THURSDAY, JUNE 23, 1904.

## THE LIFE WORK OF A SCIENTIFIC ENGINEER.

*Original Papers by the late John Hopkinson, D.Sc., F.R.S.* Vol i., Technical Papers. Edited by B. Hopkinson. Pp. lxvi+294. Vol. ii., Scientific Papers. Pp. vii+393. (Cambridge: University Press; London: C. J. Clay and Sons, 1901.) Price 10*s.* 6*d.* net each volume.

THREE years have elapsed since the two volumes of original papers by the late Dr. Hopkinson were published, and an explanation is naturally required for such a protracted interval being allowed to elapse before the work was reviewed in these pages. Shortly after its appearance, the writer became seriously ill, and the diminished vigour that accompanied a long tedious convalescence was marked by increased requests that work should be undertaken, exemplifying apparently the anecdote of the doctor who to obtain rest doubled his fees, but only succeeded thereby in doubling his practice. Hence the performance of a duty had to be postponed again and again, and it was not until Mr. C. S. Whitehead was kind enough to bring his mathematical power to bear on a critical analysis of this collection of papers and furnish the substance of much which follows that this tardy review came to be written.

In these two volumes we have the collected works of a man eminent not merely as a scientific investigator, but also as an engineer; they constitute the record of a worker who took a very leading part in showing his fellow electrical engineers how the application of scientific theory and knowledge helped more than crude trial and error in solving some of the numerous problems with which their industry abounds. Pioneers, as a rule, have the mortification of seeing their advances overlooked and neglected by their contemporaries, but Dr. Hopkinson had the happy fortune of being spared this; indeed, his papers resemble the writings of Shakespeare in that they appear to be full of quotations.

It might have been expected that a mathematician like Hopkinson, a senior wrangler and Smith's prizeman, would have freely used mathematical processes of some complexity, a transformer, for example, offering a most tempting field for mathematical excursion. But this is far from being the case; the great majority of the processes are such as can be easily understood by anyone moderately well versed in the calculus. But it must not be supposed that all these papers are easy reading; some of them are far from it, and it often takes considerable thought to grasp their meaning.

The first volume contains the technical portion of the papers, and opens with two dealing with lighthouses, one pointing out the advantages of what are known as group-flashing lights, the other describing the optical and electrical apparatus at the lighthouses of Macquarie and Tino.

The remainder of the volume deals almost exclusively with dynamo electric machinery. In the papers reprinted therein Dr. Hopkinson first shows how the curves now universally known as the "characteristic curves" are to be plotted, and then how to extract useful information from them; how, for instance, to determine the lowest speed at which a given dynamo can produce a short arc. He then directs attention to the necessity of taking account of both colour and direction in measurements of the brightness of the electric arc. A little further on we come to two papers on dynamo electric machinery, the first of which was written in conjunction with his brother, Dr. E. Hopkinson, in 1886. In these papers, which were published at about the same time as an equally important one on the same subject by Mr. Kapp, we are shown how the characteristic may be predetermined from theoretical principles based on the equations of a magnetic circuit, and on the magnetic properties of iron as found by experiment.

The paper of 1886 is classical, for with that of Mr. Kapp it laid the foundation of the design of electric machinery. Previously the proper shape to give to a dynamo was unknown, and it was impossible to foresee what effect on the performance of a dynamo would result from altering its shape. The late Prof. Rowland advocated long, lanky-legged machines, and Mr. Edison told the writer that the most astonishing thing in his life was finding that the dynamo which he sent to the Paris Electrical Exhibition of 1881 developed about the amount of electric power that he had hoped it might give.

Next follows the ingenious and economical method of testing the efficiency of a dynamo by coupling it mechanically to another of approximately equal size, and measuring the extra power that had to be supplied from an external source to keep the combination running when one of the machines acted as a motor and drove the second, which in its turn acted as a dynamo and supplied current to the first.

In reading through these papers one cannot fail to be struck with the keen insight which their author displays in picking out the essential points needing examination in the machine under discussion, and with the beautiful methods which he employs for presenting the results of his investigations. Thus, in his papers on the dynamo, he realised that, if the machine were to be improved by scientific study, it was absolutely necessary to ascertain, not merely how much power was put into it, and how much came out in a useful electrical form, but also what was going on in the various parts of the machine itself. Others before him had considered the input and output. Dr. Hopkinson, in conjunction with his brother, took up the second, and equally important, part of this investigation, and gave the results to the world in a manner that was as simple in expression as it was novel in conception.

