of the ocean trough no less than 3,075 fathoms (18,450 feet, in thickness).—*Nature.*

Dacotah.—General H. B. Carrington (British Association).—In the very midst of the North American continent, long known as a desert, and extending from the Mississippi on the east to the Rocky Mountains on the west, was the land of the Dacotahs. The geographical and physical features of this tract were long neglected by the American people. Upon the completion of the Union Pacific Railroad, a substantial station was needed for repair shops. Fort David Russell was built, and Cheyenne City sprang up as in a night. The geography of Dacotah is now under careful revision, as troops have been sent to protect the Indians from white encroachment, and examine the country with a view to its final purchase. The territory is hilly rather than mountainous.

The Big Horn Mountains are a snow range, but on the west within the new subdivision, Wyoming Bad Lands constitute the larger portion of the surface, while the valleys that fringe the rivers are often of matchless fertility. These bad lands are largely lignite, and a low grade of wood-coal crops out in all directions. Lake De Smedt is bordered by scoriæ and volcanic *débris*, and its water is alkaline and useless. Almost in the centre of the territory is the region of the Black Hills, an exceptional group of peaks and ranges, surrounded on all sides by bad lands, but, through this very isolation, a charming retreat for Indians as well as wild game. The hills are drained by the forks of the Big Cheyenne River. These streams are not navigable, and many of them dry up in mid-summer. Within this encircling group is embraced all the new Eldorado which is now challenging the aggression of adventurers. Much of Dacotah is above the Dew Point, and with the exception of occasional mountain fever and rheumatism, disease is almost unknown. There is no limit to pine timber, but all other timber is scarce and hardly fit for fuel. Sage brush and cactus predominate except in the valleys, and independently of the questionable gold element there is little to attract a worthy emigrant. Irrigation might redeem, however, some portions, as in Utah.

Darien.—It is reported that the Government has despatched another Darien Expedition, under the direction of Lieut. F. Collins, with a view to the connexion of the Atlantic and Pacific Oceans by a canal. Lieut. Collins will examine the Wapipi route, the engineering difficulties of which will be compared with those of the Nicaragua route. The latter has been sufficiently surveyed for the purpose, and it was proposed on that route to utilize the river San Juan as a canal, reaching Lake Nicaragua by seven sluices. From the lake an outlet to the Pacific can be obtained by means of a canal with ten sluices.

The Isthmus of Darien.—The Panama Inter Oceanic Canal Surveying Expedition, sent out by the U. S. Government under Commander Lull, has returned to New York. They have demonstrated that the Isthmus route by the Chagres river is the most feasible one for the canal. This route extends from Limon Bay on the Atlantic to Bay Vaca del Monto on the Pacific. This line will be adopted by the Columbian Government, and if the canal is attempted it will be by this route. Columbia intends to ask the co-operation of Europe as well as America in its construction.

Minnesota Valley.—Major J. K. Warren. — The writer argues that this valley was formerly the course of a great river which drained the basin of Lake Winnepeg, the drainage passing down the Minnesota and Mississippi to the Gulf of Mexico. At that time the existing outlet by Nelson's River to Hudson's Bay could not have existed. The change in the direction of drainage is explained, according to the author, by assuming a slow elevation of the southern portion of the continent, and a subsidence of the northern portion, the subsidence extending over a vast period, and, indeed, still going on.

Dominica.—This island was formerly one of the chief coffee-producing countries, but of late years it has almost entirely ceased to grow the plant. The capabilities of the island, however, are apparently so great, not only for the cultivation of coffee, but also for many other food products, that the attention of the authorities has been directed to the matter. Mr. Prestoe has been commissioned to examine and report on the prospects of the island generally, and the best means of developing its resources. It is sad to find that an island so fertile and beautiful as Dominica, has, no doubt through the absence of European capital and energy, been allowed to drift almost into an unprofitable waste.

Boiling Lake in Dominica.—This lake is situated in the forest-covered mountain behind the town of Roseau, 2,500 feet above the sea, and is two miles in circumference. The margin of the lake consists of beds of sulphur, and its overflow finds exit by a waterfall of great height.

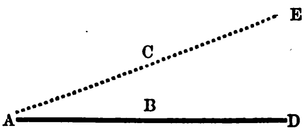
The *Trinidad Chronicle* of May 21 contains an account of a visit to the spring by Mr. H. Prestoe, superintendent of the Trinidad Botanic Gardens. The lake lies in the mountains behind Roseau, and in the valleys around many *souffrières*, or solfataras, are to be met with. The Boiling Lake is a gigantic solfatara, with an excess of water-volume over the ejective power exerted by its gases and heat. It is affected by a very considerable volume of water derived from two converging ravines which meet just on its north-west corner, and owing to the existence of a small hill immediately opposite (which has had the effect of diverting the course of the ravine-water into its present channel), the action of the solfatara has caused the formation of a crater-like cavity, which is now the Boiling Lake with its precipitous and ever-wasting banks on its north and south sides, of some sixty feet depth. The temperature of the lake ranges from 180° to 190° F. The point of ebullition seems to vary its position somewhat; the water rising two, three, and sometimes four feet above the general surface, the cone dividing occasionally into three, as though ejected from so many orifices. During ebullition a violent agitation is communicated to the whole surface of the lake. The sulphurous vapour arises in pretty equal density over the whole lake, there being no sudden ejection of gas observed from the point of ebullition; there are no detonations; the colour of the water is a deep dull grey, and it is highly charged with sulphur and decomposed rock. As the outlet of the water is constantly deepening, the surface of the lake must gradually become lower, and will ultimately be destroyed, and its character be changed to that of a geyser. It will then be gradually filled up by the reduction of the adjacent hill-sides, and innumerable solfataras will be formed in the place of the present gigantic one. Mr. Prestoe found no bottom with a line of 195 feet, ten feet from the water's edge. One great result of the action of solfataras is the decomposition of the volcanic rock and the development therefrom of various kinds of gypsum. Mr. Prestoe thinks that these large solfataras have had much to do in bringing about the present conformation of the district.

Produce of Guayaquil.—The cultivation of cocoa (*Theobroma cacao*) is being largely extended. New plantations have been formed, and new trees planted on the old estates, so that the average yield will be greatly increased. Another of the chief products of Guayaquil is indiarubber, or caoutchouc, the yield of which has however very much decreased of late, owing to the custom of destroying the trees to collect the gum, so that it has become necessary to go further into the forests in search of the trees, which, together with the increased difficulty of transport, has added much to its first cost.

Threatened Destruction of Caub.—The picturesque city of Caub, or Kaub, in Nassau, S.W. Germany, will very shortly, it is feared, be crushed and destroyed by the disintegration of the mountain on which Guterfeld Castle was built in mediæval times. The rocks which threaten Caub are not less than 600 feet in height. Two rows of houses have been deserted, as no human power can prevent the catastrophe.

True North Compass (Symons's Patent).—It is not sufficiently known that the compasses usually sold do not point to the true north or south pole of the earth, or agree with the positions represented upon maps. The magnetic pole not being identical with the geographical pole, which is the north point of all maps.

The difference between the two is considerable, and is no doubt often the cause of tourists losing their way. At the instigation of Mr. Symons, Mr. Casella is manufacturing a corrected compass which points to the true north. The accompanying diagram represents the paths of two tourists, B and C, starting from the common point, A, for the common destination, D. The black line ABD represents the path of the traveller B going by a true north compass, the dotted line ACE that of the other traveller going by an ordinary compass.



If the distance from A to D be six miles, and the direction in which both travellers intended to go, north, the second traveller, C, would find that his ordinary compass had led him two miles west of the spot he meant to reach.

The "Alert" and "Discovery."—Punctually at the time arranged, four o'clock in the afternoon of the 29th May, 1875, the *Alert* and the *Discovery*, accompanied by the *Valorous*, left Portsmouth for their work in the Arctic regions. No better equipped expedition, it may be said, has ever left any country, and no previous British expedition has ever been so universally popular. Every available point on land was occupied by spectators who had come to see the departure of the expedition. The vessels in the harbour and the yachts and boats along the beach were dressed with flags, and as the two ships stood out to sea their course lay through a perfect flotilla of craft of all kinds, whose occupants cheered Capt. Nares and his companions on their way. Among the last messages received by Captain Nares was a telegram from the Queen "wishing you and your gallant companions every success." The ships arrived at Queenstown on Tuesday, the *Alert* and *Discovery* going on to Bantry Bay. The *Valorous* joined them, when the three proceeded on their way.

The "Valorous," Tender to the Arctic Ships.—The *Valorous*, which accompanied the two Arctic ships, the *Alert* and the *Discovery*, as far as Disco, with coals and provisions, returned home in August last. Severe storms were met with in crossing the Atlantic, but all three vessels seem to have borne themselves well, though the *Alert* and *Discovery* each lost a whale boat, a loss which was made up to them by the *Valorous* before leaving Disco. The *Valorous* was the first to reach Disco, which she did on July 4, the other two not coming up till the 6th. The ships remained together at Disco till the 15th, the two exploring vessels filling up from their consort as much coals and provisions as they could stow away. Mr. Kraup Smith, the inspector of North Greenland, had orders from his Government to pay every attention to the expedition, and he carried out his instructions most thoroughly. He provided the Expedition with sixty-four dogs and an Esquimaux. The *Alert* and *Discovery* having been put into complete trim, the Expedition left Godhavn on July 15, and on the 16th the *Valorous* took leave of her consort ships, after seeing them fairly on their way to their work in the high north. The Danish officials' reports as to the weather were favourable, leading to the belief that the navigation of Melville Bay and northwards would be comparatively easy. It is hoped that suitable winter quarters will be found for the *Discovery* on the north shore of Lady Franklin's Strait, from whence hunting parties will issue. The *Alert* will then press onwards alone to the north, landing depôts, building cairns with records at intervals of about sixty miles. The surest way of reaching the Pole, in Captain Nares' opinion, is not to risk failure by pushing forward away from the land. The *Alert* will probably winter in 84° and begin sledge travelling so as to get information of the country, and then in the summer of 1876 will push boldly northwards. The grand achievement will be done by a system of depôts and auxiliary sledges, enabling the foremost to be absent about 112 days, and to advance upwards of 500 miles from the ship. The *Discovery*, in the meantime, will go on exploring and advancing slowly.

On the Progress of the Arctic Expedition.—C. R. Markham (British Association).—After a long and stormy passage, the *Alert* and *Discovery* arrived at Godhavn, at the south-west end of the island of Disco, on July 6th, the *Valorous* having preceded them by two days. The embarkation of sledge-dogs, transhipment of coals and supplies from the *Valorous* to the expeditionary ships, and various scientific work, occupied ten days, and the two ships, *en route* to the Pole, were last seen in the evening of the 17th, making their way amidst icebergs through the Waigat, or the passage between Disco Island and the mainland. The last hours with the Expedition were thus described in the report:—On Thursday, July 15th, at 4.45 P.M., the Expedition left Godhavn, the *Alert* towing the *Discovery*, and the *Valorous* following. The crow's-nests were in their places, and the boats (no longer on the skids, as when crossing the Atlantic) were all hoisted up to davits. The surface of Disco Bay was like glass, and was all dotted over with icebergs of great size and most fantastic shapes, while to the north rose the basaltic cliffs forming the south shore of Disco, resting on the yellow sandstones of the Miocene period, which contain coal. At midnight on the 15th the *Alert* passed close under the landward face of a magnificent iceberg, a cliff of dazzling white, the top covered with gulls, which flew up in a great cloud. On the other side, the berg rose to a peak 200 feet high, under which there was a grand arch, the inner sides being of a deep, rich blue. The sea was as smooth as glass, and the sky, seen through the arch, was crimson tinged with gold. As we gazed upon this scene of wondrous beauty, the *Valorous* hove in sight through the arch, her dark hull and tall masts standing out against the sky. In another hour there was a dense fog, which cleared away towards morning, disclosing a fine panoramic view, with smooth sea and cloudless sky. On the left were the high basaltic rocks of Disco, with the opening of the Waigat full of icebergs, ahead the lofty mountains of the Noursoak peninsula, and to the right the gneiss cliffs and precipices of Arve Prins Island. . . . The *Valorous* was to sail at four the next morning, and proceed to a place on the Disco shore of the Waigat to dig for coal, and the discovery ships were to follow them two hours later. The 16th of July was, therefore, the last day on which the gallant explorers would see any of their countrymen, and here I took leave of them. The *Valorous* sailed from Ritenbenk at 4 A.M. on July 17th, the *Alert* and *Discovery* following at 6. At 1 P.M. the *Valorous* anchored off the coal-bearing cliffs on the Disco side of the Waigat. From the hills above these cliffs there is a magnificent view of icebergs streaming out of the Fossakatek fjord, at the head of which there is a great discharging glacier, and amongst them the Arctic ships could once more be seen under all plain sail, over on the Greenland side of the strait. They were standing down the Waigat (the *Alert* leading), appearing and disappearing behind the huge icebergs. At 5 P.M. the *Valorous* hoisted a signal at all three mastheads, "Farewell! Speedy return!" It was not seen for a long time, but at last the *Discovery* hoisted "Thank you," and afterwards the *Alert* ran up the affirmative pendant. They continued to stand on, and were just about to disappear behind a point of Disco Island, when, at 6·15 P.M. the *Alert* hoisted a signal to the *Discovery*,—"Do you wish to communicate?" A few minutes afterwards the *Alert* went about, apparently intending to beat up to windward and communicate with the *Valorous*; and at 6·30 P.M. she hoisted a second signal to the *Discovery*—"Optional, beat up to windward," we thought it was. Then a fog suddenly sank down on the water and hid both ships from sight. This is the last that the crew of the *Valorous* saw of the Arctic Expedition.

Latest News from the "Alert" and "Discovery."—C. R. Markham (*Geographical Magazine.*)—On leaving Ritenbenk Captain Nares desired to communicate with the *Valorous*, as he had sent no private letters by her. This was the signal which was not made out when the fog came on and separated the vessels. Whilst beating up towards the *Valorous*, the officer of the watch, thinking he was going to weather an iceberg, stood on, but the ship drifted bodily down on it, and all the boats on the port side were nearly lost. The *Alert* scraped right along the side of the berg, but providentially without serious damage.

On the night of Saturday the 17th July, the fog was so dense that it was desired to make fast the ship to a berg, to await clear weather. They sailed quietly up to a large solid-looking mass and lowered the ice boat with David Deuchars, ice-quartermaster, Reuben Francombe, maintop man, and two other hands, to make fast an ice anchor. Deuchars had, however, no sooner struck the ice, when a loud crack was heard, followed by a tremendous report and a crash. The berg had calved, sending Francombe, who was actually standing on the calf, flying out into the water, whilst Deuchars was thrown head downwards into a rent, by the rolling of the main piece, and the ice boat was nearly swamped by the commotion of the water. A boat was lowered, the men rescued unhurt. It was a wonderful escape.

On Sunday the *Alert* and *Discovery* were off the Omenata Fiord, with a fair wind and heavy rain. On July 19, at midnight, they arrived off the little Danish settlement of Proven. Here they engaged Hans Hendrick as dog-driver for the *Discovery*, and fortunately he consented to come without his wife and family. Hans has served in the three American expeditions up Smith's Sound. On Tuesday Proven Harbour was surveyed. Information was obtained here respecting the season and the state of the ice. The whalers had not been able to get through Melville Bay at first and returned to Upernivik. They made a second attempt in about the first week in June, and got safe through. Northerly winds had been almost constant, so that there had been a remarkable clearing out of the ice.

On leaving Proven, at 5 P.M. on Wednesday the 21st, the ships proceeded to the far-famed "loomery" at Hope Sanderson, the furthest point reached by gallant old John Davis in 1587. The quaint name was given to this magnificent cliff by its discoverer in honour of one of his supporters, a merchant of Bristol.

At 6 A.M. of July 22 Upernivik was reached. The Governor's wife is "Sophie," a charming Greenland lady, whose acquaintance was made. The *Alert* brought her a present of a tea-service from Sir Leopold M'Clintock. Commander Markham has sent home some very ancient flint implements taken out of old graves near Upernivik. The arms of the Eskimo, as far back as anything is known of them, have been of bone, so that there can be scarcely any doubt that these flint instruments are very ancient.

At 8 A.M. the expedition left Upernivik, but soon a dense fog made it necessary to take shelter in a small bay near Kingitok Island, the most northern Danish settlement. Here the *Alert* ran on a rock, and remained immoveable for five hours, getting off without difficulty at high water. The fog having cleared up, the expedition shaped a course due west (true), for it had been determined to make a dash through the middle pack. At 1 A.M. on Saturday, July 24, the ships made the pack edge, and at once pushed into the ice, which was very loose, not more than twelve inches thick and with lanes of water in all directions. Evidently all the ice formed during the winter had been drifted south by the northerly winds, and this new ice had been formed in the spring. It was an unprecedented open season.

In the afternoon of the 24th the first bear was sighted. At 11 A.M. on the 25th the ships got clear of the pack and entered the north water of Baffin's Bay. The expedition had only been 34 hours in the ice, and 70 hours in going from Upernivik to Cape York. Former expeditions were 38 and 42 days struggling through the ice in Melville Bay, before they sighted Cape York. The *Discovery* then went in shore to communicate with the natives to engage a second dog-driver, while the *Alert* proceeded to the easternmost of the Cary Islands, which she reached at midnight, July 26. One month's provisions for 120 men, a whale boat, and the record and letters (brought home by the *Pandora*) were landed during the night. The *Discovery* here joined the *Alert*.

There was an extraordinary absence of floe ice. At 6 A.M. on Tuesday the 27th July the expedition left the Cary Islands and proceeded to Smith's Sound, with the brightest prospect of an open sea, and of being able to obtain a high northern latitude. They had six weeks of navigable season before them, and the temperature of the water was 40° Fahr. at 4 P.M. and remained so at 8 P.M.

Character of the Polar Ice, and its Periodical Changes.—Dr. Joseph Chavanne.—That the ice will not be always the same in the same portions of the Arctic sea in different years, is a fact well known to all Northern navigators. Hence the difficulty and uncertainty of Arctic exploration. A bay or a sound may be cleared of ice one summer, and choked up the next—until "Open Polar seas" have become among students of Arctic voyages the "Mrs. Harris's" of geography. It was therefore with Arctic authorities a subject of anxious discussion as to how the ice would be in the dreaded Melville Bay, through which our expedition would, in the course of its voyage through Smith's Sound, have to pass. Smith's Sound is sometimes so clear of ice that a whaler who sailed into it a few years ago believed that he could have gone on, without much hindrance from ice, to "any latitude." Kane, on the other hand, could only reach a point very little beyond that of Inglefield, while Hayes was forced to winter in a harbour thirty miles south of Kane's. When such are the changes of the ice (his bête noire) the Arctic navigator very soon enters upon his troubles, and as he descends from the "crow's nest," his eye chilled and his heart sick with disappointment at the sight of white ice fields on the very spot where his predecessor had found "sailing water," he understands that in the frozen seas at least there is nothing certain unless that nothing is certain.

Mr. David Gray is the captain of a Peterhead whaler who seems to be imbued with a good deal of the scientific spirit of his famous predecessor in the same rough branch of commerce, Scoresby, skipper and divine. For thirty years Captain Gray has sailed the Arctic seas, and, being known to keep his eyes open to what is going on around him, he has gradually grown to be a practical authority among Arctic men in matters pertaining to his calling, and in places where geographers assemble. In Petermann's *Mittheilungen* appears one of those suggestive letters which for some years past he has been in the habit of addressing to that journal. Its drift may be briefly summed up. Along the east coast of Greenland a continuous stream of ice, borne along by the current, is continually pouring down from the direction of Spitzbergen. It was in this ice that the *Hansa*, one of the vessels of the German East Greenland Expedition, was lost. In most years the whalers cannot reach the coast, but can sight the Capes and Headlands on the other side of this ice-stream. In favourable years they will often go far north. Such a season was the one just closed. Capt. Gray penetrated to the northward, apparently, of this icy barrier, and found, on the 9th of August, an "open Polar sea." Capt. Gray considers, that had this been his business, or been consonant with his duty, he could have sailed northward for an indefinite distance.

Boats for the Arctic Expedition.—These were built by White of Cowes, and are of somewhat peculiar construction. The yawls and cutters have a planking of mahogany laid on diagonally, which is payed over with marine glue and is covered with a coating of strong linen cloth. A hot iron is then passed over till the glue rises through the cloth. The outer planking, consisting of the best elm and Christiana pine, is put on in the ordinary manner. A cork belt is put on under the waist strake and covered with strong canvas. Six boats are constructed in a similar manner, but are to be double-ended like whale-boats. These will not have the cork belts, but will be provided with rails and hand-holes. Half a dozen ice-boats were also built, with a sheathing of cork between the inner diagonal planking and the outer planking of elm and pine.

Sledge Travelling in the Arctic Regions.—Admiral Sir Leopold M'Clintock (Royal Geographical Society).—Sledge travelling is limited to the spring months; and even then it cannot be commenced until there is sufficient daylight. Speaking from his own experience in the yacht *Fox*, the gallant admiral described the hardships and the privations, frost bites, snow blindness, faces blistered by the scorching sun, and rheumatism, which sledge travellers have to endure. On their return, they weigh, on an average, 12 lb. less than when they set out; still, they are strong, and can walk for hours without fatigue, and their sight, for distant objects, is keener. If, added Sir Leopold, the men were not accustomed to the use of spirits, I think that except on special occasions they would be better without it, as nutritious food might be carried instead of it.

"Polaris" Arctic Expedition.—In a letter to the French Geographical Society, Dr. Bessels gives some of the scientific results which were obtained. The position of the observatory was 81° 38′ N. lat., 61° 44′ W. long., and 34 feet above sea-level. Many careful observations were made on the tides, in meteorology, magnetism. zoology, botany, geology, and with the pendulum, in order to determine the force of gravity. Unfortunately, in the catastrophe which happened to the ship, many of the results of these observations were lost; nevertheless, enough was saved to afford a fair idea of the physical geography, the geology, the fauna and flora of the region visited.

The magnetic observations are more complete than any hitherto made in the polar regions. The observations on declination were made every hour for five months, and during three days in each month every six minutes. The western declination was found to be 96°, and the absolute declination 84° 23′.

The observations on the tides were made every hour, and for three or four weeks every ten minutes, in order to obtain the precise moment of the flux and reflux. High water occurs about every 12h. 13m.; the highest flux observed was 8 feet; the lowest reflux, 2·5 feet; mean of high and low tide, 3·8; mean of spring tide, 5·47; mean of neap tide, 1·83.

After having entered Smith Sound, a current was observed running southwards, the rate of which varied from 1·5 to 5 miles. This current carried with it much driftwood, all the specimens of which seen by Dr. Bessels were coniferous, with very close ligneous layers, indicating that the specimens came from a cold climate.

The fauna and flora of Hall's Land are very rich. Eight species of mammals were observed, twenty-three kinds of birds, fifteen species of insects, and seventeen species of plants. Of the mammals, myodes, spr. (pallas) and ovibos moschatus (Zimm.) were found in West Greenland for the first time. The greater part of the insects are Diptera, of which one species is new.

The geological formation of Polaris Bay and its neighbourhood presents only Silurian limestone, containing few fossils. At elevations of 1,800 feet, not only was driftwood found, but also shells of molluscs (*Mya*, &c.), of species which still exist in the neighbouring seas. On examining some of the small lakes which abound in the region, marine crustaceans were found to be living in these fresh waters. This is certain evidence of the gradual elevation of the coast of this part of Greenland.

Wherever the country is not too steep, large numbers of erratic blocks are met with, of a kind quite different from the rocks on which they rest. There are blocks of granite, gneiss, &c., from South Greenland, and these blocks have evidently been borne, not by glaciers, but by floating icebergs; a proof that at one time the current in Davis Strait had a different direction, and passed from south to north. Dr. Bessels believes that Greenland has been separated from the American Continent in a direction from south to north.

Antarctic Exploration.—In 1873 the German Arctic Society of Hamburg, presided over by Albert

Rosenthal, who has contributed so much to the equipment of polar expeditions, sent out an expedition to the south polar region under the command of Capt. Dallmann. Some of the results of this expedition will be found in the recently published expedition of Stieler's "Hand-Atlas," especially with reference to Capt. Dallmann's exploration of Graham Land, discovered by the whaling Captain Biscoe, in 1832. At the place where Biscoe saw nothing but what appeared a continuous coast line, Dallmann has discovered a strait from fifteen to eighteen nautical miles wide, with highlands between as far as the eye could reach, and an archipelago of islands about sixty nautical miles in extent, which has been named after Kaiser Wilhelm. Two other deep bays and many islands have been discovered and named, and will be found on the map already referred to.

METEOROLOGY.

Typhoon at Hong Kong.— The typhoon at Hong Kong of September, 1874, is the greatest calamity that has visited the crown colony since its establishment in 1841. The force of the wind during a cyclone or typhoon is always in direct proportion to the height of the mercury in the barometer. Now, the lowest reading of the barometer previously recorded at Hong Kong was during the typhoon of 1871, viz., 29·15; whilst at Macao, on the same occasion, the mercury fell to 28·39. But during the recent event, the reading at Hong Kong at 2·15 on the morning of the 23rd was 28·75 according to one barometer, and 28·73 according to another; whilst at Macao the mercury actually fell to 28!— a fall altogether unprecedented in the history of atmospheric reading in China.

Many points of interest are connected with the late typhoon. It was observed that the clock upon the tower at Peddar's Wharf in Hong Kong stopped shortly after two, and it has been stated upon good authority that five or six other pendulum clocks stopped at the same hour. Now, this was exactly the time when the most violent throe of wind that was experienced throughout the entire night took place; hence we are justified in assuming that, at the precise moment when the typhoon was at its height, a shock of earthquake probably occurred, pointing to the conclusion that the atmospheric disturbance induced physical disturbances in the crust of the earth.

The rate of progression of the typhoon was twice as great as that of the West Indian hurricanes, which have been computed at twenty to twenty-five miles per hour.

At Hong Kong the S.W. monsoon blows from April to September, and the N.E. monsoon from September to April. It is during the change from S.W. to N.E. that typhoons usually occur. The theory is this. When the cold N.E. monsoon sets in suddenly it strikes upon a vast tract of land in Southern China, and on a portion of the China Sea warmed by the mild breezes of the opposite monsoon, occasioning rapid precipitation or condensation of vapours, and an extensive vacuum where the rarefied air formerly was. Other air then rushes violently in to fill the vacuum, and strong breezes, sometimes developing into typhoons, are the result. The reason of the gale as a rule blowing from the east is apparent. Inland of the coast line is a towering range of mountains, extending down to Cochin China, and effectually arresting the rush of air from that quarter. The open sea, therefore, is the only free point of access. The prevailing direction of typhoons at Hong Kong is, in point of fact, very nearly that of the N.E. monsoon just commencing, but possibly slightly diverted by the remaining influence of the opposite monsoon. Hong Kong, Amoy, and Macao being just opposite to the opening between Formosa and Luzon, the full sweep of the wind rushes in unhindered towards them from the Pacific Ocean. Macao, however, fares worst, for it is situated precisely where the typhoon is arrested by the high land of the coast. The lowest readings of the barometer are invariably therefore recorded at Macao.

Cyclones from the Trade-Wind Region.—Dr. W. C. Wittner(*Austrian Journal of Meteorology*).—Water resembles air in many of its movements. When a stream of water is met by another at right angles, a depression is formed at the point of interruption; particles bordering this depression sink into it in obedience to gravity, and particles at a greater distance move spirally inwards. Besides rotation there is a progressive motion of the whole eddy, in the direction of the resultant of the forces of the two streams. In turbulent streams eddies last a very short time; they are filled up almost as soon as formed. In quiet rivers, on the contrary, the whirl continues for a length of time sufficient for observation. In the development of hurricanes, difference of air-density corresponds to difference of level in water. Hurricanes, like eddies, are destroyed when the surrounding medium moves very irregularly, and we should therefore look to the neighbourhood of the tropics, where atmospheric conditions are remarkably regular, for a region favourable to their growth and progress. Near the northern boundary of the region of calms, the equatorial current begins at about S., and the polar meets it from about E., nearly at right angles, so that in this respect also the development of whirls, like those in water at the junction of rivers, is favoured. The resultant progression, towards N.W., becomes deflected as the storm advances, until, at a latitude where the eastward component of the equatorial may be supposed to vanish against the westward component of the polar wind, an excess seems to remain of the southerly over the northerly component, causing movement towards N. In still higher latitudes the more westerly equatorial and northerly polar drive the cyclone in an easterly direction. Occasionally, when the northerly component of the polar happens to be stronger than the southerly of the equatorial wind, as in the storm of October 10th, 1847, the system moves towards S.W. In the southern hemisphere, as in the northern, the direction of rotation indicates an irruption of the anti-trade into the trade-wind. The equatorial current, or anti-trade, appears to be the strongest both by its invasion of the trade-wind region and by the direction of advance of the consequent hurricane.

The Great Storms at Geneva, July 7, 8, 1875 (*Journal de Genève*).— As midnight came on, though the heat was suffocating, and not a breath of wind stirred below on the streets, light objects on the roofs of the houses began to be whirled about and carried off as by a tempest of wind. At the same time a dull rumbling sound, resembling neither that of wind nor that of thunder, announced the approach of the thunderstorm, and at twelve midnight exactly it burst over Geneva in all its fury. An avalanche of enormous hailstones with no trace of rain was precipitated from the sky, and shot against opposing objects by a tempest of wind from the south-west. In a moment the street lamps were extinguished, and in a brief interval incredible damage was inflicted, the glass and tiles of houses smashed to powder, trees stripped of their bark on the side facing the west, and crops of every sort were in many places all but totally destroyed. The smallest of the hailstones were the size of hazel-nuts, many were as large as walnuts and chestnuts, and some even as large as a hen's egg. Some of the hailstones measured four inches in diameter. For the most part the hailstones were of a flattish or lenticular form, with a central nucleus of 0·16 to 0·40 inch in diameter, enveloped in several concentric layers of ice, generally from 6 to 8, alternately transparent and opaque. The flashes of lightning succeeded each other with so great rapidity from midnight till a few minutes after one o'clock in the morning, that a mean of from two to three were counted each second, or from 8,000 to 10,000 per hour. Electrical phosphorescence was remarkably intense before and during the hail. The ground, animals, prominent objects, as well as the hailstones, were strongly phosphorescent. Immediately after the hail, ozone was greatly developed, the smell being so pronounced as to be compared by nearly all observers to garlic. The incessant electrical discharges passed from cloud to cloud over a central point from which the hail fell, but thunder was very rarely heard.

Construction of Lighting Conductors.—By Dr. R. J. Mann (*Meteorological Society*).—This paper dealt especially with the material and dimensions of conductors. The conditions which are insisted upon as indispensable to efficiency of protection by the author are:—1. Ample dimension and unbroken continuity in the lightning-rod. 2. Large and free earth contacts, with frequent examination by galvanometers of the condition of these to prove that they are not in process of impairment through the operation of chemical erosion. 3. The employment of sufficient points above to dominate all parts of the building. 4. The addition of terminal points to the conducting system wherever any part of the structure of the building comes near to the limiting surface of a conical space having the main point of the conductor for its height, and a breadth equal to twice the height of that point from the earth for the diameter of its base. 5. The avoidance of all less elevated conducting divergencies within striking distance of the conductor, and especially such dangerous divergencies of this character as gas-pipes connected with the general mains, and therefore forming good earth contacts.

The "Times" Weather Chart.—The method of preparation of the chart seems simple enough, but it has been the fruit of much thought, as the problem of producing, in the space of an hour, a stereotype fit for use in a Walter machine was not solved without many and troublesome experiments.

In the first place, a material had to be provided which would admit of being engraved rapidly without burr or chipping, and would, without further preparation, serve as a mould for type metal. Secondly, drill pantagraphs had to be adapted to engrave the lines, and to be furnished with a gauge so as to vary their depth at pleasure.

The actual process is as follows:—The outline of the land is kept standing, and the composition is run in a mould bearing this outline on one face. The block, which is now an outline chart of the British Islands, is then placed under the pantagraph drill, which reduces the original drawing, furnished from the Meteorological Office, to one-fourth. The barograms and wind arrows are put on direct from the drawing, the figures and words by means of templates, in order to ensure uniformity in the type.

The instant the block is engraved it is ready to be stereotyped, and then it is a simple matter to adapt it in the usual manner to the cylinder of the machine.

Weather and Epidemics of Scarlet Fever.—Dr. Mitchell (Scottish Meteorological Society). The object of the author was to determine whether, in the case of a disease which is strongly epidemic, the obedience to seasonal influences would exhibit a steadiness and uniformity of character, such as is presented in the case of pulmonary diseases. In London there have been six epidemics of scarlet fever during the last thirty-five years, reaching their maxima in 1844, 1848, 1854, 1859, 1863, and 1870. Curves were constructed representing the average weekly deaths from scarlet fever for each of these six periods. These curves were then compared with the curve for the thirty years, 1845–74, the leading features of which are that it is above the average from the beginning of September to the end of the year, and below the average during the rest of the year; and that the period of highest death-rate is from the beginning of October to the end of November, when it rises to about 60 per cent. above the average, and the period of lowest death-rate in March, April, and May, when it is about 33 per cent. below the average.

On comparing the curves for the six short portions of the thirty-five years, each dealing only with four, five, or six years, with the general curve for the long period or thirty years, a remarkable similarity is found to occur. They are all substantially the same curve. The description of the general curve given above applies almost literally to every one of the six curves for short periods, and indeed so close is the correspondence that they all cross their mean almost in the same week of the year. In every case the maximum occurs in October and November.

On the Apparent Connection between Sunspots, Atmospheric Ozone, Rain, and Force of Wind.—Dr. Moffat (British Association).—In discussing ozone observations from 1850 to 1869, the author observed that the maxima and minima of atmospheric ozone occurred in cycles of years, and that he had compared the number of new groups of sunspots in each year of these cycles with the quantity of ozone, and the results showed that in each cycle of maxima of ozone there is an increase in the number of new groups of sunspots, and in each cycle of minima a decrease. The years of maximum ozone and number of sunspots were generally distinguished by an increase in the quantity of rain and the force of the wind.

Periodicity of Rainfall in Relation to Periodicity of Solar Spots.—Prof. John Brocklesby (*American Journal of Science*).—The author finds a connection existing between the variations of the sun-spot area and those of the annual rainfall, the rainfall tending to rise above the mean when the sun-spot area is in excess, and to fall below when there is a deficiency of solar activity.

Periodicity of Hail.—Professor H. Fritz (*Central-Blatt für Agrikultur Chemie*).—The author finds that the seasons when hail is most frequent are those in which spots in the sun are most numerous. On the other hand, the years when solar spots are at their minimum are characterised by the rarity or absence of hail. It has also been observed that when the aurora is very frequent during the winter, frequent hail-storms occur in the following summer.

Rain in the British Isles in 1874.—(G. T. Symons).—The results of observations carried on at about 1,700 stations on those islands shows that the average rainfall in the years 1850-9 was 32·12; in 1860-9, 35·74; and in 1874, 34·28. The rains of October the 6th were the most remarkable of the year 1874, and they had no equal since July 6th, 1872. At about eighty stations the fall exceeded two inches; at twenty-eight stations it exceeded three inches; at Little Langdale it was more than four and a half inches;

and at Bryn Gwynant it was four and a half inches.

Rain in 1875.—Mr. W. F. Denning sends us from Tyndale House, Ashley Down, Bristol, the following condensed summary of his observations of rainfall at this station in the south-west of England:—

"Rainfall in 1875, 43·148 in.; annual average, 32·048 in.; excess over average, 11·100 in.; rain fallen in the 16 consecutive months ending November, 1875, 63·221 in.; average of same period, 44·275 in.; excess over average in 16 months, 18·946 in.; mean daily fall during the 16 months, 0·122 in.; average daily fall of same period, 0·086 in.; mean daily excess (on 518 days), 0·036 in. The excess on the past year was very large—larger, in fact, than had previously been recorded; but the immense surplus over the average yield during the 16 months ending November last was much more extraordinary, amounting to 19 in. (nearly), which corresponds to 1,919 tons of water per acre. There were two remarkable periods, equal in duration, of very heavy and frequent rains, as under:—Nine weeks ending October 7, 1874, 13·521 in.; nine weeks ending November 20, 1875, 15·942 in. Thus, 29½ in. fell during the 18 weeks specified. The aggregate fall of the whole 16 months nearly equalled a two years' average, and is quite without parallel so far as I can find from existing records of rainfall in this locality. The averages given above are deduced from 20 years' observations (1853-72) by Dr. Burder, F.M.S., of Clifton."

The Climates of the Present and Past and the Causes of their Variability. — Professor Duncan (Royal Institution).—The result of the action of dew and quiet rain falling on rocky surfaces is to be seen on old tombstones in country churchyards, where, except in the case of hard stones such as granite, ti is rarely possible to decipher epitaphs after a lapse of a hundred years. The action of frost as a disintegrator depends on the fact of water expanding when freezing; on thawing, the contact formerly existing between the crevices of the rocks and the flakes of sandstone is abolished, and there remains only so many pieces of shale in place of what had formerly been a compact mass. Plenty of evidence of this action can be obtained by visiting any cliff in the spring.

Climate is determined by currents of air and water, by the high or low land in the neighbourhood, and to a certain extent by latitude and its relation to the direct influence of the sun's rays. Of course, the equator, where there are fewer oblique rays, receives more of the sun's heat than the Polar regions, where the rays are more oblique and have to pass through an intensely cold atmosphere before reaching the earth's surface. Taking the Himalayas, the Southern Sahara, and South Mexico, as places within the same parallel, denudation in each of these districts is produced by entirely different agents. In the Himalayas disintegration was the result of an astounding rainfall, nearly sixty feet in a few months, and so powerful is this agent, that tops of the hills are bare of soil, and great gorges have been cut in the sides of the mountains, which are formed of the hardest granite. In the Sahara, on the contrary, the denudation is the effect of the very powerful solar heat on a country destitute of sufficient moisture, whilst in South Mexico nature accomplishes her purpose by an equal temperature resulting from sea on either side.

Climate of Northern Siberia. —(Professor Köppen.)—The winter lasts eight months: in the middle of May the geese begin to come, and at the end of the month the river is open. In the middle of June the air is filled with birds of passage, whose flight produces a constant rustling noise. The gardens are planted, though the thaw has not penetrated to a depth greater than a foot or eighteen inches. In 1859 nine pounds of barley were sown June 17. The corn came up June 30, was in ear July 29, and in flower August 15. The crop was cut on September 6, unripe, owing to frost setting in, but yielded sixty pounds of grain.

In the end of July the heat is very oppressive, with quantities of gnats; the sky is generally clear. In the end of August cloudy days begin, with southerly winds, and in September the frosts commence. Early in October the river closes again.

The great feature of the climate is the "purga." The purga is a chaos of hard, driving snow dust, closing the eyes, stopping the breath, and forcing its way through your dress, while the force of the wind is such as to overturn man and reindeer, and the traveller must stop and sit on his sledge with his head to the wind till the storm is over. These storms seldom last less than twenty-four hours, and often hold for three, six, or even twelve days with occasional intermissions. They occur in autumn and spring, not in winter, when the weather is for the most part calm.—*Academy*.

Earthquake Indicator.—(*Scientific American*).—A simple device has been for some time in use at the Cambridge Observatory, Massachusetts. The great equatorial of the observatory is mounted on a massive granite pier, whose foundations extend far below the surface of the ground. The floors of the building are carefully kept out of contact with this pier, so that no tremor may be communicated to the telescope. The pier can therefore only be moved by actual motion of the earth. Four little pins, slightly conical in form, are balanced—small end down and large end up—on the upper face of the pier. They are so nicely pointed that it requires some skill and care to set them up. Once set up, only movements of the earth can throw them down. When thrown down, the direction in which they lie indicates the direction of the earthquake wave.

Earthquakes.—Shocks of earthquakes are more numerous and frequent than is generally supposed. As many of the slight ones were apt to escape notice, P. Bertelli, formed the purpose of studying these specially. He has published the results of 5,500 observations made during a year, on pendulums suspended vertically, and observed in several azimuths by means of fixed microscopes. Making out, in decades, the curve of microseismic (small earthquake) intensity for the whole year, he finds that it does not agree with the thermometric curve, nor with the phenomena of tides, nor with the distances or positions either of the sun, or of the moon; but with the barometric curve there is agreement. In most cases, the intensity of the movements increases with the descent of this curve; so that (P. Bertelli says), gaseous masses imprisoned in the upper layer of the globe escape more easily when the weight of the atmosphere diminishes. The agreement between the two curves (barometric and microseismic), does not appear in every case; and the author attributes the movements of the pendulum to other causes besides the one he has studied. In the true shocks, this movement is in several azimuths successively.—*English Mechanic*.

Earthquake in Asia Minor, May 11, 1875.—*Kölnische Zeitung*.—On the 11th of May, at 5 A.M., a severe shock was felt at Smyrna which lasted several seconds. Two other shocks followed the same morning, and although many houses were shaken, yet none fell. It is thought that the centre of the earthquake was in the Sporades Islands. According to other reports on the dreadful earthquake of the 3rd-5th of May in the interior, the sources of the Mæander river were indicated as the centre of the volcanic action. This point is situated in the canton of Ishikli, to the south of Ushak and Afium Karahissar. The destruction was fearful at Ishikli: about 1,000 houses were completely destroyed and several thousand people killed; only about twenty dwelling-houses and two mosques were left standing. In the village of Yivril not one of 300 houses is left, and about 450 dead have been extricated from the ruins. Not far from there an immense chasm has formed in the ground, from which is running a stream of hot water. The village of Yaka is likewise annihilated. In other villages, as Savasli, Karayapli, &c., the inhabitants escaped with a violent shock.

Earthquake in South America.—May 18, 1875.—The region affected by the shocks covered five degrees of latitude, and was 500 miles wide. The shock extended along the northern range of the Andes. It was felt first at Bogota, the capital of New Granada, thence seemed to travel north, gathering intensity as it advanced, until it reached the south-east boundary line of Magdalena, where the work of destruction began, continuing as it advanced along the eastern boundary of Magdalena, following the line of the mountain range, and destroying in part or whole the cities of Cucuta, San Antonio, El Bosario, Salazar, San Cristobal, San Cayetano, and Santiago. The first premonition of the terrible visitation occurred on the night of May 17th, when a strange rumbling sound was heard beneath the ground, although no earthquake occurred. It travelled in the direction afterwards taken by the earthquake, and lasted only a few minutes. On the morning of May 18 a terrible shock occurred. It suddenly shook down the walls of houses, churches, indeed all the principal buildings, burying the citizens of the place beneath the ruins. Another shock completed the work of desolation. Three more shocks followed of equal intensity, but there appears to be no evidence that there were any openings in the earth (at least not in Cucuta), which on similar occasions have engulfed buildings and inhabitants. The shocks, with lesser force, however, seem to have been felt throughout the whole region of the earthquake for two days afterwards, extending to Cartagena and the western sea-coast. To add to the horror of the calamity, the Lobotera Volcano suddenly began to shoot out lava in immense quantities, or, as a correspondent writes, "it sent out a mass of molten lava in the form of incandescent balls of fire into the city."

Chameleon Barometer, its value as an Hygrometer.—A piece of filter paper soaked in a strong solution of cobaltous chloride ($CoCl_2$) is blue when dry, and red when moist; and is very sensitive to slight changes in the quantity of moisture in the atmosphere.

It appears that the temperature has nothing to do with the colour of the paper, as it registers the same tint whether the day be hot or cold.

Such a paper is a handy addition to the thermometers, as you can see at a glance whether the air is wet or dry.