The papers on alternating currents are, speaking generally, more important for what they suggest than for what they actually prove. Thus, to take those that deal with the parallel running of alternators. Two lines of argument in support of the opinion that they can do so are brought forward, one a purely

analytical method, the other proceeding from a consideration of the curves of current and E.M.F. If these two lines of argument rested on independent foundations, then their mutual agreement that alternators can so run would give weight. But, unfortunately, both proofs assume that the machines give smooth E.M.F. waves of the sine form and that the armatures have no iron, or, at any rate, that their self-inductions are constant. Further, the serious difficulty arising from "hunting" of the machines is not referred to. Hence the general conclusion, "You may therefore with confidence attempt to run alternate-current machines in parallel circuit for the purpose of producing any external effect," must be regarded as at any rate a bold one.

As a matter of fact, the two machines he experimented on did run in parallel perfectly, and others have since been built to do the same, but it does not follow, and indeed it is not the fact, that all machines possess this property. Dr. Hopkinson, of course, realised the limitations of his equations; indeed, he expressly mentions some of them. Hence in making his prediction we must conclude that he was more influenced by his experimental results than by his theoretical reasoning. In the numerator of the expression which occurs at the bottom of p. 149 of this paper

$$\frac{2\pi^2}{T} \text{ should be } \frac{2\pi}{T}^2.$$

A similar criticism as regards limitation in the reasoning may be passed on the equations used at the commencement of paper No. 10, p. 156, vol. i., on "Alternate Current Dynamo Electric Machines." Here he starts with the equation:—

$$Rx = E - (Lx)',$$

where the dot (left out by a printer's mistake on p. 163) signifies differentiation with respect to time. But, as Dr. Hopkinson remarks, "we do not know how L may vary," and so to obtain a solution he assumes L to be independent of time, which of course is not the fact, and so, as he points out, the ordinary theory does not fully account for the facts. This criticism, however, does not apply to the remainder of this paper, which is occupied with an experimental investigation of the currents induced in the coils and in the cores of the magnets of alternate current machines by the varying currents and by the varying position of the armature. A method of determining the efficiency of alternate current machines is also given, and the result used to show that in certain cases of relation of phase of current to phase of electromotive force, the effect of the local currents in the iron cores is to increase instead of to diminish the electromotive force of the machine.

We next come to a short but important paper in which the equations which hold in a transformer with a closed magnetic circuit are given and partially discussed; and in the next paper a method of testing transformers is described and illustrated, the method being similar to that previously given for continuous current dynamos

The remaining papers in this volume, consisting mostly of addresses, do not call for special remark, except for one paragraph, on p. 249, viz., "We know nothing of what light is; we do know that it is a wave." "Is it not infinitely probable that the waves of light are none other than the electrical waves which we know must exist, and must be propagated with the observed velocity of light? And, mark, this theory demands no ether." "Whether the postulate of an all-pervading ether be, or be not, a metaphysical necessity, surely it is well for the practical man and the physicist to leave the question to the metaphysician." Here, then, waves are allowed but an ether is denied, or looked on with suspicion, and so we have apparently to imagine a wave as independent of and apart from any medium; a vibration with nothing to vibrate seems a rather difficult conception. Nor is it easy to see what the metaphysician, in the proper sense of this much abused word, has got to do with the question of an ether; the physicist in his laboratory rather than the metaphysician in his armchair would seem to be the proper man to deal with it.

The papers in the second volume may be roughly divided into three groups. The first group contains papers dealing with residual charge and specific inductive capacity, the second group papers on the magnetisation of iron and the effect of temperature, whilst the third consists of papers on miscellaneous subjects.

The accurate determination of a physical constant of any substance is always a matter of scientific interest, but great additional interest and importance were attached to Dr. Hopkinson's experiments on specific inductive capacity from the fact that, according to Maxwell, the specific inductive capacity of a dielectric ought to be equal to the square of its index of refraction. To appreciate properly the full importance of these experiments we must remember that when Maxwell's treatise appeared in 1873, Maxwell was able to write that there was only one substance, paraffin, the capacity of which was known with sufficient accuracy for a comparison. To this solitary example Dr. Hopkinson added some four different kinds of glass and nine different oils, and it is hardly too much to say that if in all these substances the above relation had been fulfilled, then Hopkinson, and not Hertz, might have been regarded as the man who first experimentally verified Maxwell's theories, although Hertz's work would still have had its great value in connection with the actual propagation of electric waves in space. Unfortunately for Hopkinson, though the relation was found to be true in the hydrocarbon oils, in the vegetable and animal oils and in the glasses it was far from being satisfied.