Self-Recording Barometer.—Messrs. Dollond & Co. have devised an ingenious and simple clockwork arrangement by means of which a strip of metallic paper passed round a drum is carried at a uniform rate beneath a point which each hour is brought against it. This point expresses by its vertical rise and fall the height of the mercurial column. The paper band is sufficient to last one week, when it is changed for a fresh one.

Certain Small Oscillations of the Barometer.—Hon. R. Abercromby (Meteorological Society).—These small oscillations of the barometer (sometimes called "pumping") have long been associated with gusts of wind, but the precise nature of their action has not been determined. The author gives two examples as typical: 1, window looking south, wind nearly south, in strong gusts. In this case the first motion of the barometer is always upwards about 0·01 inch, as if the effect of the wind being arrested by the house was to compress the air in the room; 2, a corner house, one window to the south, another to the west, wind south, in strong gusts. With the west window open, there are violent oscillations, but in this case the first motion is always downwards. On opening the south window as well, the pumping ceases. The explanation seems to be, that the wind blowing past the west window draws air out of the room, but when the south window is open as much air comes in as is drawn out, and the pumping ceases. It is well known that many acute diseases are aggravated by strong winds; and the author has observed this distress to be associated with the pumping of the barometer. He suggests the following practical methods of palliation: if windows can be borne open, try by crossing, or otherwise altering, the drafts to diminish the distress. When, as in most cases, windows cannot be open, all doors and windows should be closely shut, as well as the vent of the chimney if there is no fire; and, if possible, the patient should be moved to a room on the lee side of the house.

The Tides.—Sir William Thomson (Glasgow Science Association).—The author defines the tides as motions of water on the earth, due to the attraction of sun and moon. We give the name of spring tides to the greater tides observed about the full of the moon and new moon, and neap tides to the comparatively small rise about the time of half-moon. It is now known that the tides are affected by the sun and other causes, as well as by the moon. If there is any dependence of the weather on the phases of the moon, it is to a degree quite imperceptible to ordinary observation. The moon's influence on the tides is about double that of the sun. The calculated effect on the tides would be that, when the sun and moon are on the same or opposite sides of the earth, the water should be three feet deeper, while it should be one foot deeper when they are at quarters. Their forces act together in the first case, and against each other in the latter. This produces the spring and neap tides. Referring to the question, why the whole earth does not yield to the influence of these forces and get squeezed out of shape, the author gives the strongest contradiction to the geological hypothesis that the earth has merely a solid crust and is molten in the interior. If this were so, the shell must be preternaturally rigid in order that it might keep in shape. Unless it were scores of times more rigid than steel it would yield to the forces, and take the form of equilibrium, and there would be no such phenomena as tides.

Mathematical Theory of the Tides.—Sir W. Thomson (British Association).—Laplace discusses the imaginary case of an ideal rigid earth, rotating with the actual velocity, and covered all over with sea, the depth being any function of the latitude. He supposes the tide-generating body (sun or moon) split into halves (moon and anti-moon), and the two halves fixed on opposite sides of the earth in the plane of the equator, and assigns to the ocean a uniform depth, which he first supposes to be $\frac{1}{2300}$, then $\frac{1}{722}$ and then $\frac{1}{361}$ of the radius of the earth, or roughly, 2,000, 8,000, and 16,000 fathoms. With the greatest of these depths, he finds that there will be high water under the moon and anti-moon, the height being 1·92 of the height of the "equilibrium tide." For the intermediate depth he finds a nearly similar position for high water, its height being much greater than before, namely, 11·27. For the smallest of the three depths, he finds that there will be low water under the moon and anti-moon, and high water in the intermediate quadrants, the height of the tide being 7·43, and reckoned negative. This is for the equatorial zone contained between the two parallels of 18°. These two parallels will be nodal lines, so that the tides in the polar caps enclosed by them will be opposite to those in the same longitudes in the equatorial zone, and will, therefore, be positive.

The increase from 1·92 to 11·27, followed by the change of sign to —7·43, indicates that as the depth is supposed less, the amount of tide will increase, provided the depth is, greater than a certain critical value. For that critical depth, the tide would be infinite, and would pass from positive to negative. The explanation of this startling result is, that for this particular depth the period of a free oscillation of the ocean would be equal to the period of the tide-generating force.

Meteorological Observations in the Pyrenees.—W. de Fonvielle (*Nature*).—M. Duruof, the French aëronaut, made three balloon ascents from Pau, for the purpose of studying the state of the atmosphere during the cold spring of 1875. Thrice he started with a north wind at the surface of the earth, and thrice he was able to find an upper current blowing from the south. The last time he started at 1.30 P.M., he travelled upward until 2.30 P.M., moving southwards, when, having reached a higher level, he was carried northwards. He landed safely at 4 P.M. in the department of Gers.

He found in his last trip on March 4 that the wind was veering regularly with increasing altitude, and was steady at certain levels, so that it was possible to go in any direction by keeping the proper altitude for a sufficient length of time.

It was observed during the spring that the barometer was low with a northern wind, which is unusual. The three ascents of Duruof may be regarded as affording an explanation of the fact, if we suppose the southern current to have been general at an altitude of 4,000 to 9,000 feet above the earth.

The superior current on the 4th of March was carrying immense quantities of snow at a temperature of 0° C. The snow rapidly melted in its descent, as the air was mild below. It is probable that this snow was caused by the influence of the Pyrenean range, which is very cold.

The southern aërial stream which carried the balloon northwards was very thick. M. Duruof was unable to find its upper surface, although he reached the level of 11,000 feet.

M. Godard made an ascent in the balloon "Saturn," from Bayonne, on March 29, at half-past five, and was drifted over the Pyrenees. The trip was difficult, as the balloon was loaded with snow and hail, and all the ballast had to be thrown over in order to keep the balloon afloat. The cold was intense, and the wind very strong. The landing took place at Azul Mayor, a small country town east of Pampeluna, at half-past seven. The grapnel having been broken, the aëronaut and the three passengers were severely hurt. This is the first time that any balloon has crossed the Pyrenees. The "Saturn" followed the French valley of the Nive, and the Spanish valley of Baztan on the southern side. An interesting observation was made when crossing the culminating point of the pass. The Larratéce Neguya was surrounded by cirro-cumulus, which resisted the force of the wind and seemed an obstruction in the way of aëronauts, who found it necessary to throw out a certain quantity of ballast, and to reach an altitude of 6,600 feet, in order to cross the sea of motionless clouds. A strong hissing noise was heard when travelling over them; whether it was produced by the friction of the air on the peaks or on the masses of electrified vapours, can only be decided by another experiment conducted scientifically.

Ascents of the "Zenith."—W. de Fonvielle (*Nature*).—The longest aërial trip on record was made by the "Zenith," a balloon which ascended from Paris on Thursday, 23rd March, at half-past six in the afternoon, and landed at Montplaisir, near Arcachon, 700 miles from Paris, on the following evening at half-past five. The aëronaut was M. Sivel, and the passengers were M. Gaston Tissandier, M. Albert, his brother, an artist, and two other gentlemen.

The balloon drifted southwards for a few miles, when, crossing Paris, it deviated in a westerly direction before reaching the fortifications. It then travelled south-west during the whole of the night, crossing Meudon, Saintes, &c., up to the mouth of the Gironde, which was crossed at ten o'clock in the morning, 600 miles having been run in 15½ hours. The wind, which was not strong, having gradually diminished, the crossing of the Gironde occupied not less than thirty-five minutes. As the sun became bright and the weather hot, a brisk wind blew from the sea towards the land, but only up to an altitude of 900 feet. The aëronauts took advantage of this current to escape the upper current drifting towards the sea, and followed the margin of the Gulf of Gascony by alternate deviations obtained by changes of level.

Landing was accomplished without any difficulty by throwing a grapnel.

A quantity of air was sent by an aspirator through a tube filled with pumice, saturated with sulphuric acid, in order to stop the carbonic acid and ascertain how many hundreds of grains are contained in each cubic foot. A series of experiments were made at different levels from 2,700 to 5,000 feet, the utmost height reached.

At Paris, the air contained 37 cubic centimètres of CO_2 per 100,000; at a height of 2,700 feet 27 cubic centimètres, and at 3,300 feet 30 cubic centimètres.

The electricity of the air, tested with copper wires 600 feet long, was found nil, except at sunrise. It is known that at that very moment an ascending cold current is almost always felt.

The minimum of temperature was about +25° Fahr.; at Paris, on the same night, it was about +28° at the Observatory.

The moon was shining brilliantly, with a few cirrus clouds that manifested their presence by a magnificent lunar halo, which was observed from five o'clock to six in the morning.

The phenomenon gradually developed: the small halo (23°) showed itself first, and afterwards the large halo (46°), but as the aëronauts were at a small distance below the level where icy particles were suspended, the larger halo, instead of being circular, was seen projected elliptically. The dimensions of the smaller halo had been somewhat diminished. The horizontal and the vertical parhelic (or rather paraselenic) circles crossing each other at right angles on the moon, a cross was seen in the middle of a circle, and an ellipse concentric to it. The last part of the phenomenon was a cross, that remained longer than the two halos, which had vanished before the rising of the sun.

The "Zenith" was again sent up on the 15th of April in order to determine the quantity of carbonic acid contained in the atmosphere of an altitude of 24,000 feet. The "let go" was given at twenty-five minutes to twelve A.M. The captain was M. Sivel, and there were only two passengers, M Gaston Tissandier and M. Crocé-Spinelli. The ascent took place gradually in a slight E.N.E. wind, the sky being blue but vaporous. The rate of ascent was calculated to be nine feet per second, but diminished gradually. Shortly after one o'clock the altitude obtained was 22,800 feet, and the passengers were quite well, although feeling weak. The inhalation of oxygen produced good restorative effects when tried. Then a consultation took place, and the "Zenith" being in equilibrium, a quantity of ballast was thrown overboard. M. Tissandier then fainted, and is ignorant of what was felt by his friends.

At eighteen minutes past two he was awakened by M. Crocé-Spinelli warning him to throw over ballast as the balloon was fast descending. He obeyed mechanically, and at the same time Crocé-Spinelli threw overboard the aspirator, weighing eighty pounds. Tissandier then wrote in his book a few disconnected words, and again fell asleep for about an hour. When he awoke, the balloon was descending at a terrific rate; no more ballast was left to be thrown away, and his two friends were suffocated. Their faces had turned black, and the blood was flowing from their mouth and nose. They were evidently dead. It was a terrible situation.

The only resource was to cut the grapnel rope a little before the instant when the car should strike the ground, which Tissandier did with astonishing ccolness. The wind had increased in strength, and Tissandier was obliged to tear open the balloon in order to stop it. It was caught on a hedge in the commune of Ciron, 190 miles S.S.W. from Paris.

The tragic fate of Sivel and Spinelli is to be ascribed to the fatal resolution of accomplishing, at any price, a height of 24,000 feet.

The only instruments broken were the potash tubes for the absorption of carbonic acid. The experiment had been tried successfully; two aspirators had been used, but the tubes were not lodged in their proper case.

Careful readings were taken with the thermometer, and, although diminishing, the temperature was high.

The temperature of the gas in the interior of the balloon was found to vary very little, owing to the heating power of the sun.

The aëronauts had in their car maximum barometers in a sealed box, in order to test the altitude in which they were travelling. These tubes were tested in the laboratory of M. Hervé-Mangon. They show that the height actually reached was 14,000 mètres, or eight miles.

M. Tissandier was slightly hurt in his fall. Great sympathy has been elicited for Sivel and Crocé-Spinelli, who may be said to have spent their lives in the battle-field of the air. Sivel was formerly a captain of the mercantile navy; his age was forty-two years. Crocé-Spinelli was a pupil of the Ecole Centrale, and was thirty-two years of age.

Subsequently, M. G. Tissandier stated to the Academy of Sciences that at the height of about 2,890 feet, the temperature being 0° C., the amount of CO_2 per 100,000 parts of air was 24·0.

With reference to this lamentable misfortune, M. Faye has addressed a letter to the President of the French Academy, in which he proposes that the Academy should fix a limit of elevation, beyond which no ascent having a scientific object in view should be allowed to go, or its results received by them. "In my opinion," he says, "the extreme height of 7,000 mètres answers all the serious needs of modern science. The atmosphere extends, indeed, more than 28 leagues beyond that; for the observations of shooting stars, of which the extreme point of inflammations is nearly 120 kilomètres (about 75 miles) in height, assign a thickness of 30 leagues to the aërial stratum which surrounds our globe. But of these 30 leagues, the first two only are of importance, and it is not the exploration of a kilomètre more or less which can seriously influence the progress of science. Yet this kilomètre the more implies the temporary annihilation of our faculties, and perhaps death. . . Observations made in danger of death, or whilst fainting is imminent, can be of no real benefit to science. There will still remain sufficient perils to face to please those intrepid souls to whom danger only forms one attraction the more."

Ballooning.—Mr. Donaldson, the American aëronaut (*English Mechanic*).—The lifting strain of a balloon is principally on the net. If a balloon will stand inflation it is safe in mid air. In winter the atmosphere is warmer one mile above the clouds than it is at the earth's surface. The weight of a balloon to carry one man, including net and basket, should not exceed 80 lb. A cotton balloon will last for about 60 ascensions. A balloon 30 feet in diameter undergoes a strain of 1¼ lb. to the square foot of surface. Gas which at the earth fills the bag only half full, will, at an elevation of 3½ miles, expand so as to fill it completely. One thousand feet of coal gas will raise 38 lb. Gas which gives a poor light is the best for aërostatics. Kites can be used to steer balloons by sending them up or lowering them into currents of air travelling in different directions from that in which the balloon is sailing.

ASTRONOMY.

The Government Eclipse Expedition to Siam.—F. E. Lott (*Nature*).—The King sent several of his officials to assist us, and ordered such observations to be made at Bangkok as the chief of the expedition, Dr. Schuster, might consider of use to the expedition; the King himself observed and made a drawing of the corona. Our camp and observatory were situated some fifty miles from the city of Bangkok, on the west of the Gulf of Siam, in the central line of totality.

The eclipse itself differed from former ones in respect to the greater brightness of the corona and the smallness and fewness of the red flames.

Two sets of instruments were employed as telespectropes. The image of the corona, which appeared very distinct and bright on the slit-plate, although exposed during the whole of totality, gave no visible results on the photographic plate; even the sun itself, exposed for two seconds for the purpose of obtaining an index, gave likewise no result.

Numerous drawings were sent in by the Siamese, which will be very valuable.

Solar Eclipse of 1875.—Dr. J. Janssen (British Association).—The author observed the eclipse of April, 1875, at Bangchallô (Siam). He used a special telescope for the study of the corona. The results were—1. The establishing that the line 1474 is infinitely more pronounced in the corona than in the protuberances. This line seems even to stop abruptly at the edge of the protuberances without penetrating them. The light, then, which gives the line 1474 belongs entirely to the corona. This observation is one of the strongest proofs which can be adduced to prove that the corona is a real object, a matter radiating by itself. The existence of a solar atmosphere situated beyond the chromosphere—an atmosphere which M. Janssen had recognised in 1871, and proposed to call the coronal atmosphere—thus receives confirmation. 2. Height of the coronal atmosphere. In 1871 Dr. Janssen announced that the coronal atmosphere extended from half the sun's radius to a whole radius at certain points. This assertion has been confirmed not only by the direct views of the phenomenon, but also by photography. At Dr. Janssen's request Dr. Schuster took photographs of the corona with exposures of one, two, four, and eight seconds. In this series of photographs the height of the corona increases with the time of exposure. The height of the corona in the eight-seconds' photograph exceeds at some points a solar radius. (It is true that we ought to take account of the influence of the terrestrial atmosphere.) 3. As the sky was not of perfect clearness at Bangchallô, Dr. Janssen observed phenomena that explain previous observations of eclipses which seemed to invalidate the existence of the corona as a gaseous incandescent medium. On the whole, the observations of the 5th of April, 1875, have advanced us a fresh step in the knowledge of the corona by bringing forward new proofs of the existence of an atmosphere round the sun, principally gaseous, incandescent, and very extended.

The Solar Eclipse of April 16th, 1874.—Mr. Stone (Astronomical Society).—The author had observed the reversion of the Fraunhofer lines at the commencement of totality, and had detected dark lines in the faint continuous spectrum of the Corona. His drawings agreed generally as to the outline of the Corona, and indicated symmetry with regard to the Sun's axis.

The Sun's Motion in Space.—Mr. Safford, of the Chicago Observatory, has entered on a new investigation of this problem, founded on the assumption that the greater a star's proper motion, the nearer it is to us. The difficulty of this question is that, in order to find that movement of the sun which will account for as great a part as possible of the proper motions of stars generally, it is necessary to make some assumption as to the relative distances of the stars considered. Airy and Dunkin in their investigations took a star's magnitude as a guide to its distance; but Mr. Proctor has given strong reasons, based on the proper motions of the star used, for concluding that this is not even approximately true, and Mr. Safford has rejected this hypothesis and redetermined the solar motion from the proper motions used by Argelander, Galloway, and Lundahl respectively in their investigations, dividing the stars into groups of ten, for each of which the proper motions are nearly equal. The sun's motion being then found from each group, on the assumption that the distance is inversely proportional to the proper motion, the accordance of the results will be a test of the truth of this hypothesis, while the amount of the proper motions thus accounted for will give an idea of the reality of the result arrived at. On both points the answer is satisfactory, and from these investigations Mr. Safford draws the following conclusions:—1. In studying the solar motion, the distances must be assumed with reference to the amount of proper motion and (approximately) in inverse proportion to it. 2. The smaller proper motions ($0''\cdot13$ or less annually) need careful study at this time. 3. There is some hope of using the solar motion as a sort of base to advance our knowledge of stellar distances. 4. The parallaxes of all stars whose proper motion exceeds $1''$ annually (about 60 in number), should be systematically determined by a co-operative arrangement.—*Academy.*

Heliostat.—Samuel Wells (Boston, U.S., Acad. Nat. Science).—This instrument is made from a marine clock, capable of running like a watch, in any position; the hands being removed, a pulley of ½ in. diameter is slipped on to the arbor of the hour-hand; on the woodwork at the top of the clock is fastened bearings for a small shaft, carrying at its upper end the plane mirror intended to follow the movement of the sun. On this shaft is a pulley one inch in diameter, deriving motion from the pulley on the hour-hand arbor by a cord. A support attached to the side of the clock carries a subsidiary mirror directly above the revolving mirror. The clock is hung on a board, hinged so as to be capable of elevation to an angle equal to the completement of the latitude. The face of the clock is turned to the north. The revolving mirror is adjusted to the declination of the sun so as to reflect the ray to the north. The ray is received on the subsidiary mirror, which reflects it in any required direction.

The Sun's Diameter. — Dr. Fugh (*Astronomische Nachrichten*).—From considerations of the measures of the sun's diameter made at Greenwich from 1836 to 1870, the author has ascertained that there is no appreciable compression, a conclusion arrived at several years ago by the present Astronomer Royal.

The Sun's Parallax.— Prof.

Galle.—The author has completed his reduction of the observations taken in both hemispheres near the opposition of the planet Flora in 1873, when it approached the earth within about 0·87 of our mean distance from the sun. The final result for the parallax 8″·873 corresponds to 23,247 equatorial semi-diameters of the earth, or, according to Galle, 19,979,000 geographical miles of 15 to the degree of the equator.

Prof. Galle remarks upon the close agreement of his result with that obtained by the numerous and very exact measures of the velocity of light, by M. Cornu, at the Observatory of Paris, with the theoretical determination of M. Leverrier from the perturbations of the planet Mars, and with M. Puiseux's first result from observations of the transit of Venus at Pekin and St. Paul Island.

M. Liais, Director of the Imperial Observatory of Rio de Janerio, has intimated his intention to make a serious attempt to determine this important element from the very favourable opposition of the planet Mars, which will occur early in September, 1877. The planet arrives at perihelion on the 21st of August in that year, and in opposition at midnight on the 5th of September; it is in perigee on September 2nd at a distance of only 0·3767, which is not far from the minimum.

The horizontal parallax of Mars will attain a value which will be sensibly equal to that of Venus, diminished by that of the sun. With firm instruments and experienced observers, it is very probable that the amount of solar parallax may be determined by differential observations of Mars at the opposition of 1877, with a precision which may be comparable with that resulting from observations of a single transit of Venus.

Minor Planets. — (*Nature*). — Flora has the shortest period of revolution, 1,193 days, and Sylvia the longest, 2,374 days; the corresponding mean distances, expressed in parts of the earth's mean distance from the sun, being 2·201 and 3·482. The nearest approach to the sun is made by Phocea, 1·787, while Freia recedes furthest from him, the aphelion distance being 4·002. We may add to these the following values near the extremes of distance:—

	Distance in Perihelion.
Melpomene	1·796
Clio	1·805
Victoria	1·823
Iris and Ariadne	1·835
Eurydice	1·854
Flora	1·856
Polyhymnia	1·890
Virginia	1·899

	Distance in Aphelion.
Sylvia	3·757
Cybele	3·803
Pales	3·810
Euphrosyne	3·849
Hermione	3·882

Polyhymnia has the greatest eccentricity, 0·33998, and Lomia the least, 0·02176; Pallas the greatest inclination, 34° 42′, and Massalia the least, 0° 41′. It will be seen that the difference of distance from the sun between Phocea in perihelion and Freia in aphelion is 2·315, corresponding to about 204,000,000 miles.

Satellites of Uranus.—Prof. Holden.—It is well known that Sir W. Herschel sixty years ago announced that Uranus was accompanied by six satellites; but of the existence of four of these there has always been considerable doubt, since no one was ever able to confirm the observations of Herschel. In 1847 Lassell discovered two intetior satellites; and since that day the four problematical satellites of Herschel have been generally discarded by astronomers. Professor Holden now brings testimony to the high excellence of Herschel's observations, as, by computing backward, he has shown that probably this distinguished astronomer actually observed the two interior satellites of Lassell (named by him Ariel and Umbriel); but that he was prevented from identifying them as satellites because his telescope could not show them on two successive nights.

Saturn.—M. Le Verrier has presented to the French Academy his theory of the planet Saturn. He has compared the results deduced from his theory with the Greenwich and Paris observations, the former commencing in 1752, the latter in 1837. The agreement throughout is very satisfactory, the only discordances being of a few (five or six) seconds of arc in the heliocentric longitudes in some of the early Greenwich observations and in some of those made both at Greenwich and Paris between 1839 and 1844. When it is considered what a difficult object Saturn is to observe well, when it is partly more or less covered by the ring, or rather rings, this cannot appear surprising; and from the nature of the discordances in question, M. Le Verrier believes that they are chiefly due to this cause.

Mercury.—Dr. Zöllner has deduced some important conclusions as to the physical condition of this planet's surface from measures of the intensity of its light by the use of his photometer. This instrument is a very beautiful application of the principle that if light be reflected from a smooth surface, such as a plate of glass, inclined at a certain angle, it undergoes a modification of such a nature that the amount reflected from a second plate inclined to it at the same angle varies as the plate is turned about the ray as an axis, being greatest when the two plates are parallel, and nothing when the second plate is turned round through a right-angle from this position. Thus by turning the one plate round, the light of a lamp may be reduced in any required degree till it is equal to that of the heavenly object of which the brightness is required, and the angle turned through from the position for extinction gives a measure of this brightness. Dr. Zöllner uses a rather more convenient arrangement than two glass plates: viz., two Nicols' prisms, but the principle is the same. From his measures of the brightness of Mercury with this photometer, he concludes that the reflective power of this planet is much the same as that of the moon (being a little higher than quartz porphyry); and that the change of brightness with the phase is just what would hold for a rough surface in which the average slope of the hills was 52°; from this he infers that Mercury must therefore be without an atmosphere. The reflective power of the other planets, with the exception of Mars, is very much larger, and they have, therefore, probably very dense atmospheres, which reflect nearly all the sun's rays. Mars would appear to hold an intermediate position—part of its light being reflected from its atmosphere, and part from its surface.

Cassandra.—The period of revolution assigned to Cassandra for November, 1872, is 1598·5 days. Several of the groups to which this planet belongs are now adrift, the elements not having been determined with sufficient approximation to keep them in view. The planet found by Borrelly at Marseilles, 1868, May 29, and that detected by Pogson at Madras on November 17 in the same year, are thus situated; both travel beyond the limits of our ecliptical charts, which contain very small stars.

New Variable Star.—Herr R. Falb, of Vienna, has discovered a new variable star, near Orionis, on the night of January 31. The discovery was confirmed on the same night by Prof. Oppolzer at his private observatory, and on subsequent nights by the astronomers at the Imperial Observatory of Vienna. The star is visible with the naked eye.

New Planets. — The small planets discovered by Palisa at Pola, near Trieste, on March 18, April 21, and October 13, last year, have received the names Austria, Melibœ, and Siwa, respectively. The only one still in want of a name is that discovered by Prof. Watson, in China, on October 10, No. 139.

Another new member of the minor planet group was discovered by Palisa at the Observatory of Pola, on Jan. 28, 1875. Its position at 8h. 42m. local time was in R.A. 9h. 57m. 56s., N.P.D. 76° 14′. The planet is of the twelfth magnitude. This discovery was made with a telescope of 7⅔ ft. focal length. It appeared of the 12th magnitude, and on Jan 28, at 11h. 23m. 47s. Pola mean time, under R.A. 8h. 25m. 56s.82, and Decl. + 18° 17′ 38″4, with a daily motion of - 1m. 6s. R.A., and + 2′·8 Decl.

This planet (No. 142) has received the name of Polana, in allusion to the place of discovery, Pola, near Trieste.

Planet No. 143 was detected by Palisa at Pola on Feb. 23. It has received the name of Adria. The large number of these bodies makes it extremely difficult to obtain accurate ephemerides for them all.

Two new small planets (Nos. 144 and 145) were observed on June 4th and 5th, by Prof. C. H. F. Peters, at Hamilton College Observatory, Clinton, U.S.

M. Borrelly, on the 8th of June, detected a small planet, No. 146, which has received the name of Lucina. These he has named Vibilia and Adeona.

No. 148 was discovered at the Paris Observatory on the night of August 7, by M. Prosper Henry. The same gentleman had previously discovered Nos. 125 and 127 in the year 1872.

Transit of Venus—Atmosphere of the Planet.—Professor C. S. Lyman observed the planet Venus on the 8th of December, a few hours before its transit began, and found that from the time when it was 1° 50′ distant from the sun's centre, up to the time of its passage across its disc, it was apparently surrounded by a ring of light, which appearance was due to the refraction of the sun's light passing through the planet's atmosphere on its way to the earth. This phenomenon was first observed by Prof. Lyman in 1866, and will again occur in 1882, being repeated, in fact, as often as the planet approaches within the limiting distance above mentioned. When further from the sun than this limit, the circle of light becomes a segment only, whose size diminishes as the planet recedes from the sun.

Transit of Venus as seen in Japan.—Dr. Janssen (British Association).—The expedition divided into two parts, the one taking up its station at Nagasaki and the other at Kobi. At Nagasaki Dr. Janssen observed the transit with an equatorial of 8 inches aperture. He obtained the two interior contacts. He saw none of the phenomena of the drop or of the ligament; all the appearances were geometrical. He observed facts which establish the existence of an atmosphere to Venus. He saw the planet Venus before her entry on the sun, with suitable coloured glasses. This important observation proves the existence of the coronal atmosphere. There was taken at Nagasaki a plate of the revolver for the first interior contact. M. Tisserand observed the two interior contacts with a 6-inch equatorial; the contacts were sensibly geometrical. Sixty photographs of the transit on silvered plates were obtained; and also some other photographs (wet collodion and albumenised glass). At Kobi (weather magnificent) fifteen good photographs of the transit (wet collodion and albumenised glass) were obtained of about 4 inches in size; they will admit of being combined with the English photographs at the southern stations. The astronomical observation of the transit was successfully made by M. de la Croix, who was provided with a 6-inch telescope. His observations attest the existence of an atmosphere round Venus.

Mr. Stone, the Government Observer at the Cape of Good Hope (Astronomical Society) says:—As Venus drew near to the sun's limb he had seen, first, a faint ligament form, which gradually became darker and broader, until at last the planet appeared to be egg-shaped. He could only estimate the true contact by observing the time when the curvature of the limb of the planet appeared to be symmetrical and coincident with the sun's limb; he had made use of a power of 220 and a very bright field of view.

Mr. A. C. Russell, the Government Astronomer at Sydney (Astronomical Society) stated that he had not seen any black drop; but for a few seconds before the moment of contact he had seen what he must describe as a vibratory motion between the planet and the limb, and as soon as the contact had taken place a haziness came over the junction of the two which did not blot out the cusps, but the appearance was as if a piece of black wool had been laid over them.

Soon after this, nearly all the observers noticed a faint line of light round that part of the disc of Venus which was off the sun's limb. They estimated its breadth at less than one second in diameter. Several of the photographic plates showed this delicate bright line, and also a ring or halo of light round the part of the body of the planet that was upon the sun's disc. The halo was seen by nearly all the observers, and appeared to be similar to a halo or line of light that had been observed by Mr. Huggins on the occasion of the transit of Mercury in 1861. There distinctly appeared to be an extra deposit of silver all round the dark body of the planet, as seen upon the sun in all the photographs. He would have been quite prepared for an increase in the deposit of silver over the body of the planet, but this was outside the planet, and upon the sun's disc. It was so marked that, he said he felt he could not accept the explanation offered by Mr. Stone in 1868—viz., that it was due to contrast. One of the observers who had seen the black drop distinctly, and thought that its length was nearly a semi-diameter of the planet, immediately started the handle of a Janssen apparatus, and obtained sixty pictures upon the plate during the following minute, but not one of them showed any indication of a black drop, and the line of sunlight separating the planet from the sun's limb was perfectly sharp and hard, and, what was perhaps more remarkable still, it was only one-twentieth of the diameter of the planet, or three seconds across, whereas the conviction of the observer was that it was some thirty seconds across. Another observer who saw the black drop, and estimated its length at about a semi-diameter of the planet, took photographs immediately afterwards, and in this case the photograph showed no black drop, but an arc of sunlight between the planet and the limb, one-twentieth of the planet's diameter in breadth.

As to the ring of light round the part of the planet that was off the sun's disc, most of the observers saw it, and estimated it at less than a second in diameter. They most of them also observed that one portion of the ring was brighter than the rest, this brighter portion appeared to be situated over the part of the limb which corresponded to the pole of Venus. He himself had distinctly observed it. It appeared to be even brighter than the limb of the sun. The halo of light that was round the part of the planet's limb that was upon the sun's disc was much broader: it was difficult to estimate its breadth, but probably it was about a fifth of the diameter of the planet. There could be no doubt about it.

Mr. E. W. Pringle writes to *Nature* from Manantoddi, Wynaad:—"Owing to non-receipt of instruments from England, I had to fall back on a small 2½" refractor by Cooke, of York, the definition of which is superb, even with a power of 53—that used on the occasion. My station was on a hill nine miles from Manantoddi, about 800′ above that place and 3,600′ above sea-level. The morning of the 9th was simply perfect. I missed first external contact, and watched anxiously for the internal contact. When the planet was about half immersed, the entire disc became visible, for the portion external to the solar surface was surrounded by a fine silvery ring like a minute corona. This observation was verified by my brother, and the phenomenon was again visible at emersion As first internal contact approached I looked carefully for the 'black drop,' but, to my astonishment, the horns of the sun grew nearer and nearer, and at last seemed to fade into the last portion of the before-mentioned silvery ring, without my seeing the smallest vestige of the far-famed 'drop,' or any apparent elongation of the limb of the planet. Had it existed to the extent of one-hundredth of the diameter of Venus, I am confident I should have seen it."

Lord Lindsay at the Mauritius missed the first external and first internal contacts; the sun was not seen until 1h. 2m. after the first external contact, when it came out for a few minutes, when photographs and measures were obtained. It was not till 8 A.M. (local mean time) that it became fairly fine, and remained so with small periods of cloud obscuration until the end of the transit. Lord Lindsay took 271 plates, out of which number, perhaps, 110 will be of value. One of his photographs shows the second internal contact beautifully.

The Thebes correspondent of the *Daily News* says, Venus appeared anything but a promising subject for the purpose at first. She seemed literally to dance about the face of the sun, and her limb was jagged like a saw. They both appeared elliptical in an almost extraordinary degree, owing of course to refraction, and they did not lose it entirely till they were at least 7° from the horizon. Gradually the limbs of both got more and more defined, till Venus looked like a small black pea resting on a luminous disc. The sun, however, still remained somewhat troublesome, particularly to the photographers, and it was not till just before internal contact that he was really steady. The atmosphere of Venus was distinctly seen at certain periods. It showed as a pale white circle round part of her edge, and was totally different to the brilliant sunlight. The general remark was that it reminded us of moonlight. This caused a certain difficulty in estimating the true time of contacts, and perhaps any small discrepancy in observation may be accounted for by this phenomenon . . There is one curious coincidence to note, and that is, that no one seemed to have observed the black drop which has been so much talked about; a faint haze was seen, and a few jets of black springing out from each side of the point of contact, but nothing more. Certainly, the weather could not have been more favourable just at the critical time, though, curiously enough, immediately after a haze came on, which would seriously have affected the results. Need I say that we are all thankful the observation has passed off so well, and if only the other stations to which expeditions have been sent are equally fortunate, the sun's distance ought to be definitely settled. I fully expect that the appearance of the faint line will give rise to a long discussion in the astronomical world. One thing is certain, and that is that our atmosphere must have been very clear, and also that of Venus; clouds in the planet must have intercepted the sunlight, and have prevented the formation of the luminous ring, or rather partial ring. At one time the whole planet, when it had half passed over the limb of the sun, was visible, reminding one of the dark part of the new moon on a clear night. I may say that the whole appearance of internal contact was quite unexpected, and the absence of the black drop puzzled every observer.

Transit of Venus, Sun's Parallax.—The first result of the Transit of Venus expedition has been obtained by M. Puiseux, but its value remains to be tested. Using the observations made at Peking and St. Paul, he finds that the sun's parallax is 8·879″. The object-glasses of the instruments used in making the observations were 8½ in. in diameter. Taking the data given by the observers at the same places with instruments having object-glasses of 6·4 in. diameter he finds that the "tenth" is the same, but the hundredth less by one or two units.

MECHANICS.

Address delivered before the British Association at Bristol, August 25, 1875, by Sir John Hawkshaw, F.R.S., President.

The history of the art of the engineer, like that of many other branches of knowledge, is one of rapid growth during the last century, following a slow and broken progress from the times of earliest civilisation. It has repeated its inventions in different ages.

The ancient Egyptians had a knowledge of metallurgy, much of which was lost during the years of decline which followed the golden age of their civilisation. The art of casting bronze over iron was known to the Assyrians, though it has only lately been introduced into modern metallurgy; and patents were granted in 1609 for processes connected with the manufacture of glass, which had been practised centuries before.

Even rattening is by no means a modern practice, for (on the authority of Pliny) we learn that "an inventor in the reign of Tiberius, who devised a method of producing flexible glass," suffered the destruction of his manufactory "in order to prevent the manufacture of copper, silver, and gold from becoming depreciated."

The history of the Suez Canal furnishes examples of the repetition of blunders and obstacles from want of knowledge of what had been previously done. It was asserted that a difference of 32½ feet existed between the level of the Red Sea and that of the Mediterranean. Laplace denied this; but centuries before his time a fear of flooding Egypt with the waters of the Red Sea made Darius, and in later times again Ptolemy, hesitate to open the canal between Suez and the Nile. Yet this canal was made and was in use some centuries before the time of Darius.

Early in the growth of societies, men of learning perform multifarious services; thus mathematicians and astronomers, painters and sculptors, and priests, performed the duties of the architect and engineer. But the extension of art produces specialisation, and we find men of ability and learning devoting a great part of their time to building and architecture, and the post of architect became one of honour and profit. Division of labour existed as a necessary condition of the carrying out of large works, and in Assyria and in Egypt, as afterwards in the Roman Empire, special duties and crafts were practised by separate men.

The earliest works which display a knowledge of engineering are found in the East, and, without deciding whether the people of Chaldæa and Babylonia borrowed from Egypt, we know that some four or five thousand years ago there were men in Mesopotamia and Egypt who possessed considerable mechanical knowledge and no little skill in hydraulic engineering.

Engineering like architecture was early associated with religion. The largest stones were chosen for sacred buildings that they might be more enduring as well as more imposing; a development of mechanical contrivances for moving them, an improvement in tools for working them, followed as things of course. The working of metals was perfected in making images of the gods and the adornment of shrines.

To an engineer the pyramids of Gizeh are admirable. Although they are the earliest, and were built 5,000 years ago, they are unrivalled. The masonry could not be surpassed in these days, and moreover the design is perfect for the purpose for which they were intended, above all to endure. The building of pyramids continued for some ten centuries, and from sixty to seventy still remain; many contain enormous blocks of granite from thirty to forty feet long, weighing more than 300 tons, and display the greatest ingenuity in the way in which the sepulchral chambers are constructed and concealed.

A more difficult operation than the mere transport of weight, that of erecting obelisks weighing more than 400 tons, was performed with precision by the Egyptians, but their method of lifting them remains unknown. The use of large stones in fortifications was known to the Peruvians; in India, from their repugnance to the use of the arch, builders have commonly used large blocks both in bridges and in buildings. But the Romans surpassed in mechanics the Egyptians who set up obelisks, since they transported them from Egypt, and afterwards erected them at Rome, where more are now to be found than remain in Egypt. Large stones were used in the temples of Baalbek, erected under Roman rule; one lies ready quarried which is seventy feet long and fourteen feet square, and weighs upwards of 1,135 tons, or nearly as much as one of the tubes of the Britannia Bridge.

The ancient Assyrians and Egyptians have recorded on their walls by painting and sculpture the methods employed in transporting these masses. Apparently the lever was the only mechanical power used, and with unlimited supplies of human labour this would be the most direct and expeditious implement; but it is probable that other mechanical aids were employed where stones such as obelisks had to be lifted. From a carved slab, moreover, which formed part of the wall panels of the palace of Sardanapalus we learn that the pulley was known in a simple form.

The use of iron, and probably also of steel, dates from very remote times. Egyptians, Hebrews, Assyrians certainly regarded iron as a common metal, and as there is no great secret in making steel, they probably had the use of this also. Steel may even have been accidentally produced by a less vigorous blast than would suffice for making wrought iron. The supply of iron in India as early as the fourth and fifth centuries seems to have been unlimited. The remarkable iron pillar of Delhi is in a single piece, fifty feet in length, and weighs not less than seventeen tons.

An interesting social problem is afforded by a comparison of the relative conditions of India and this country at the present time. India, from thirty to forty centuries ago, was skilled in the manufacture of iron and cotton goods, which manufactures, in less than a century, have done so much for this country. It is true that in India coal is not so abundant or so universally distributed, as in this country. Yet, if we look still further to the East, China had probably had knowledge of the use of metals as soon as India, and moreover had a boundless store of iron and coal. Marco Polo tells us that coal was universally used as fuel in the parts of China which he visited towards the end of the fourteenth century, and from other sources we have reason to believe it was used there as fuel 2000 years ago.

The art of extracting metals from the ore was practised at an early date in this country. The ancient tin workings in Cornwall are well known, and as the Britons used iron they probably got it for themselves; also the Roman iron works in the Weald of Kent are remarkable for their extent. But the enormous increase of the mining and metallurgical industries began with this century; the use of coal for smelting superseded that of charcoal, and we find that in 1873 the quantity of pig iron produced in the United Kingdom was 6½ million tons, and the coal raised amounted to 127 million tons.

The early building energy of the world was chiefly spent on tombs, temples, and palaces. In Egypt, as we have seen, the art of building in stone had, 5,000 years ago, reached the greatest perfection; ten centuries later, in Mesopotamia, the art of building with brick was in an equally advanced state. The pyramidal buildings were very massive, and are only in ruins because they have served as quarries for the building of modern towns. The Assyrian mounds and temples are the largest, but the pyramidal temples of Chaldæa far surpass them in the excellence of their brickwork.

Egypt was probably far better irrigated in the days of the Pharaohs than it is now. Reservoirs were constructed on a vast scale, which is unapproached even in these days of immense works. The *régime* of the great rivers was studied in Mesopotamia or in Egypt, and records were kept of the rise of waters. Canals, dams and tunnels were made with great skill. A remarkable work was the canal which effected a junction between the Mediterranean and the Red Sea. Its length was about eighty miles; its width admitted of two triremes passing one another.

At least one of the navigable canals of Babylonia, attributed to Nebuchadnezzar, can compare in extent with any work of later times. Sir H. Rawlinson has traced this canal throughout the greater part of its course, from Hit on the Euphrates to the Persian Gulf, a distance of betwen four and five hundred miles. It is a proof of the estimation in which such works were held in Babylonia and Assyria, that, among the titles of the god Vul were those of "Lord of Canals," and "The Establisher of Irrigation Works."

War, with all its attendant evils, has often benefited mankind. Siege operations have developed many inventions, and the necessity of roads and bridges for military purposes has often led to their being made where the necessary stimulus from other causes was wanting. Such was the case under the Roman Empire. The ambition of Napoleon covered France and her subject countries with a system of military roads, and in this country the want of roads, so keenly felt at the time of the rebellion of 1745, led to the construction of a system unequalled since the time of the Roman occupation.

The water supply of Rome, with its nine aqueducts, is a monument of her engineering power. Harbour works and bridges, basilicas and baths, and numerous other works in Europe, in Asia, and in Africa were executed under her rule. With the fall of the empire progress in Europe stopped for a time.

But with the seventh century began the rise of the Mohammedan power, and a partial return to conditions apparently more favourable to the progress of industrial art, when widespread lands were again united under the sway of powerful rulers. Science owes much to Arab scholars, who kept and handed on to us the knowledge acquired so slowly in ancient times, and much of which would have been lost but for them. Still, few useful works remain, to mark the supremacy of the Mohammedan power, at all comparable to those of the age which preceded its rise.

A great building age began in Europe in the tenth century, and lasted through the thirteenth. It was during this period that those great ecclesiastical buildings were erected, which are not more remarkable for artistic excellence than for boldness in design.

From the twelfth to the thirteenth centuries, with the revival of the arts and sciences in the Italian republics, many important works were undertaken for the improvement of the rivers and harbours of Italy. In 1481 canal locks were first used; and some of the earliest of which we have record were erected by Leonardo da Vinci, who would be remembered as a skilful engineer had he not left other greater and more attractive works to claim the homage of posterity.

It is frequently easier to lead water where it is wanted than to check its irruption into places where its presence is an evil, often a disaster. For centuries the existence of a large part of Holland has been dependent on the skill of man. How soon he began in that country to contest with the sea the possession of the land we do not know, but early in the twelfth century dykes were constructed to keep back the ocean. As the prosperity of the country increased with the great extension of its commerce, and land became more valuable and necessary for an increasing population, very extensive works were undertaken. Land was reclaimed from the sea, canals were cut, and machines were designed for lifting water. To the practical knowledge acquired by the Dutch, whose method of carrying out hydraulic works is original and of native growth, much of the knowledge of the present day in embanking and draining and canal-making is due.

While the Dutch were getting this knowledge and we in Britain were benefiting by their experience, the disastrous results of the inundations caused by the Italian rivers of the Alps gave a new importance to the study of hydraulics. Some of the greatest philosophers of the seventeenth century—among them Torricelli, a pupil of Galileo—were called upon to advise and superintend engineering works; nor did they confine themselves to the construction of preventive works, but thoroughly investigated the condition pertaining to fluids at rest or in motion, and gave to the world a valuable series of works on hydraulics and hydraulic engineering, which form the basis of our knowledge of these subjects at the present day.

Perhaps the greatest ingenuity and creative mechanical genius are displayed in machines used for making textile fabrics. It was not until a late period that the manufacture of such fabrics was established on a large scale in Europe. China had the use of silk for clothing some thousands of years ago; but in Europe, in the time of Aurelian, the empress had to forego the costly luxury of a silk gown; and so slowly did the use of silk travel westward, that James V. had to borrow a pair of silk hose from the Earl of Mar, that he might not "appear as a scrub" before strangers.

Cotton, of which the manufacture in India dates from before historical times, had scarcely by the Christian era reached Persia and Egypt. Spain in the tenth and Italy in the fourteenth century manufactured it, but Manchester, which is now the great metropolis of the trade, not until the latter half of the seventeenth century.

Linen was worn by the old Egyptians, and some of their linen mummy cloths surpass in fineness any linen fabrics made in later days. The Babylonians wore linen also and wool, and obtained a widespread fame for skill in workmanship and beauty in design.

In this country wool long formed the staple for clothing. Silk was the first rival, but its costliness placed it beyond the reach of the many. To introduce a new material or improved machine into this or other countries a century or more ago was no light undertaking. Inventors and would-be benefactors alike ran the risk of loss of life. Loud was the outcry made in the early part of the eighteenth century against the introduction of Indian cottons and Dutch calicoes.

The year 1738 saw Wyatt's invention, which was further improved by Arkwright, for spinning by rollers instead of the fingers. In 1770 Hargreaves patented the spinning jenny, and Crompton the mule in 1775. In less than a century after Wyatt's day double mules were working in Manchester with over 2,000 spindles.

Improvements in machines for weaving were begun at an earlier date. In 1579 a ribbon loom is said to have been invented at Dantzic, by which from four to six pieces could be woven at one time; but the machine was destroyed, and the inventor lost his life. In 1800 Jacquard's most ingenious invention was brought into use, which, by a simple mechanical operation, determines the movements of the threads which form the pattern in weaving. But the greatest discovery in the art of weaving was wrought by Cartwright's discovery of the power loom, which led eventually to the substitution of steam for manual labour, and enabled a boy with a steam loom to do fifteen times the work of a man with a hand loom.

There has been in little more than one generation vast progress in steamboats, the electric telegraph, and railways, the extent of which is perhaps better known than appreciated. Yet it is amusing to hear that it is not more than forty years since one of our scientific men, and an able one too, (Sir David Brewster) declared at a meeting of the British Association that no steamboat would ever cross the Atlantic; founding his statement on the impracticability, in his view, of a steamboat carrying sufficient coal, profitably, for the voyage. Yet, soon after this statement was made, the *Sirius* steamed from Bristol to New York in seventeen days, and was soon followed by the *Great Western*, which made the homeward passage in thirteen and a half days; and with these voyages the era of steamboats began. Like most important inventions, that of the steamboat was a long time in assuming a form capable of being profitably utilised; and even when it had assumed such a form, the objections of commercial and scientific men had still to be overcome.

The first useful electric telegraph was constructed in 1838, Messrs. Wheatstone's and Cook's instruments being employed, while at the present time there are 400,000 miles of telegraph in use. Among the most important inventions of recent years have been the automatic telegraphs.

In this country the machine invented by Sir Charles Wheatstone, to whom telegraphy owes so much, is chiefly employed. By his machine, after the message has been punched out in a paper ribbon by one machine on a system analogous to the dot and dash of Morse, the sequence of the currents requisite to transmit the message along the wire is automatically determined in a second machine by this perforated ribbon. This second operation is analogous to that by which in Jacquard's loom the motion of the threads requisite to produce the pattern is determined by perforated cards.

One of the most striking phenomena in telegraphy is the duplex system, which enables messages to be sent from each end of the same wire at the same time. This practice was early suggested, but has only been possible with our more perfect insulation.

The introduction of deep-sea telegraphs affords examples of a courage in attacking a difficult problem which has hardly ever been surpassed. Although now 50,000 miles of cable are in use, to get at this result nearly 70,000 miles have been constructed and laid. Now that cables are tested under water, and made with stronger sheathing, many of the old failures are avoided.

On the subject of Railways the President spoke thus :—

You have all an interest in them : you all demand to be carried safely, and you insist on being carried fast. Besides, everybody understands, or thinks he understands, a railway, and therefore I shall be speaking on a subject common to all of us, and shall possibly only put before you ideas which others as well as myself have already entertained.

We who live in these days of roads and railways, and can move with a fair degree of comfort, speed, and safety, almost where we will, can scarcely realise the state of England two centuries ago, when the years of opposition which preceded the era of coaches began ; when, as in 1662, there were but six stages in all England, and John Crossdell, of the Charterhouse, thought there were six too many ; when Sir Henry Herbert, a member of the House of Commons, could say, 'If a man were to propose to carry us regularly to Edinburgh in coaches in seven days, and bring us back in seven more, should we not vote him to Bedlam ?'

But in spite of the suggested insanity of the projectors, coaches and railways were made.

The Stockton and Darlington Railway was opened in 1825, the Liverpool and Manchester Railway in 1830, and in the short time which has since elapsed, railways have been extended to every quarter of the globe ; and at present different countries possess in the aggregate about 160,000 miles of railway.

Railways add enormously to the national wealth. More than twenty-five years ago it was proved to the satisfaction of a committee of the House of Commons, from facts and figures which I then adduced, that the Lancashire and Yorkshire Railway, of which I was the engineer, and which then formed the principal railway connexion between the populous towns of Lancashire and Yorkshire, effected a saving to the public using the railway of more than the whole amount of the dividend which was received by the proprietors. These calculations were based solely on the amount of traffic carried by the railway, and on the difference between the railway rate of charge and the charges by the modes of conveyance anterior to railways. No credit whatever was taken for the saving of time, though in England pre-eminently time is money.

Considering that railway charges on many items have been considerably reduced since that day, it may be safely assumed that the railways in the British Islands now produce, or rather save to the nation, a much larger sum annually than the gross amount of all the dividends payable to the proprietors.

Whenever a railway can be made at a cost to yield the ordinary interest of money, it is in the national interest that it should be made.

The question of safety in railway travelling, although it depends in the first case upon the perfection of the machinery of the railway and its plant, depends also on the nature and quantity of traffic, and lastly on human care and attention.

In what we choose to call the ideal, we do not surpass the ancients. Poets and painters and sculptors were as great in former times as now ; so, probably, were the mathematicians.

In what depends on the accumulation of experience, we ought to excel our forerunners. Engineering depends largely on experience; nevertheless, in future times whenever difficulties shall arise or works have to be accomplished for which there is no precedent, he who has to perform the duty may step forth from any of the walks of life, as engineers have not unfrequently hitherto done.

The marvellous progress of the last two generations should make everyone cautious of predicting the future. Of engineering works, however, it may be said that their practicability or impracticability is often determined by other elements than the inherent difficulty in the works themselves. Greater works than any yet achieved remain to be accomplished—not perhaps yet awhile. Society may not yet require them; the world could not at present afford to pay for them.

The progress of engineering works, if we consider it, and the expenditure upon them, has already in our time been prodigious. One hundred and sixty thousand miles of railway alone, put into figures at 20,000*l.* a mile, amounts to 3,200 million pounds sterling; add 400,000 miles of telegraph at 100*l.* a mile, and 100 millions more for sea canals, docks, harbours, water and sanitary works constructed in the same period, and we get the enormous sum of 3,340 millions sterling expended in one generation and a half on what may undoubtedly be called useful works.

The wealth of nations may be impaired by expenditure on luxuries and war; it cannot be diminished by expenditure on works like these.

As to the future, we know we cannot create a force; we can, and no doubt shall, greatly improve the application of those with which we are acquainted. What are called inventions can do no more than this, yet how much every day is being done by new machines and instruments.

The telescope extended our vision to distant worlds. The spectroscope has far outstripped that instrument, by extending our powers of analysis to regions as remote.

Postal deliveries were and are great and able organisations, but what are they to the telegraph?

Need we try to extend our vision into futurity farther? Our present knowledge, compared to what is unknown even in physics, is infinitesimal. We may never discover a new force—yet, who can tell?—*Academy.*

Rock Boring by the Diamond Drill.—Major Beaumont, R.E., M.P. (Institute of Mechanical Engineers).—The (black) diamonds are set in a steel crown, which is supplied with water, and rotated at from 200 to 300 revolutions per minute, under a pressure varying with the nature of the rock, from 300 lb. to 800 lb. In this way the hard Pennant rock of South Wales may be cut at the rate of nine inches per minute. The principle is applied to prospecting, tunnel-driving, and shaft-sinking, and subaqueous operations. For holes of a depth up to 1,200 feet or 1,300 feet put down for the purpose of testing the ground an 11-inch cylinder engine, with 40 lb. steam pressure, is sufficient, the débris being removed by a stream of water pumped down the hollow of the boring bars. The diamond boring machinery for tunnel-boring consists of a couple of standards, carrying drills, which are set in motion by an engine, driven by compressed air. There are two operations in the driving of headings—the drilling of all the holes necessary to bring the face away, and blasting the holes so bored, and removing the rubbish. For putting down blast-holes under water, for the purpose of removing rocks, the diamond drill is peculiarly adapted.

The machinery then consists of drills arranged in four rows, and driven by four sets of shafting, running lengthways along a barge, the whole being set in motion by a pair of 12-inch cylinder engines. The barge is supported on eight legs, at half or quarter ebb tide, the drills set to work, and the holes drilled to the requisite depth. The holes are then charged with dynamite cartridges, and the tide having meanwhile risen, and the water taken the weight of the barge, the legs are drawn up, and she is hauled clear of the site of operations, and the charge fired. By this means 200,000 tons of rock have been removed from the bed of the river Tees.

Propulsion of Tramway Cars.—A patent has recently been obtained for propelling the cars by means of powerful coiled springs, wound up by engines stationed at the termini, or at suitable intervals along the route. Sir Samuel Canning and Mr. Scott Russell are connected with the latest proposal in connection with coiled springs, and we understand that, instead of rewinding the springs while on the journey, the mechanism is so arranged that several ready-coiled springs may be carried to replace those that have run down. What success will attend the attempt to use coiled springs remains to be seen.

A tolerably satisfactory trial of Mr. Scott Moncrieff's compressed air tramway engine took place recently in Glasgow. The machinery is contained in a frame about the size of the floor of an ordinary car, and is arranged so as not to interfere with the interior of the carriage, the floor of which, however, is a little higher than that of an ordinary car. The air is carried in six tanks, three at each end, the centre of the frame being occupied with the two engines. These air tanks will be replenished with air at intervals along the route, the proposed working pressure being between 300 lb. and 400 lb. per square inch. In the trial a temporary pump was employed, and a higher pressure than 200 lb. could not be obtained. In spite of this and sundry minor disadvantages, a distance of about three-quarters of a mile was covered, and a maximum speed of twelve miles an hour attained, the machinery being perfectly under control.—*English Mechanic.*

Use of Wire Gauze.—Wire gauze as a substitute for glass is much employed in the Regent's Park Carriage Works for the lifting door-screens of carriages. It is admirably suited in summer for this purpose, as it subdues the glare of light and moderates the heat, and admits but little dust, while it ensures perfect ventilation.—*Journal of Applied Science.*

Raising Coal by compressed Air.—Atmospheric pressure has been employed in some collieries, in the Creuzot mining district of France, in raising coal. A piston works in an air-tight tube in the shaft, to which piston is attached a cage in which the tubs of coal are placed. Air being admitted beneath the piston, the coal is at once urged to the top of the shaft, and, at the same time, more than 70,000 cubic feet of foul air are discharged from the workings, while a corresponding inrush of fresh air enters the mine. This application of pneumatics presents several advantages in mining operations.

The Lizard Lights.—New lanterns are in course of construction. The source of light in future will be the magneto-electric light of Faraday, the machine being designed by Professor Holmes. They will be worked by Ericcson's caloric engines in lieu of the steam-engines hitherto in use, thus entirely removing all risk of explosion, and the necessity of water supply. It is intended also to establish a powerful "Syren" fog signal at this station to warn mariners in thick weather of their proximity to the coast. The Syren will be worked by the same engine.

Halophotal Combination of several Flames for Lighthouse Illumination.—Thomas Stevenson (Royal Scottish Society of Arts).—A series of rays proceeding from each flame are made to fall upon lenses or refractors surrounding it in the ordinary way, while those passing above the lower flame and below the upper, and which escape interception by the ordinary lenses, fall upon prisms which are so made as to have their conjugate foci in the upper and lower flames, so that the rays in question pass through the flames, and are intercepted by the other optical agents. The rays from both the upper and lower flames which pass above the upper flame are parallelised by an inverted truncated paraboloidal mirror. By this plan or by means of dioptric agents on the same principle, the whole light from two or more flames is utilised.

Carillon at Shoreditch Parish Church.—The instrument by which the music of the bells is produced is in many respects quite new. The most valuable part of the new invention is said to lie in the separation of what was formerly a combined action into two distinct parts. In the old machine the pins of a huge barrel effected first the elevation and then the blow of the hammer. According to the new principle the work of the pins is confined to the release of the detents. The motive power is obtained by weights, and the speed is regulated by revolving vanes. The peal at Shoreditch church is said to be one of the finest in London. The tenor bell weighs 34 cwt. An air is played every three hours, being changed regularly at midnight. The carillon machine is arranged for fourteen tunes, and a fortnight's variety is thus ensured.

The Tallest Chimney in the World.—R. M. Bancroft (Civil and Mechanical Engineers' Society).—The tallest chimney in the world is the "Townsend chimney," Glasgow. The total height from foundation to top of coping is 468 feet, and from ground line to summit 454 feet; the outside diameter at foundation being 50 feet, at ground surface 32 feet, and at top of coping 12 feet 8 inches. The number of bricks used in the erection were 1,400,000. The weight of bricks is equal to 7,000 tons. When within 5 feet of completion, the chimney was struck by a gale from the north-east, which caused it to sway 7 feet 9 inches off the perpendicular, and it stood several feet less in height than before it swayed. To bring back the shaft to its true vertical position, "sawing back" had to be resorted to, which was performed by Mr. Townsend's own men, ten working in relays, four at a time sawing, and two pouring water on the saws. The work was done from the inside on the original scaffolding, which had not been removed. Holes were first punched through the sides to admit the saws, which were wrought alternately in each direction at the same joint on the side opposite the inclination, so that the chimney was brought back in a slightly oscillating manner. This was done at twelve different heights, and the men discovered when they were gaining by the saws getting tightened by the superincumbent weight.—*Iron.*

Lithographic Stones.—A method of increasing the supply of lithographic stones has been patented in this country. It consists in slitting stones of the ordinary thickness into three or more thin pieces, which are then blocked up by a cement compressed and moulded on the stone. Besides the economy thus obtained, the liability to fracture is stated to be much reduced by the use of "veneered" stones.—*English Mechanic.*

Artesian Well at Leamington.—The shaft is 50 feet deep, and at the bottom of this capacious well a bore has been carried down for another 200 feet, part of the way 18 inches, and the remainder of the way 12 inches in diameter. The shaft and bore, except a few feet at the surface, have passed through sandstone, and several springs have been tapped. The yield of water is at present 697,200 gallons per 24 hours, and it is intended to go deeper. The promoters state that they will not be satisfied unless at least. a million gallons daily are obtained from the artesian well.

Methods for giving Distinctive Characters to Lighthouses. — Sir William Thomson (British Association).—Speaking of coloured lights, he said they would not be of value except for marking a specific direction, and for this, colour had been the only successful invention. At Ardrossan a ship went ashore through a mistake of a light in Ardrossan for a harbour light. There was a red light in an apothecary's shop in Ardrossan, and the pilots had told him that they regularly steered in by the "light of the doctor's shop." The greater speed of steam traffic required that light should be seen at a greater distance and recognised sooner, and the lights must be more powerful. Rapid advances have been made in the English lights, particularly in respect to their power, but more distinctions were required. Many harbour lights were now confounded with gas. Now there was a blaze of gas, and it was, in some cases, impossible to make out which was which. The authorities were exceedingly sluggish in making such changes as were required in the appliances. The eclipse light, which he advocated would signal three lights, which he described as "short, short, long," indicating the periods for which the light would be eclipsed.

Charing Cross Floating Bath.—The first of a set of floating swimming baths has been opened on the Thames, near the underground railway station at Charing Cross. It is 135 feet long by 25 wide, and the interior is very conveniently and neatly fitted up. The depth ranges from 3 to 7 feet, and it is so constructed that there is a continual supply of filtered water, which runs in through the filters at the rate of 500 gallons per minute.

The water from the Thames first runs into a large iron tank, and thence into numerous strong fine canvas bags, which act as filters. The water comes from the filters perfectly clear, and it is afterwards forced by steam power from the main filter or reservoir into the bath. There are convenient dressing-rooms on either side, and at the west end a well-decorated saloon intended for a lounge.

Garibaldi's Scheme—(*Times*)—consists of a rectification of the course of the Tiber, to be effected by means of a canal about 30 kilomètres in length and 100 mètres wide, from some spot above Rome, at Ponte Molle, to the port of Fiumicino, near Ostia. By this canal, the city would become to all practical effect a seaport; the level of the country along its banks would be raised by the earth dug out of the bed of the canal; the land would be thoroughly drained and laid out for cultivation. To meet the first expenses, Garibaldi proposes to devote to it the sum of £500,000.

Strasbourg.—Works were undertaken almost immediately after the termination of the war, which will, when completed, make Strasbourg a fortified place of the first rank.

The fortifications comprise three distinct parts; first, the enlargement of the place and the formation of a large basin, in which is now the esplanade of the citadel, brought into direct communication with the

Rhine by means of a canal; secondly, the modification and completion of the whole of the existing lines of railway, the formation of new lines, and of two new stations, one central, and the other specially devoted to the matériel of war; thirdly, the establishment of twelve detached forts, at a distance of about five miles from the place. All these points are to be connected by a circular railway, which will touch all the grand lines, and thus secure communication between the town and the forts.

The forts are erected by the side of roads, railways, and navigable waters, at distances not exceeding one or two hundred yards. Their form is generally that of a very elongated pentagon, which, from its relatively small surface, presents scarcely any face for projectiles to attack, and they are surrounded by fosses nearly 50 feet wide. The front is straight and open, and the faces are flanked by casemated bastions with two stages, and approached through passages closed by doors. From the summit of the polygon starts a casemated passage which terminates at the gorge, and divides the fort into two parts. The centre of this passage is pierced with two openings, and its interior is capable of containing a garrison of about four hundred men.

The Channel Tunnel.—In 1872 the Channel Tunnel Company was incorporated; and Sir John Hawkshaw, Mr. James Brunlees, and M. Thomé de Gamond were appointed the engineers of the undertaking. The assent of the Governments of England and France has been obtained; but until the time arrives for constructing junctions with the railways terminating at Dover there will be no occasion to apply to Parliament. On the English coast, St. Margaret's Bay, a depression in the chalk cliffs, about four miles east of Dover, has been selected as the point of departure; and on the French side, a spot about midway between Calais and the village of Sangatte, has been fixed upon. By adopting this line, it appears that the tunnel can be almost wholly excavated in the lower bed of homogeneous chalk; and this stratum is upwards of 500 feet deep on each shore from high-water mark. It is believed that the chalk is continuous, and that it stretches beneath the sea uninterruptedly across the Straits. The maximum depth of water on the line of the proposed tunnel nowhere exceeds 180 feet below high-water mark, the water being deepest in the centre, and gradually diminishing in depth towards the sides. The tunnel itself would be placed by the engineers at such a level that the depth of strata over it would never be less than 200 feet; and this depth, which is amply sufficient for security, would permit the railway approaches to be formed with tolerably easy gradients. It has been ascertained by actual experiment that, provided the chalk be solid, the water will not permeate it; and it has also been shown that comparatively little subterranean water exists in that formation. But the best possibility of tunnelling beneath the sea level is to be found at Brighton. Sir John Hawkshaw has there completed a tunnel 5¼ miles in length along the sea shore, and in close proximity to the margin of the sea. This tunnel is wholly in the upper chalk, where the material is not very compact; and it is 12 feet at one end, and 20 feet at the other end, below high-water mark. Considerable quantities of water, chiefly fresh, were encountered in the progress of the work, and as much as 10,000 gallons per minute had sometimes to be pumped out; but the works were not prevented from proceeding. As pumping power ten times the magnitude of that employed at Brighton could, if necessary, be applied, the entry of small quantities of water during the construction of the Channel tunnel would not be in the least dangerous. Nothing, probably, could hinder the completion of the work but the existence of open, unfilled fissures reaching from the sea to a depth of at least 200 feet.

Hoosac Tunnel.—The completion of the Hoosac Tunnel, in the United States, just announced, ends a labour of many years. It is four miles long, has required the work of many men, and cost 13,000,000 dols. One hundred and forty-two lives were sacrificed in its construction. It opens a new and short line between New England and the West.—*Iron.*

New Forts on the Thames.—These forts below Gravesend, designed for the protection of London and Woolwich, are now so far complete as to allow of their armament being commenced. The guns are all of a powerful kind. It is considered impossible for any ship yet built or proposed to pass through the cross fire which these and the other forts upon the Thames will soon be able to deliver. Sheerness and the works on the Isle of Grain, at the mouth of the Medway, have all been strongly fortified, and the new armament at Tilbury Fort and at Gravesend, assisted by the forts at Cliff, Shornmeade, and Coalhouse Point, are considered capable of presenting an irresistible front to any enemy which might attempt to forec his way up the Thames.

The "Iron Gates" of the Danube.—To avoid the rocks by which the navigation of the Danube has for ages been obstructed at this point, a new bed has been prepared for the river, of which the Danube has taken possession for itself without waiting for any opening ceremony. This river was dug out in three sections, separated from each other by two dykes, which were left, and over which the roads led to the old bed. The embankment had been raised all along the line and revetted with stone. It was determined to make an opening in the upper dyke, so as to allow the stone barges to pass through. Scarcely was the channel opened when the stream rushed in, widening the gap soon from 12 feet to 100 feet, carrying away the bridge which had been constructed. The dyke being in an oblique direction the gap was made towards the right bank, the consequence of which was that the force of the stream rushed in that direction, carrying away the masonry and stone revetment for a considerable distance. In less than twelve hours the basin filled. Curiously enough, the difference in the level of the old channel is not so great as might have been expected, 18 inches being registered as the fall, and for the present there are two main streams, the old one not having been as yet stopped, by sinking stone barges, &c.

The new channel is nearly 9½ miles in length, and brings the waters of the Danube within a short distance of Vienna, it extends from Messdörf to Kaiser-Ebersdorf. It consists of two parts; the minor channel, which, in ordinary times will receive all the waters of the river, is 245 metres wide and 3 to 3·50 metres deep; the other, which is destined to provide against floods, is 515 metres wide and 2 metres deep, with a dam 6·32 metres high. Sixteen millions of cubic metres had to be executed for raising the level of the soil and forming the dam, and half of this by dredging; the stonework of the new banks represented a cube of 350,000 metres, and the pitching nearly as much. The quays absorbed 35,000 cubic metres of concrete, and 30,000 metres of masonry, a quarter of which is in granite. In addition to the ordinary work, 200,000 cubic metres of old work, including piles, stockades, stonework and fascines under water had to be demolished.

Severn Tunnel.—Mr. Charles Richardson (British Association).—The Dock Tunnel has been undertaken by the G. W. Railway for the purpose of connecting their railway system at Bristol with that in South Wales. It will be about 4½ miles long. One half of this length (2¼ miles) will be under the river Severn. The shaft is already sunk on the shore about half-a-mile from the "Shoots," and a heading has been commenced to be driven, and has already entered the Pennant Rocks and has reached a distance of 300 yards from the shaft.

Whitworth's Planes, Standard Measures, and Guns.—Professor Tyndall (Lecture at Royal Institution).—Sir Joseph Whitworth, born on the 21st of December, 1803, was placed at the early age of fourteen under the care of his uncle, a millowner in Derbyshire. He quitted the mill at eighteen; went to Manchester, and worked there for four years, under Crichton, Marsden, and Walker, and other employers. At the age of twenty-two he went to London, lived there for eight years as a journeyman mechanic, working in succession in the establishments of Maudslay, Holtzapfel, Wright, and Clements. In 1833 he returned to Manchester, rented a room with steam power, and wrote over his door "Joseph Whitworth, tool-maker from London." The ground on which his works now stand in Manchester is worth nearly a quarter of a million sterling.

His aim from the first was mechanical veracity, and his earliest step towards the realization of this aim was the production of true plane surfaces. The most accurate planes, when he began, were obtained by first planing and then grinding the surfaces. They were never true. He abandoned grinding for scraping. Taking two surfaces, as accurate as the planing tool could make them, he thinly coated one of them with colouring matter, and rubbed the other over it. Were both surfaces true, the colouring matter would spread itself uniformly over the upper one. It never did so, but appeared in spots and patches. These marked the eminences, which, with an appropriate tool, he scraped away. In this way he gradually rendered the surfaces more and more coincident. But the coincidence of two surfaces would not prove them to be planes. If one were concave and the other convex, they might still coincide. This was got over by taking a third surface, and adjusting it to both the others. Were one of the latter concave and the other convex, the third plane could not coincide with both. By a series of interactions and adjustments, all three surfaces were at length rendered coincident; then, and not before, were they considered "true planes."

When one true plane is placed upon another, the former floats upon the latter, as if some lubricating material existed between them. But when one of them is slidden, with pressure, over the other, they cling firmly together. The effect is thus described and accounted for by Sir Joseph Whitworth: "If one of them [the planes] be carefully slided over the other to exclude the air, the two plates will adhere together with considerable force, by the pressure of the atmosphere." (This clinging together of flat surfaces had been noticed before the time of Robert Boyle.) This explanation was experimentally tested. Two exceedingly accurate hexagonal planes were found to remain adherent in the best vacuum obtainable by a good air-pump. The vacuum was still further improved by filling the receiver with carbonic acid, and absorbing the residue with caustic potash. In this way the atmosphere was reduced until its total pressure on the surface of the hexagon amounted to only half a pound. The lower plate weighed 3 lbs., and to it was attached a mass of lead weighing 12 lbs. Though the pull of gravity was here thirty times the pressure of the atmosphere, the weight was supported. Indeed, it was obvious, when an attempt was made to pull the plates asunder, that had a weight of 100 lbs., instead of 12 lbs., been attached to the lower hexagon, it also would have been sustained by the powerful attraction of the two surfaces.

To show the probable character of the contact between the planes, two very perfect surfaces of glass were squeezed together with sliding pressure. They clung, apparently as firmly as the Whitworth planes. Throwing by reflexion from the glass plates a strong beam of light upon a white screen, the colours of "thin plates" were vividly revealed. Clasping the plates of glass by callipers, and squeezing them, the colours passed through various changes. When monochromatic light was employed the successions of light and darkness were numerous and varied, producing patterns of great beauty. All this proved that, though in such close mechanical contact, the plates were by no means in optical contact, being separated by distances capable of embracing several wave-lengths of the monochromatic light.

Having obtained his true planes, Whitworth turned them to account in producing standard measures. He pitted the sense of touch against the sense of sight,—end-measurement, felt by the fingers, against line-measurement seen by the eye,—and succeeded in proving that the millionth part of an inch was capable of accurate measurement. With instruments capable of this accuracy he produced his standard screws and "difference gauges," urging impressively upon the mechanicians of his age the enormous waste which might be avoided by the adoption of uniform dimensions, capable, when accurately measured, of being accurately reproduced.

The mechanical genius of Mr. Whitworth was next applied to the improvement of the rifle. When a lead bullet is cut in two, a cavity is always found within, produced by the contraction of the metal. This, and other causes, render coincidence between the centre of gravity and the geometric centre of the ball the exception, and not the rule; and where this coincidence does not exist, the bullet is almost sure to quit the gun with a motion of rotation added to its motion of translation. It is then found to deviate, sometimes to the right, sometimes to the left of the true trajectory. Sometimes, moreover, it exceeds, and sometimes falls short of the proper range. The cause of this deviation was first assigned by Professor Magnus of Berlin.

Magnus's explanation of the deviation of projectiles is by no means difficult to grasp. That the deviation was produced by no shock of the projectile against the muzzle of the gun was proved by the fact that the deviation augmented in a quicker ratio than the distance from the gun. The cause of the deviation must be sought in the external air. If we blow through a tube so as to cause a current of air to pass close to the flame of a candle, the flame, instead of retreating, bends towards the current. The atmospheric pressure, in fact, is less in the current than elsewhere; hence arises a motion of the adjacent air towards the current. If a sheet of foolscap be held with its two leaves enclosing an angle of twenty or thirty degrees, on blowing through a tube between the leaves they close up, instead of flying asunder. The old experiment of Clement and Desormes is thus explained: a tube is fixed in the centre of a perforated disk, and a second unperforated free disk is brought up against the first. On blowing through the tube the second disk is not driven away, but on the contrary held fast until the current ceases, when it falls.

We have now to apply the knowledge thus gained to the deviation of projectiles. Let us suppose ourselves looking down on the bullet as it quits the gun, that the axis of rotation is vertical and perpendicular to the trajectory, and that the direction of rotation is right-handed, like that of the hands of a watch. So circumstanced, the bullet will infallibly deviate to the right of the true trajectory. If, on the contrary, the rotation be left-handed, the deviation will be to the left. In one case only can the ball rotate without having this deflecting force acting upon it, and that is when the axis of rotation is a tangent to the trajectory. It is the object of rifling to impress upon the projectile, at the outset, this particular kind of rotation.

But whence the deflecting force, when the axis of rotation is perpendicular to the trajectory? The ball cannot rotate without producing all round it a cyclone, by its friction against the air. On opposite sides of the ball the air of this cyclone moves in opposite directions. When such a ball passes rapidly through the air, it encounters an opposing wind; and it is obvious that on one side of the trajectory this wind coincides with that produced by the rotation of the ball, while on the other side the two winds are opposed to each other, and more or less neutralize each other. The ball will move towards the side on which the strongest current exists, the pressure on that side being a minimum. When the axis of rotation is perpendicular to the trajectory, and horizontal, it is obvious that the proper range will be exceeded when the two currents are in opposition on the under surface of the ball, a lifting of the ball being the consequence; while the range will be too short when the currents coincide on the under surface, a depression of the ball being the consequence. Thus, by the coalescence of the wind of rotation, with the wind of translation, the deviation of the ball from its true trajectory is in all cases completely accounted for.

Prior to the year 1853 rifles had been made by hand labour. Mr. Whitworth proposed to devise and construct the machinery necessary for the production of the rifle barrel. Lord Hardinge obtained the assent of the Government, and a gallery 500 yards long was erected on Mr. Whitworth's grounds near Manchester, where experiments on the best form of rifle were tried.

The powder then employed for small arms consisted of the siftings of cannon powder. The first step of Whitworth was to demonstrate its inefficiency. It was afterwards abandoned in favour of a quicker burning powder. A spiral groove within the barrel constituted the rifling of the Enfield weapon. The ball was elongated, being a cylinder with a conoidal front. Its length was 1·81 diameters of the bore. A wooden plug was inserted into the ball behind, which, pressed by the gunpowder, forced the lead into the grooves, and secured the desired rotation. The pitch of the spiral was such that to make a complete rotation the ball would have to pass through a length of 78 inches. Whitworth soon abandoned the rifling by grooves, and fell back upon polygonal rifling. He formed two accurately-fitting semi-cylinders, and having made the inner surface octagonal, with a certain amount of twist, he placed the semi-cylinders together, surrounded them by steel rings, and thus built up his first rifle barrel. It was only 10 inches long, but it beat the Enfield rifle. He lengthened the Enfield bullet, but found that fired from the Enfield barrel it tumbled over. He then passed from a twist of 1 in 78 to 1 in 30, then considered excessive, and with the augmented twist he was able to employ a longer bullet. With a thoroughness worthy of all admiration he passed in succession to obliquities of 1 in 20, 1 in 10, 1 in 5, even to 1 in 1. He thus exhausted the subject, and decided finally in favour of the hexagonal barrel, with a twist of 1 in 20. The length of the bullet was three diameters of the bore.

The performance of the new weapon astonished everybody. The School of Musketry at Hythe was then under the direction of Colonel Hay, who, in a report to Lord Hardinge, thus speaks of the Whitworth rifle: "The shooting with the gun on Mr. Whitworth's principle is truly wonderful. . . . . The mean absolute deviation of the shots fired would not, if calculated, be above 0·65 of a foot at 500 yards; whereas, at the same distance, the mean absolute deviation of the best target of 20 shots I can produce, exceeds 2 feet." At 1,400 yards the Whitworth deviation was 4·62 feet, while at this distance a target 14 feet square was not at all hit by the Enfield.

The Whitworth rifle sent its bullets through thirty-four half-inch elm boards; the Enfield penetrated twelve of the boards, and was stopped at the thirteenth. But a totally new capacity was here manifested. The form of the Whitworth rifling permits of the use of a steel bullet, and with such bullets, at the time here referred to, Mr. Whitworth pierced plates of iron half-an-inch thick, not only point blank, but at obliquities varying from 0° to over 50°. I am not aware that up to the present hour any other rifle has accomplished anything approaching to this.

Call now to mind that Mr. Whitworth in 1854 found rifling by grooves the accepted method. This he changed for polygonal rifling. He found the twist 1 in 78; this he changed to 1 in 20. He found the rifle bullet 1·81 diameters in length; and this he changed to 3 diameters. The Martini-Henry rifle, which is now the favourite weapon, is rifled polygonally, a heptagon being substituted for Whitworth's hexagon. The twist of this rifle is 1 in 22, or almost identical with the twist of the Whitworth rifle, while the length of the bullet is 2·93 diameters, which is practically Whitworth's proportion. The Martini-Henry bullet is, however, rifled within the gun by the pressure behind it; and to permit of the employment of hard alloys of tin and lead, which it would be difficult to force into the angles of the heptagon, a sharp spiral projection accompanies the polygonal twist. This projection is forced into the bullet by the pressure from behind, and it gives the bullet the required rotation. The Whitworth bullet, on the other hand, is rifled outside the gun. Its inventor accomplishes by his steam engine the work which, in other rifles, falls upon the gunpowder; the brunt of this work, moreover, being borne by the shoulder of the marksman.

To sum up, when Sir Joseph Whitworth began his experiments, he was ignorant of the rifle, but he, nevertheless, mastered his subject to an extent never previously approached. He found the powder used for rifles unfit for its purpose. In point of precision, he obtained a "figure of merit" greatly superior to any previously obtained. He carried his ranges far beyond all previous ranges; and in point of penetration achieved unexampled results. He did this, moreover, by a system of rifling peculiar to himself, which had never been thought of previously, and which is substantially adhered to in the favourite weapon of to-day. It would be difficult to point to an experimental investigation, conducted with greater sagacity, thoroughness, and skill, and which led to more important conclusions.

Whitworth saw that the mechanical principles brought to bear in the infantry weapon were equally applicable to cannon. But here let me say that I am not too much influenced by the phrase "mechanical principles," so frequently employed by our great mechanician. These principles are as enduring as the universe, or rather as the mind which interprets the universe, when all the data have been embraced in the conclusion. But in practical matters mechanical principles, like wisdom, must be justified of their children; and these are the tests of experiment.

Armour plating 4 inches thick, manufactured by an eminent firm, with the knowledge that it was to be tested with the Whitworth gun, was penetrated by an elongated, flat-headed, rifled projectile, which itself hardly exhibited the least mark of distortion. The gun which fired the bolt was a 12-pounder; but owing to its elongation the actual weight of the projectile is 29 lbs. This assuredly was a great achievement for so small a gun. Like plates were perforated, not only by direct impact, but at obliquities of 35°, 45°, and 65°. The projectiles which did this work are flat-headed. When ogival pointed shot, of "chilled" metal, or of steel were used, instead of being penetrated, the plates were indented merely. Fired at an angle of 45° the pointed shots glanced from the plates, scooping out a small hollow, instead of piercing them. In this experiment, the chilled shot broke up into fragments, but the steel remained intact. Taking a steel bolt in the hand, and urging the edge of its flat front obliquely against an iron plate, the bolt is arrested, because the edge cuts the plate like a chisel; urging the pointed shot at the same obliquity against the plate, it glances off. Thus, a mere hand-experiment shows the difference between the flat-headed and pointed shot, when the incidence is sufficiently oblique. And as in actual warfare oblique incidence will probably be the rule, and perpendicular incidence the exception, this demonstrated power of the flat-headed bolt to penetrate, when the pointed shot fails, seems worthy of the most serious consideration.

Almost equally instructive are the experiments executed to determine the comparative power of flat-headed, round-headed, and pointed projectiles to penetrate water at an oblique incidence. The angle of depression was 7° 7′, and the length of water to be penetrated was 80 inches, the mark aimed at being 10 inches below the water line. The flat-headed projectiles appear to have gone almost directly to the mark; the round-headed ones were tilted up and struck the plate just below the water line; while the pointed or ogival ones were completely ejected from the water, and struck the plate at 9 inches above the water line.

In the Preface to 'Guns and Steel' Sir Joseph Whitworth gives the following summary of his experiments on penetration:

"In 1857 I proved, for the first time, that a ship could be penetrated below the water line by a *flat-headed* rifled projectile.

"In 1860 I penetrated, for the first time, a 4½-inch armour plate, with an 80 lbs. *flat-headed solid* steel projectile.

"In 1862 I penetrated, for the first time a 4-inch armour plate, with a 70 lbs. *flat-headed steel shell*, which exploded in an oak box supporting the plate.

"In 1870 I penetrated, with a 9-inch bore gun, three 5-inch armour plates, interlaminated with two 5-inch layers of iron concrete.

"In 1872, with my new 9-pounder breech-loading-gun, and a flat-headed steel projectile, I penetrated a 3-inch armour plate, at an angle of 45°."

All these performances were the first of their kind, and were made, with one exception, with flat-headed projectiles.

The tentative skill and insight which were so conspicuous in Mr. Whitworth's experiments with the rifle, are not less conspicuous in his experiments on rifled cannon. In 1856 he demonstrated that a rifle bullet should be 3 diameters long. "The rule," he affirms, "holds good for a 35-ton gun, as well as for a rifle." His experiments on the relation of the amount of twist to the length of the projectile are in the highest degree interesting. Projectiles varying from 1 to 7 diameters in length, yielded the following results:—

"With one turn in 10 inches, all the projectiles went steadily with the point first.

"With one turn in 20 inches,

Fig. 1.—Taper Rear.

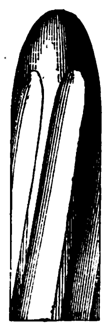


Fig. 2.—Parallel Rear.

the projectile became unsteady when more than 6 diameters in length.

"With one turn in 30 inches, it fell over when more than 5 diameters in length.

"With one turn in 45 inches, the projectiles turned over, and flew very wild, when more than 3 diameters in length."

The conclusion drawn from these experiments was, "that unless a gun be rifled with a quick pitch, so as to give a high rotation to the projectile, it would not be possible to fire long projectiles." With a sufficient twist, Mr. Whitworth succeeded, in 1856, in firing projectiles 10 diameters in length, and weighing 150 lbs. For range, the best form of projectile has a conoidal front, a slightly tapered rear, and is from 3 to 4 diameters long. With high elevations, the flight of such a projectile may exceed, by a mile, that of one with its rear untapered. These two forms of the projectile are shown in Figs. 1 and 2.

The greatest range hitherto obtained was reached at Shoeburyness in 1868. It amounted to 11,243 yards, or nearly 6½ miles.

The possibility of attaining so

great a range depends on the weight and cross-section of the shot. Were there no atmospheric resistance, the range would depend solely on the velocity of the projectile on quitting the gun. But if two projectiles, one possessing a greater transverse section than the other, start with the same velocity, the thicker bolt, encountering greater resistance, is brought more rapidly to rest. The velocity at starting may be even greatly in favour of the thicker projectile, while at long ranges it is left behind.

And here we are met by one of those practical reflections which force themselves upon the thoughtful mind, and in regard to which I have already claimed liberty of expression. If the object of the artillerist be solely to throw his shot with the maximum precision, to the greatest distance, then, so far as the data before me enable me to judge, Sir Joseph Whitworth has made out a conclusive case. In the common rifle, where each bullet is intended to kill or maim a single man, these two elements of range and precision are paramount. But in artillery practice another consideration comes into play. The use of shrapnel shell is one of the most important features of such practice. In this case vastness of range is not the only thing sought. At a certain point in its trajectory — a point which the practical artillerist might fix at two, three, or four thousand yards—the projectile has to burst, and spatter a rain of bullets round it. The effectiveness of such a projectile must obviously depend on the bursting charge which it is able to carry, and the number of bullets which it is able to scatter. If—and bear in mind that I use the "if"—if the projectile be so attenuated as to diminish seriously the bursting-charge and the number of bullets, then it is easy to see that while it might assert a clear superiority as regards length of range, it might be less effective than a projectile of greater diameter, at the distances most advantageous for the use of shrapnel shell. I am far from saying that the Whitworth shell is unable to fulfil all the necessary conditions; but I do say that the shrapnel shell raises a question which was not raised in the case of the rifle. And were I on a committee entrusted with the decision of this question, I should require it to be proved that the very perfection of a gun, regarded from one point of view, is not an imperfection when regarded from another. The question is one for experiment to decide.

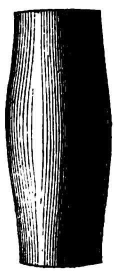
Sir Joseph Whitworth has always advocated the use of steel in the construction of guns; but without some guarantee of its trustworthiness he could hardly have expected to convert the world to his views. It would be unreasonable to expect military authorities to make their guns of a metal which, through some defect impossible to guard against, might at any moment convert the gun into a shell, scattering ruin among those who trusted it. The onus therefore rested upon the advocate of steel, to produce a metal which could be relied on. With the tenacity of purpose, and fruitfulness of inventive skill which characterised his whole previous career, Sir Joseph Whitworth attacked this problem. The solution of it will, perhaps, be best understood by an experiment which I witnessed at Manchester.

Within a hollow steel cylinder, of enormous strength, were placed a series of cast-iron bars, so as to form a kind of lining. The bars were laid loosely side by side, so as to admit of the passage of a gas between them. They were also grooved, with a view of facilitating gaseous motion. The bars were coated by a porous lining of sand and other materials, through which gases could readily be driven by pressure. In the middle of the cylinder stood a core, also formed so as to permit of the escape of gas from it. A space of several inches existed between the inner core and outward sheath. A large ladle was at hand, and into this was poured the molten metal from a number of crucibles. From the ladle again the metal was poured into the annular space just referred to, filling it to the brim. Down upon the molten mass descended the plunger of a hydraulic press. On first entering it a shower of the molten metal was scattered on all sides; but inasmuch as the distance between the annular plunger and the core on the one side, and the sheath on the other, was only about one-tenth of an inch, the fluid metal was immediately chilled and solidified. Thus entrapped it was subjected to pressure, which amounted eventually to about six tons per square inch.

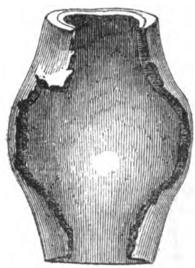
Doubtless gases were here dissolved in the fluid mass, and doubtless also they were mechanically entangled in it as bubbles. I figure to myself the fluid metal as an assemblage of molecules, with the intermolecular spaces in communication with the air outside. Through these spaces I believe the carbonic oxide and the air to have been forced, finding their escape through the porous core on the one side, and through the porous sheath on the other. From both core and sheath issued copious streams of gas, mainly, it would seem, in the condition of carbonic oxide flame. A considerable shortening of the fluid cylinder was the consequence of this expulsion of gases from its interior. The pressure was continued long after the gases had ceased to be ejected; for, otherwise, the contraction of the metal, on cooling, might subject it to injurious internal strains. In fact, castings have been known to be rent asunder by this contraction. By the continuance of the external pressure, every internal strain is at once responded to and satisfied, and the metal is kept compact.

The metal employed for guns must be of the maximum "strength,"

1.



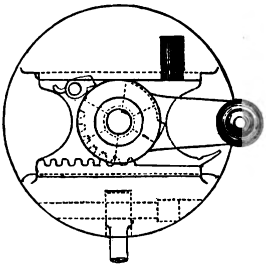
2.



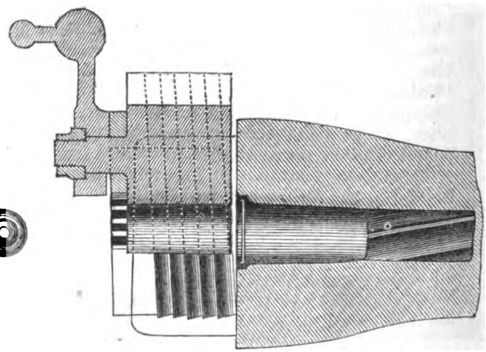
3.

compatible with a "ductility" which shall cause the gun to *tear*, if it should burst, and not fly into fragments. Sir Joseph Whitworth's method of testing the capacity of his metal to resist pressure is as follows:—A powder charge is placed in a cylinder, both ends of which are stopped, the only exit for the gases being through the vent-hole. The annexed figures show the appearance presented by such a cylinder during the process of testing. 1, represents it before firing; 2, after firing a few rounds; 3, after bursting. "The excellence of the metal was proved by the amount of powder used, and its tearing open in one piece."

I wind up by a brief reference to Whitworth's breech-loading gun. This gun is made of fluid compressed steel, and the breech is closed by a heavy sliding block of the same material, working between two portions of the breech end of the gun, under and over the sliding block, which may be called block guides. The faces of the block guides are grooved with a number of parallel grooves, the upper and lower surfaces of the block being similarly formed, and inclined at a very small angle to a plane perpendicular to the axis of the gun, thus forming a portion of a screw thread which would be traced upon a cylinder of extremely large radius. These threads constitute what may be called a "straight-line screw," having their sides nearest the muzzle undercut, so that when the heavy strain resulting from firing the charge comes upon the block, there may be no tendency to force the block guides apart; but, on the contrary, they are more tightly held.



End view, breech closed.



Longitudinal section, breecn open.

The powder chamber is enlarged in diameter and reduced in length, being 2¼ diameters long, and containing a charge of 50 per cent. more powder than the service charge of a muzzle-loader. There is also a slightly enlarged shot-chamber to ensure ease in loading. The enlargement of the shot-chamber permits of the reduction of the windage in a degree which could not otherwise be attained. In this gun the enlargement is ·03 of an inch, the remaining part of the bore having windage of ·01 of an inch.

The mechanical features of the breach-loader may be stated briefly as follows:

1. A heavy breech-piece with a large area of bearing surface.

2. An enlarged diameter of powder chamber.

3. A slightly enlarged shot-chamber.

4. A diminished windage in the bore of the gun.

Pneumatic Transmission of Telegrams.—R. S. Culley (Institution of Civil Engineers.)—There are twenty-four pneumatic tubes in London, of an aggregate length of 17 miles 1,160 yards; four tubes in Liverpool, three in Dublin, five in Manchester, three in Birmingham, and one in Glasgow. Lead is preferred to iron as the material for the tubes. An experience of twenty-one years has shown that with felt message-holders, or carriers, there is no abrasion of that metal, which becomes highly polished, and that the tubes are practically air-tight, the exhaustion in one, 1,289 yards in length, occupying thirteen minutes in falling from 17·25 inches of mercury to atmospheric pressure, including the leakage from the valves. Iron had been used for two tubes, each 2,610 yards long, but it was found to rust rapidly, and to wear out the carriers. In the Paris system the iron tubes do not rust, probably because the air in Paris is carefully cooled by water, and heavy carriers of iron covered with leather, producing much friction, are used; while the air in London is used warm from the pumps, and the carriers are made as light as possible.

The diameter adopted for the tubes is $2\frac{1}{4}$ inches. The carriers are cylindrical boxes of gutta-percha, covered with shrunk drugget; their weight being $2\frac{3}{4}$ ounces. The traffic is regulated by electric signals. Stoppages are rare, and are cleared by filling the tubes with water and applying pressure. It has never been necessary to open a lead tube, except in cases of bad construction, or of external injury caused by workmen. The engines are on the Wolff principle, and in ordinary work expended 134 I.H.P. The pumps are so arranged that each can be set to compress or to exhaust at pleasure, and the air-valves are fixed in sliding pieces, so that a defective valve can be quickly replaced.

Experiment shows that the speed of a carrier driven by compressed air is greater when the pressure is cut off after each transit; or, in other words, that there is a loss of speed when the air is kept constantly in motion. In the former case the carrier starts into a comparative vacuum at atmospheric pressure; in the latter case into dense air; consequently the higher the pressure employed the greater the difference in speed—with 14 lbs. pressure the difference was 6 per cent. In working by vacuum a reverse result is obtained. When compressed air is admitted into a long tube, or the air is pumped out of it, a sensible time elapses before the permanent condition of the air pressure is established. In a tube 5,523 feet long this interval was forty-five seconds for the end next the air-pump, and about seventy-five seconds for the centre of the tube. The temperature of the air issuing from a tube is not lowered to an extent corresponding with its expansion in the tube, because it gains heat from the soil in London; but in Berlin, where the tubes are bedded in dry sand, the theoretical temperature is more nearly attained. Comparing a 3-inch tube with a $2\frac{1}{4}$-inch, it was found that more than double engine power gave only 16 per cent. higher speed in the larger tube, so that any increase of diameter above that actually necessary to carry the traffic in the required time is attended with unnecessary expenditure. Again, by doubling the pressure only 30 per cent. in time was saved, but thrice the engine power was needed.

Gun Fog Signals.—In the construction of the guns from which the signals are fired, a new form of parabola has been tried in competition with the cone-shaped muzzle, and is found to excel it at long ranges. It has also been proved that gun-cotton makes more noise than gunpowder when equal weights are used, and that a parabolic reflector adds to the power of the gun-cotton as well as the powder. When large charges, viz., 3 lbs. of powder, fired from guns of various kinds, in competition with 1 lb.-charges of gun-cotton, which costs about the same, there was found to be but little difference in intensity of sound. Even 1½ lb. of gun-cotton was found to give scarcely such good results as the 3 lb. charges of powder.

Cotton Mills in India.—There are 25 cotton mills in India in full operation, working 600,000 spindles and 7,000 looms. The spindles produce about 130,000 lbs. of cotton thread a day, of which about 50,000 lbs. are used to produce cloth. These mills are chiefly in the Bombay Island, where a new spinning mill, just opened by a wealthy Hindoo, and working 25,000 spindles, makes a total of 17 working mills. Up country there are several others. Extensions are also rapidly going forward. Eight extensions are in course of construction at Bombay, chiefly on share capital, and these will provide for the working of at least 40,000 more spindles and 1,345 looms.—*The Homeward Mail.*

Accidents on English and American Railroads. — (*The Times.*)—The consideration of the returns of railway accidents in the United States affords a ground of inference as to the degree of carefulness and efficiency of the general management in respect to preservation of property as well as safety of persons. The following compilation is made from official returns of those American States which are, collectively, most analogous to the United Kingdom in population and railway traffic. The favourable comparison with the returns for the United Kingdom will probably be a matter of surprise to many persons not familiar with the subject. It is to be ascribed chiefly to the lower rate of speed and the improved appliances adopted. On the other hand, however, it should be mentioned that the American returns indicate an amount of accidents to persons other than passengers or employés largely in excess of the same item in the returns for the United Kingdom, though sufficient data on which to found an exact comparison are wanting. This is the result, almost entirely, of the practice in the States of allowing railway lines to cross the highways at grade, and the common use of the lines as footpaths by the public. The following table gives the comparative statement referred to:—

1873.	United Kingdom.	Ten States.
Miles of railway	16,082	21,683
Population	31,000,000	15,671,000
Passengers during the year	455,320,188	131,493,508
Miles run by trains	194,249,692	191,248,659
Passenger	94,944,067	70,633,410
Freight	99,305,625	120,615,249
Killed, passengers	160	90
Ditto, employés	773	452
Injured, passengers	1,750	337
Ditto, employés	1,171	1,161
Proportion of passengers killed or injured	1 in 238,387	1 in 307,947
Average number of miles run by trains for each passenger and employé killed or injured	50,402	93,747

The ten States are the six New England States, New York, New Jersey, Pennsylvania, and Ohio.

Petroleum in Turning Hard Metals.—M. L. Bechstein reports that it was required to turn with the greatest precision a piece of work 29 centimetres in diameter, composed of a very hard alloy of seven parts of copper, four parts of zinc, and one part of tin. Every ordinary mode was tried without success, when M. Bechstein had the idea of trying the effect of petroleum constantly applied to the cutting tools, and the alloy was then turned with about the same ease as steel tempered to straw colour; the latter, says M. Bechstein, turns with the greatest ease when the cutters are kept moistened with a mixture of petroleum and turpentine.—*English Mechanic.*

Fireless Locomotive. — S. Pichault (*Annales Industrielles*).—At Seraing, in Belgium, the author has tested the power of a locomotive to work after the fire has been dropped. The conclusion he has drawn from a well-arranged series of experiments is, "that the employment of an ordinary engine, fed from a simple hot-water tank, for drawing cars along tramways is possible, and even easy, not only in theory, but also in practice." His calculations prove very satisfactorily that engines without fire may be employed on our tram-roads, and with especial advantage in the underground railways.

Locomotive on Legs.—Fortin-Hermann.—An engine has been tried on the French Eastern Railway, in which the displacement is effected, not by motor wheels, but by veritable articulated feet, which are successively applied to the ground. Two of these feet act at the front part of the engine, and two behind. They are pressed on the ground by the action of steam, and a horizontal engine produces, in suitable order, the oscillations of connecting rods joined to the feet; so that the engine is pushed along. The feet are fitted with india-rubber shoes. There is a large increase of adhesion: so that whether on rails, or on ordinary roads, a train four times heavier may be drawn by the same force, and much steeper inclines may be ascended. Since the construction of his first machine of 15 tons weight, the inventor has made some improvements (in a small model), increasing the number of feet, and making four of them perform the trot and two others the amble; the action is thus more continuous, and the stability of the machine increased, so that lateral wheels are unnecessary. The locomotive tried on the Eastern Railway went only 7 or 8 kilometres in an hour; but with the new arrangement, he hopes to accomplish 17 or 20 kilometres.

The Pioneer Railway.—Mr. Haddan (*Iron*).—The construction of this "pioneer" railway is simple and ingenious. Instead of requiring the ground to be elaborately prepared for the rails, and gradients carefully adjusted, it may be made almost anywhere, and involves little outlay. The carriages and engine are in shape much like a couple of panniers, and the railway on which they run answers to the donkey's back, it being a single centre rail laid along an elevated narrow platform, which may be supported on tressels or merely on poles sunk well in the ground, as desired. In addition to this centre rail, on which the carriages are hung, and where the real friction of the running and driving wheels is, there are two side rails which jut out on cross bars so as to catch a wheel running on each side of the carriages below. These latter rails, answering to the sides of the donkey or pack-horse, serve to steady the train, and also supply a means of applying additional gripping power whereby the train can be pulled up steep inclines. This mode of construction necessarily causes all the carriages and the engine to be divided into two equal halves, and thus cuts down the stowage room, but enough seems to be left to afford ample accommodation for passengers where they are not likely to be numerous, and to afford room for a great deal of comparatively heavy traffic. When erected this railway presents at a distance the appearance of a strong fence, it being so far above the ground, and this form of construction makes it an easy matter to get over difficulties in the configuration of the country. Where advisable, the top rail is laid on posts stuck in the ground, and should these not be procurable, or should the soil present obstacles to their being securely rooted, then tressels may be used, or a wall may be built of solid masonry against which the light side rails are easily bracketed. For crossing streams the expedients are essentially the same, long posts driven into the bottom, on tressels laid on it and secured. The sides of a mountain may be climbed by this railway with ease, and its inventor claims for it :—Rapidity and low cost of construction; employment of marketable materials only, earthworks being entirely dispensed with, capacity, therefore, of making a railway at a fixed factory, and of making it instantly transport itself; low working expenses; portability, it being easy to remove the whole apparatus from one locality to another. Hence, also, its value in aiding the construction of a solid railway of the ordinary kind.

The South Cliff Incline Carriage-way, Scarborough.—This novel and ingenious construction was opened last summer. The carriage-way is laid on the face of the cliff, looking down from a point near the Prince of Wales Hotel to the Spa. The motion is precisely that of a slow railway train, but the chief peculiarity is in the ascent, when the eye catches the ground beneath, the sensation being decidedly that of a journey to the clouds. The gradient is very great, and it is said that this incline carriage-way is the first of its kind in England. The length of railway is 300 feet, on a radius of 33 degrees of incline. There are two handsome carriages, calculated to carry fourteen persons each, one ascending as the other descends, occupying altogether about three or four minutes for landing and transit. These carriages are sustained by a steel rope, capable of bearing a weight of 28 tons, whilst the utmost weight it is required to carry will never exceed two tons. This rope is also supplemented by another of equal strength as a safety rope. The fare is one penny.

Constantinople Underground Railway. — This railway, from Galata to Pera, was opened last year. This unique work is 672 yards long, and conveys passengers from the level of the Bosphorus to the extreme height of Pera, an elevation of 200 feet, with an average gradient of one in ten. Its greatest depth below the surface is 80 feet. The motive power is a stationary engine, working a drum with endless bands. The railway company is English. Trains run up and down simultaneously every five minutes, and are calculated to carry 30,000 passengers per diem. The carriages work very easily at an average speed of ten miles an hour.

The "Inflexible" Ironclad.—This double-turret armour-clad, which is in course of construction at Portsmouth, represents at the present time the highest attainment of constructive genius as applied to naval warfare: she is well deserving of the attention which she arouses. She is in every sense the most formidable engine of war that has ever been conceived. With the exception of the three broadside ships of the *Minotaur* class, she is the largest ironclad in the navy. In addition to her armament she has a submerged prow, so that she will be able to butt an enemy with her head as well as penetrate him with her guns. Her engines work up to 8,000 indicated horse-power.

The *Inflexible* was designed by Mr. Barnaby. She is a rectangular armoured castle, 110 feet in length and 75 feet in breadth, and protected by 24 inches total thickness of iron. The other parts of the ship, which are not armour-plated, are simply used as means to float and move the iron citadel. Altogether the *Inflexible* is 320 feet in length and 75 feet in breadth. Her mean draught is 24 feet, and her displacement 11,000 tons. All the longitudinal frames are made of steel. The outer skin plating is three-fourths of an inch in thickness, except the plates on each side of the keel, and here the thickness is increased to 13-16ths of an inch. The armoured castle, which rises to 10 feet above the water-line of the vessel, encloses within its walls the engines and boilers, the two turrets with their four 80-ton guns, the hydraulic loading gear, and the magazines. The armour is of different thicknesses of iron, making, however, with the teak backing—which varies inversely to the thickness of the plating—a uniform thickness of 41 inches throughout. The turrets are of iron of a single thickness of 18 inches. The deck is 1-inch iron, supporting 2-inch armour-plating. The ship proper will be divided into no fewer than 127 watertight compartments, containing altogether somewhere about 150 watertight doors. The whole of the steam steering gear is placed below the water-line, so that it is impossible that the rudder-head, although unprotected by armour, can be injured by shot or shell during an engagement. The rudder, which is squarely formed, will be worked by a tiller 4 feet 6 inches below water. The coals (1,200 tons) will be stored at the water-line. The expense of her construction is £400,000, making, with her engines, a total cost of £521,000. Her crew will number 350 officers and men.

Collapsing Boats.—When built for emigrant and troop ships, the dimensions of these boats are as follows:—Length over all, 37 feet; breadth, 12 feet; and depth, 5 feet. Along the middle of the boat, the whole length fore and aft, is a locker with convenient hatches, in which is contained half a ton of the best provisions in tins, and a large water tank with a condenser, producing twelve gallons of water daily, in addition to the original supply. In the bow is the chain locker, and in the stern the binnacle, with compass, sextant, and general chart. The whole of the sternsheets is covered in with waterproof canvas, affording a snug shelter and privacy for forty women. A boiler for soup, &c., completes this part of the arrangement. The boat is rigged with two lower masts, topmasts, and five sails, the whole of which, with twelve oars, together with the boat itself and all the above-named contents, collapses into a space only two feet wide. These boats are not intended to be placed on deck, but to be lashed outside the ship, from which position they can be detached, expanded and lowered in a few seconds. Each will carry 150 people with perfect safety in any sea, and being provisioned for that number for at least four weeks, there is nothing to hinder its occupants from continuing their voyage, or making for any convenient port. These boats need not interfere with any of those existing in a ship, and they may be carried in any required number without danger or inconvenience.

The Arctic sledge boat weighs only 34 lbs., and when carried under a man's arm it is only four inches wide. It is opened in three or four seconds, and then becomes so remarkably buoyant as to carry four men, although not intended for more than two. When filled with water it will still carry two men.

"Alexandra."—The distinguishing features of this vessel, which was launched last year, may be broadly stated to be powerful fire ahead and astern from elevated batteries, viz., two guns of 25 tons and two of 18 tons ahead, and two of 18 tons astern; a powerful broadside fire, one gun of 25 tons and five of 18 tons; double screws (giving two means of propelling and two of steering), and a complete separation between the two sets of propelling machinery and boilers; the establishment of the entire heavy artillery of the ship in three separate armoured batteries instead of in one, or at most two, as is usual. The *Alexandra* is to be fitted with four Martin's self-canting anchors of 5 tons each, and two of 47 tons each. The design for the ship was prepared under the supervision of Admiral Robert Hall, C.B., and Admiral W. Houston Stewart, C.B. The naval architect was Mr. Nathaniel Barnaby. The principal dimensions of the ship are:—Length between perpendiculars, 325 feet; breadth, extreme, 63 feet 8 inches; depth in hold, 18 feet $7\frac{5}{8}$ inches; burthen in tons, $6049\frac{12}{94}$; displacement in tons, 9492·2; draught of water forward, 26 feet; ditto aft, 26 feet 6 inches.

Circular Ironclad.—E. J. Reed (*Times*).—The first of the Russian circular ironclads, the *Novgorod*, has made passages in the Black Sea which fully justify the Imperial Government in having adopted this form of vessel as one well adapted for providing very powerful naval defence for certain purposes. After steaming from Nicholaief round the south of the Crimea to the Circassian coast, thence back as far as Sevastopol, and then on to Odessa, this extraordinary vessel has performed what was probably her chief object by entering the Sea of Azoff through the Straits of Kertch, where the depth of water is but 14 feet, and where no other European ironclad carrying armour 11 inches thick and guns of 28 tons could possibly pass. I do not wish what I have previously said, or am here saying, to be construed as an approval of these circular ironclads for all purposes, and in all their details; but I certainly think the performances of the *Novgorod* are such as will excite the notice and admiration of many thoughtful persons besides shipbuilders, and will reflect great credit upon the Imperial Russian Government and their enterprising designer, Admiral Popoff. It is true that the *Novgorod* is not designed for, and does not attain, a high speed, but she has lately been steaming at eight knots, which is more than was intended, and she could have been made very much faster had she been increased in size. It must be remembered that although carrying the heavy armour and guns already mentioned, she is a comparatively small vessel, being of but 100 feet in diameter, and having a total displacement of only 2,500 tons, which is but one-half that of our *Glatton*, and much less than one-fourth of our *Inflexible*, or even of our *Minotaur*. She has engines of only 480 horse-power. Her cost, if built under like conditions with other ships, would be roughly proportioned to her tonnage and horse-power, from which the cheapness of such a vessel may be readily inferred.

City of Berlin (Inman Line of Liverpool and New York mail steamers).—This vessel, the largest in the world (*Great Eastern* excepted), was built by Messrs. Caird and Co., Greenock, launched October 27, 1874, the draught of water being—forward, 12 feet 9 inches; aft, 14 feet 3 inches. Dimensions:—Length, 488 feet; breadth, 44 feet; depth to tonnage deck, 19 feet; ditto to upper deck, 34 feet; tonnage under tonnage deck, 2,613 tons; gross, 5,490 tons; register, 3,139 tons; builder's, 4,634 tons; length over all, 512 feet; builder's number for vessel, 181; ditto for engines, 236. Two engines, inverted cylinder principle; cylinders, diameter respectively 72 and 120 inches; length of stroke, 5 feet 6 inches; 850 horse-power, 12 boilers, 36 furnaces, 2,136 tubes. The accommodation for passengers is 1,702, besides accommodation for a crew of 150 persons; constructed on the most approved principles for speed, combining large carrying capacity for cargo. During the year she has made most rapid passages to and from America. Description:—Demi-female figure-head, no galleries, elliptical stern, four decks, three masts, ship-rigged, standing bowsprit.

Steering of Screw Steamers. —Prof. Osborne Reynolds (British Association).—In screw steamers the effect of the rudder depends on the direction of motion of the screw rather than on the direction of the motion of the boat. When the screw is going ahead the steamer will turn as if she were going ahead, although she may be going astern. When the screw is reversed the rudder will act as if the vessel were going astern, although she may be moving forward at the time. The more rapidly the boat is moving in the opposite direction to that in which the screw is acting, the more nearly will the two effects on the rudder neutralise or destroy each other. When not breaking the surface the screw will not exert much tendency to turn the ship so long as the rudder is straight; but when breaking the surface the screw will tend to turn the stern of the boat in the opposite direction to that in which the tips of the lower blades are moving. When the boat is going ahead the effects of the screw will be easily counteracted by the rudder, but when starting suddenly the effect of the screw may be greater than that of the rudder.

Motive Power from Wave Motion. — Beauchamp Tower (British Association). — A heavy weight, supported upon springs, vibrates in periods of the same length as the wave-periods. By means of gearing the motive power obtained from the rising and falling of the weight is made to propel the vessel.

Preservation of Life from Fire at Sea.—Messrs. Harris and Paton.—A barge of between forty and fifty tons burden was fitted up so as to form a hold 30 feet long by 8 feet wide, and about 10 feet deep, lined with sheet iron, and covered at the top by extemporised hatchways. Along the entire length and width of the hold cotton waste, shavings, and small wood saturated with oil and naphtha, were placed to the depth of about 2 feet, and ignited on a given signal, within two minutes of which dense volumes of flame and smoke issued from the open hatchways. The hatchways were then battened down, and the apparatus being set to work, the flames were completely extinguished within four minutes. The "pyroleter," by means of which this result was effected, is a small pump, which draws from tubs placed on each side of it simultaneous supplies of muriatic acid and a solution of bicarbonate of soda and water. Both mixtures then meet in a generator, and instantaneously pass into a "separator," whence dry carbonic acid gas is evolved, and passes through fixed pipes to the *locale* of the fire, which it speedily suppresses. It is computed that 3½ per cent. of carbonic acid gas introduced into any place where a fire is raging will be sufficient to extinguish it. The proportion of chemicals required to be carried is one pound of each per tonnage measurement, which for a ship, say of 1,200 tons burden, woud cost from £20 to £30. The chief merit of the invention is that a fire can be readily extinguished by dry gas, and without the smallest injury to the cargo. Experiments made with this fire annihilator have been very successful.

Progress of the Electric Telegraph.—Latimer Clarke (Society of Telegraph Engineers).—In 1870 the English Telegraph system was transferred to the Post Office. It is estimated that in the days of the telegraph companies the total number of messages in a year did not exceed 6,000,000; in 1871, the number had been increased to 11,000,000; in 1872 to nearly 15,000,000; in 1873 to upwards of 17,000,000; and in the year (1874) to 19,100,000. The number of miles of wire possessed by the Post Office at the present time is upwards of 106,000, in addition to 1,500 miles of submarine cables. The number of postal telegraph offices now open is 5,572, and the number of instruments worked by the Post Office exceeds 9,200.

The 81-Ton Gun.—This gigantic piece of ordnance is 27 feet in length outside, and has a bore of 24 feet. It was originally 14½ inches in diameter, but is now being increased to 16 inches. The outside width at the muzzle is 2 feet, and at the breech 6 feet. In September last the gun was tested at Woolwich with charges of pebble powder, increasing from 170 lbs. to 240 lbs.; the weight of the shot varying from 1,254 lbs. to 1,260 lbs. Each grain of the powder is 1½ inches square, and the cartridge resembles a huge sack of coals.

The cartridge was placed in the gun and rammed home by half-a-dozen men, with a steel rammer. Next came the shot, a solid bolt of iron, with flat ends, and eleven spiral rows of brass studs to fit the rifling of the gun.

The gun was fired by electricity. The sand rose in a column to an immense height, and at the same time a well-defined ring was seen whirling away from the muzzle of the gun, and passed over the river with a noise as great as would have been made by a shell. This was only seen after the first shot. The projectile went 40 feet into the sand. The recoil was about ·29 feet (on an inclined tramway), and the "energy" was ascertained to be fully 20,000 tons.

It is expected that when the ultimate capacity of the gun is attained, it will be able to send a shot through a 24-inch iron plate at a range of ten miles. The velocity of the shot proved to be 1393 feet per second. The weapon cost 8000*l.*, and the cost of each discharge is from 20*l.* to 25*l.*—*Graphic.*

MISCELLANEOUS.

Alexandra Palace.—On May 1 last the new palace on Muswell Hill was inaugurated by the Lord Mayor. The new building is a vast improvement upon the old one in size and accommodation; it covers 7½ acres of ground; the central transept or great hall will seat 12,000 persons; the building includes a theatre and a concert room, besides picture galleries, a reading room, a conservatory, and an open Italian garden. To the westward of the palace in the park, is the Japanese village, removed from the Vienna Exhibition, and re-erected by Japanese workmen. North of the palace are several ornamental lakes, on one of which a water village has been erected on piles. In another part of the grounds is a Norwegian house, and the park is dotted over with small Swiss châlets.

Smith's "Assyrian Discoveries."—(*Nature*).—Since 1866 George Smith has periodically published some of the discoveries he made among the fragments of the terra cotta inscriptions deposited in the British Museum. His most startling discovery, however, he communicated in a paper read before the Society of Biblical Archæology, December 3, 1872, which gives the Chaldean account of the Deluge, and which he deciphered on the tablets of the Assyrian library discovered by Layard. In consequence of the great interest excited by these finds, the proprietors of the *Daily Telegraph* placed a thousand guineas at Mr. Smith's disposal, to undertake fresh researches at Nineveh. It was no easy task for him to go over the same ground and reopen trenches in the same localities so successfully worked by his predecessors. Still, the field of research is so extensive, and the hidden palaces are so numerous, that even now far greater treasures may be exhumed than those which have already been reclaimed by the French and English explorers. In less than four months he found on the sites of Kouyunjik and Nimroud, over three thousand inscriptions and fragments of inscriptions, besides many other objects of antiquity. The great object for which Mr. Smith undertook this expedition, namely, to recover, if possible, some of the missing portions of the inscribed terra cotta tablets he had deciphered in the British Museum, was thoroughly achieved. Among the discoveries he made at Kouyunjik is a veritable fragment containing the greater portion of seventeen lines of inscription which belong to the first column of the Chaldean account of the Deluge, completing the only place where there was a serious lacuna in the story.

Izdubar, the hero of these legends, is a giant who has a court, a seer or astrologer, and officers. Having lost his seer, and being unable to replace him, he determines to seek counsel of Hasisadra, the sage who escaped the Deluge. After protracted wanderings through fabulous regions, he at last alights upon Hasisadra and his wife, and inquires of the sage how he became immortal. The sage thereupon tells Izdubar the story of the flood, and of the vessel which he built according to the directions of Hea, to save himself and his belongings from the universal deluge which the gods brought upon the earth to destroy the human family because of the wickedness of the children of men. This deluge lasted six days, and on the seventh day the storm ceased, when the vessel was stranded for seven days on the mountains of Nizir. At the end of the second hexa-hemeron, Hasisadra sent forth some birds to ascertain the state of the ground, the description of which we give in the language of the legend :—

"On the seventh day in the course of it
I sent forth a dove and it left. The dove went and turned, and
A resting-place it did not find, and it returned.
I sent forth a swallow and it left. The swallow went and turned, and
A resting-place it did not find, and it returned.
I sent forth a raven and it left.
The raven went, and the corpses on the water it saw, and
It did eat, it swam, and wandered away, and did not return.
I sent the animals forth to the four winds,
I poured out a libation,
I built an altar on the peak of the mountain,
By seven herbs I cut,
At the bottom of them I placed reeds, pines, and simgar.
The gods collected at its burning, the gods collected at its good burning:
The gods like flies over the sacrifice gathered."

The Parthenon.—Those interested in ancient historical relics will be sorry to learn that the Parthenon at Athens is being shockingly wrecked and ruined. Tourists every season visit it, knock off limbs of statues, pull down portions of the frieze which Lord Elgin left, and, clambering up with hammer or stone, break off bits of the Doric capitals. These capitals are painted with rows of leaves, which are supposed to be bent double under the weight of the architrave, and relic-hunters seem to be especially fond of chipping this portion of the masonry. Not long ago a tourist knocked off the finger of one of the finest statues, as he wished to add to his private collection of curiosities at New York. The Greeks have almost completed a museum at the back of the Acropolis, but the work has come to a stand-still for lack of money. This fact has only to become known among artists and art-lovers in this country, and doubtless immediate steps will be taken to preserve that noblest remnant of Greece in her glory—the Parthenon.

In 1802, Lord Elgin visited the Piræus, and carried away from the Acropolis of Athens a large collection of sculptures, friezes, and other antiquities. These were packed in seventeen cases, and embarked on board the *Mentor*, which was overtaken by a storm off Avlemona, in the island of Cythera (Cerigo), where three days after she sank during a violent tempest. Lord Elgin wrote to the Admiral at Malta asking for assistance, which shortly arrived in the form of a number of divers from Calymnos, who succeeded in recovering twelve out of the seventeen cases. The antiquities which were saved were placed in the British Museum, but the other five cases have remained hidden beneath the waves until the present time. M. Makoukas, a gentleman residing at Cerigo, has, says *The Levant Herald*, sent a report to the Archæological Society of Athens, stating that these marbles are plainly visible lying on the bottom of the sea, at the depth of about 16 fathoms (96 feet). It is thought that with the present diving appliances these marbles will be easily recovered.

German National Monument to Hermann, or Arminius.—The inauguration of a gigantic statue to the deliverer of Germany from the power of the Roman, in the earliest age of her existence as a nation, was celebrated last August amidst unwonted enthusiasm and rejoicing. This statue is a great nation's expression of its hero-worship. Ernest von Bandel, the veteran German sculptor, who has at last seen the accomplishment of his lifelong work (he made the first sketch for the Hermann monument in 1819), has been more successful in his endeavour after typical grandeur than most of the modern sculptors of Germany, who seem to have been trying of late to attain sublimity simply by making their statues of Germania of larger and larger dimensions. The Hermann statue is more than usually colossal, measuring as it does from the feet to the point of the uplifted sword no less than eighty-five feet; but it has other claims than its size upon attention. Herr von Bandel has worked at it almost entirely with his own hands through years of neglect and public indifference, often spending his own money, it is said, upon the necessary expenses; for it was not until public patriotism was aroused by the events of the late war that the nation felt any great interest in his work. Now, at last, however, it is recognised as a noble achievement, and due honour paid to the persevering and single-minded artist. The gigantic statue itself is of cased copper, and represents the old German chieftain with uplifted sword and inspired strength accomplishing the mighty deliverance of his nation. It is raised in the very forests where the memorable defeat of the Romans took place so many centuries ago, and is placed on the top of a hill where it can be seen for many miles around. The pedestal on which it stands is in the form of one of the circular temples with round arches and massive pillars belonging to early German architecture.

India Museum.—The India Museum, which was opened in South Kensington in June last, was founded by the Court of Directors of the Honourable East India Company in 1798. In 1860 it was removed from Leadenhall Street to Fyfe House, and in 1869 to the India Office. The galleries of the Exhibition Building, in which it is now temporarily lodged, have been leased from H.M. Commissioners for the Exhibitioners of 1851 for three years. The lower gallery is devoted to Raw Products, and the upper gallery to Manufactures.

Louise Lateau "Stigmata."—The Royal Academy of Medicine at Brussels has given its opinion on this so-called "miracle." Louise Lateau, it is said, by divine assistance, abstains from taking food, and has done so for years together. Moreover, this miraculous creature has some wounds in her hands, side, and feet, which are said to be true representations of those of Christ, and which bleed profusely every Friday. The opinion of the Brussels Academy is as follows:—"Louise Lateau works and requires heat; every Friday she loses a certain quantity of blood by her wounds. When she breathes, she exhales water vapour and carbonic acid; her weight has not decreased since she has been observed; she therefore consumes carbon which is not furnished by her system. Where does she take this carbon from? Physiology simply replies, 'She eats.' The alleged abstinence from all food of Louise Lateau is contradictory to all physiological laws; it is therefore hardly necessary to prove that this abstinence is an invention. Whoever alleges that Louise Lateau is not subject to physiological laws, must prove it; until this is done physiology will denote the miracle to be a deception. Could Louise Lateau be closely observed night and day by scientific men, the deception would soon come to light. It is of no use to talk of miracles, even when eleven doors are shut against deceit, as long as the twelfth is left open."

Submarine Telegraph Cables.—The entire length of the submarine cables that have been laid is about 70,000 miles, of which 50,000 miles are in use, and 58 cables of 20,000 miles length have become useless. Previously to 1865 no cable was tested under water after being manufactured, and each had only a sheathing of light iron, weighing about 1,500 lb. the mile; this sufficiently explains the abandonment of so many cables. Among new cable lines projected are the following:—From San Francisco to Yokohama, by Honolulu and the Midway Islands (this would complete the "girdle"); from Panama to Payta, Ecuador; from Pisco, Peru, to Valparaiso; from Sydney to Wellington; from Aden to Mauritius; from Mauritius to Natal and Algoa Bay; from Honolulu to the Fiji Islands; from the Fiji Islands to Mauritius; from Porto Rico to Trinidad. The speed of telegraphing now attainable with the Atlantic cables is 17 words a minute in ordinary work, but for experiment's sake 24 words can be sent. With the cable of 1858 the highest speed realised was 2½ words per minute.

Some idea of the ramifications of the electric telegraph may be gathered from an experiment successfully accomplished in London last year. Captain Sartorius, then in Teheran, wished to test his chronometer, and to check with absolute correctness its time in Persia with Greenwich time. To do this it was necessary to have a clear line from Teheran to London, a distance by "wire" of nearly 4,000 miles. After getting the German relays into satisfactory order (the lines come through Berlin), the signal was made several times to insure accuracy, with the result that the watch was found to be two seconds slow by Greenwich time.

Electric Clock.—Professor Wheatstone's electro-magnetic clock has been applied to the Clydesdale Bank, the Royal Institution, etc. This ingenious and interesting piece of mechanism, although not indicating the "time of day" by any index of its own, is so arranged as to control the movements of any number of connected clocks by means of magnetic currents. A hollow coil is made to oscillate to and fro over magnets opposed, and thus creates a current (Faraday's magneto-electricity), which is repeated as often as the coil passes over the poles. A ponderous weight supplies the original motive power. This weight acts by cog-wheels upon a pendulum carrying the coils and working between two piles of magnets, a current of electricity being drawn from each set in turn. By the agency of spiral wires this current is conducted to the clocks (in the Clydesdale Bank, sixteen, in the Royal Institution, twenty-two in number), placed in different parts of the premises. Each dial has a miniature coil connected with the central magnetic pile which forces a needle to revolve by alternate currents just as the needle of a compass would do were the same influence brought to bear upon it. This needle guides and controls wheels, the pivot rods of which are extended to the front of the dial where the hands are joined on in the ordinary way. Of course, it is absolutely necessary to maintain the accuracy of the central machine, and this is obtained by establishing electrical communication between the pendulum at the bank and the Observatory clock at Dowanhill. Should the machinery in the bank move too fast it may be regulated every two hours by an electric current freeing a lever which has the effect of stopping the machinery during the space of time it may be in advance. Accurate time-keeping is thus maintained in the central and dependent machinery.

Royal Westminster Aquarium.—The dimensions of the aquarium, as designed by Mr. A.

Bedborough, the architect, is about 600 feet long by 240 feet in depth at the widest part. The building is in the classical style, constructed of red brick and Portland stone, with an arched roof of glass, similar in general plan to that of the Crystal Palace. It is two stories in height, and contains in the basement a great central tank of salt and fresh water, holding 600,000 gallons. The water will be kept in constant motion, and made by a steam-engine to pass continually through a series of small tanks. It is expected, by the incessant action of the machinery, that the water will be kept fresh for ten years, even if not renewed by additional supplies from time to time. The salt water in the tanks of the aquarium at Hamburg is found to be quite pure at the end of thirteen years.

On the ground floor at the eastern end is a large antechamber leading to the Central Hall. It contains a series of table tanks to hold the smaller fish, the zoophytes, sea-anemones, &c. In the Central Hall, which is 475 feet long, are seats for visitors, groups of statuary, and two large fountains. Flower-beds divide it from the aquarium tanks in what may be called the side aisles, and creepers and evergreens will be trained up the columns. The ascent to the first-floor galleries is by staircases similar in plan to those at the Crystal Palace. On the north side of the hall is an organ and an orchestra, capable of containing 1000 performers. The entire roof is of glass. A reading and writing-room and a library will be opened for the use of visitors and subscribers.

Where We Deal.—(*Times.*)—In the year 1874 we imported foreign and colonial merchandise, for consumption or resale, of the value of above 370 millions sterling, and we exported produce of the United Kingdom of the value of nearly 240 millions, making a total of nearly 610 millions. The bulk of this vast trade—above 500 millions of it—was with 16 countries :—with the United States, 102 millions; with France, 63 millions; with British India, above 55 millions; with Germany, nearly 45 millions; with Australia, nearly 38 millions; with Russia, nearly 30 millions; with Holland, 29 millions; with British North America, above 21 millions; with Belgium, 21 millions; with China, above 20 millions; with Brazil, nearly 15 millions; with Eygpt, 14 millions; with Spain and Canary Islands, above 13 millions; with Turkey, nearly 13 millions; with Sweden, nearly 12 millions; with Italy, 10 millions. Holland and Belgium serve, in part, as gateways for a trade really carried on with Central Europe, and Egypt for trade with the East. The 16 countries above named do not stand in the same order in the amount of imports and exports. In 1874 we imported merchandise from the United States of the value of nearly 74 millions sterling, but exported thither our own produce to the value of not quite 28¼ millions. Our imports from France exceeded 46½ millions, but our own exports thither were not very much over 16¼ millions. Our imports from British India exceeded 31 millions; our exports thither were a little over 24 millions. On the other hand, our imports from Germany were below 20 millions, but our exports thither were nearly 25 millions. Our imports from Australia were less than 19 millions, our exports thither were rather over 19 millions. Our imports from Russia reached nearly 21 millions; our exports thither not 9 millions. Our imports from and exports to Holland were nearly equal, both exceeding 14 millions. Our imports from British North America reached nearly 12 millions, our exports thither not 9½ millions. Our imports from Belgium exceeded 15 millions, our exports thither were below 6 millions. Our imports from China were nearly 12 millions, our exports thither were less than 8½ millions. Our imports from Brazil amounted to 7 millions, our exports thither were larger by nearly £700,000. Our imports from Egypt were 10½ millions, our exports thither little more than 3½ millions. Our imports from Spain exceeded 9 millions, our exports thither were less than half that amount. Our imports from Turkey were below 6 millions; our exports thither exceeded 7 millions. Our imports from Sweden were 8½ millions; our exports thither were less than 3½ millions. Our imports from Italy exceeded 3½ millions; our exports thither were nearly 6½ millions. Our imports from the 16 countries in 1874 amounted to nearly 309 millions sterling, and our exports thither of our own produce exceeded 191 millions, without including our exports of foreign and colonial goods.

Japanese Antiquities.—At Nara, an old capital of the Mikados, is an immense wooden barn, built by one of the kings of the eighth century, where he placed all the treasures of his palace previous to the removal of the Government to Kiyoto, where it has been ever since. The treasures have been from time to time inspected, and have now for the first time, after lying for 1,100 years, been brought out, and are exhibited in the great temple of Daibutz. Such a collection of authentic antiquities, illustrating one era, certainly does not exist in any other part of the world. There are books, screens, pictures, sculptures, pottery, metal vessels, masks, fans, weapons, ornaments, beads, tortoiseshell objects, and soap (!) in large cakes. One packet of Chinese paper, not written on, looks as clean and fresh as if it had been just brought from a stationer's. Some of the screens and pictures are a little the worse for years, but, as a rule, all the objects are in the most perfect preservation. Amongst the glass is a white ewer, about a foot high, which looks more modern than the eighth century. It is asserted however, by an antiquary who is engaged in describing the collection, that this ewer is one of the objects entered in the original list or catalogue which was deposited from the first. These antiquities are exposed in the inner hall of the temple of Daibutz, a colossus of bronze, 53 feet high. The old barn in which the Mikado's treasures were preserved is a most remarkable building. It is composed of solid timbers, woven and dovetailed together, and rests upon pillars formed of stout trunks of trees eight or ten feet high, so that the air passes underneath. It stands on the side of the hill, and has been kept dry by the constant winds—Japan is the windiest of countries. This alone can explain the preservation of such perishable objects as paper.—*Athenæum.*

Legend of Sakya Buddha.—Samuel Beal.—Those who are acquainted with the old Christian legend of Barlaam and Josephat, will recognise in the most striking incidents of Buddha's early life the original of that narrative. Buddha, like Josephat, was born of royal parents, who employed every device to secure him against even a knowledge of the disease and misery with which he was surrounded in the world. Every form of voluptuous pleasure was provided for him within the walls of the palace. Only the young and beautiful of the two sexes were admitted to be his playfellows. All his whims were eagerly gratified, and no source of earthly joy was withheld from him. But in the midst of these fascinations the youth's good genius, the Devaputra T'so Ping, imparted to him a desire to visit the outer world. No sooner was his wish made known to the king his father, than orders were at once issued that everything which might suggest to the prince the existence of old age, disease, or death, should be removed from the city. But again the Devaputra T'so Ping interfered, and caused an old man with shrivelled skin, a bald head, and a body bent down with age and infirmity, to appear before the prince. "What human form is this, so miserable and so shocking to behold?" inquired the prince of his coachman. "Great prince! this man is what is called old," replied the servant, who, in answer to further questions, explained that old age, which is but a prelude to death, is the lot of all who survive youth and middle age. On hearing this the prince returned to the palace sick at heart, and, though he again entered into the enjoyments provided for him, it was not with the same thoughtlessness as formerly.

Thrice again, at the instigation of T'so Ping, he passed beyond the palace walls, and, on these occasions he met respectively a sick man, a corpse being carried to the grave, and a shaman. The first two sights filled him with horror, and he returned to his apartments shocked and distressed. But his interview with the shaman brought peace and comfort to his troubled spirit, and he determined from that time forth to learn to look upon "all objects of sense as impermanent, to think no evil, and to do none; but, on the contrary, to benefit all creatures by his life and teaching. The king, on hearing of this decision on the part of his heir, was exceedingly distressed, and directed that every form of sensual pleasure and delight should be thrown in the way of the prince to dissuade him from his purpose, but all to no avail. The holy desire which inspired him, enabled him to see the canker which was at the root of every earthly joy, and to perceive the vanity of pleasure. His determination, therefore, being unshaken, he arose at the dead of night, and, mounting his horse, Kantaka, left his father's house for ever.

Having thus launched himself on the world, he steadily prosecuted his pursuit after holiness, and at length "attained to the perfect state of enlightenment," and freed himself from the "bondage of all impure desires."

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THE END.

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