So far, however, from jumping to the conclusion that Maxwell was wrong, Dr. Hopkinson, in a paper written in 1878, regards it as sufficient to add the caution, "it should not be inferred that his [Maxwell] theory in its more general character is disproved," whilst in a paper written in 1881 he remarks, "It must, however, never be forgotten that the time of disturbance in the actual optical experiment is many thousands of millions of times as short as in the fastest electrical experiment even when the condenser is charged or discharged for only the 1/20,000 second."

Further, in a paper published in 1882, he suggests that a further reason for the discrepancy as regards glass may be the fact that his experiments seem to show that glass would exhibit anomalous dispersion if the spectrum could be examined below the visible rays. Yet another reason for the discrepancy also suggested itself to Dr. Hopkinson, and this was the effect of residual charge, for he regarded capacity, residual charge, and dielectric conductivity, all as ordinarily known, as parts of one continuous phenomenon, and he assumes that we may add the effects of simultaneously, or successively, applied electromotive forces, and that residual charge is proportional to the electric forces producing it. He thus gets the expression :—

$$y_t = \int_0^\infty x\psi(\omega)d\omega,$$

where $y_t$ is the displacement at a time $t$, $x$ the P.D. applied at a time $\omega$ before $t$, and $\psi(\omega)$ is a function of $\omega$ only.

The experimental verification of this formula, and the detailed examination of various substances such as glass, ice, and castor oil, from this point of view are described in two exceedingly interesting papers. The influence of temperature on the phenomena is also examined. It appears from these experiments that the value of the specific inductive capacity of a substance depends on the time of contact. Thus Dr. Hopkinson found that the specific inductive capacity of ice when measured for periods of 1/100th to 1/10th second increases both with rise of temperature and with increase of time, and its value is of the order 80, but when measured for periods such as $1/10^6$ second its value is about 3, and he adds, "We conclude that the great deviation of ice from Maxwell's law is due to residual charge, which comes out between frequencies 10,000 and 100."

We may mention here that there are some misprints in the papers just referred to. On p. 15 equation (6) $\{X\psi(t) - B\}$ should be $X\{\psi(t) - B\}$ ; on p. 107, in equation (8), $V^2/x$ should be $V/x$ ; on p. 113, a slight extension of the upper radius of the lower right-hand quadrant makes it appear as if this quadrant were joined to the right-hand top quadrant ; and on p. 120, $dy_t/dt = \psi t$ should be $dy_t/dt = X\psi(t)$, and the reasoning that is given relatively to $\psi(t)$ really applies to $X\psi(t)$.

The magnetic papers commence with one on the magnetisation of iron, its value being greatly enhanced by the chemical analyses which are given of the specimens experimented on. An exact definition of coercive force is given, and the ascending and descending curves are found for a large number of samples by the split bar and yoke method. Attention is also directed to the way in which a small quantity of manganese changes the magnetic properties of iron ; thus iron with 12 per cent. of manganese is practically non-magnetic.

The papers dealing with the effects of temperature on the magnetic properties of iron contain some very striking results. It had long been known that iron or steel became non-magnetic when raised to a sufficiently high temperature, viz. about 780° C. This Dr. Hopkinson calls the critical temperature, and he shows that for small magnetising forces the magnetisation of iron increases with rise of temperature until it approaches the critical temperature, but, on further heating, the magnetisation very suddenly almost entirely disappears. It is also shown that as conjectured by Barrett, recalescence occurs at the critical temperature, and that the quantity of heat liberated in recalescence is comparable with the heat required to melt bodies ; and, as a further proof of the connection between recalescence and the disappearance of magnetism, Dr. Hopkinson shows that no liberation of heat takes place in a non-magnetisable manganese steel when experimented on in the same way as hard steel and iron.

Most remarkable results were found with certain alloys of iron and nickel. Thus it was found that a specimen containing 25 per cent. of nickel could exist in two different and quite stable states through a range of temperature from a little below freezing to 580° C., one state being non-magnetisable, the other magnetisable. Other physical properties of this alloy were found to change with its magnetic properties ; thus its mechanical strength, its extensibility, its electric resistance, its density, are all different in the two states. From the memoir attached to the first volume we learn that Dr. Hopkinson tried if other substances, such as chromium and manganese steel, would behave in a similar manner when experimented on in the same way as the nickel and iron alloy, but none of them showed any sign of becoming magnetic, although cooled in solid carbonic acid.

Next follow papers on magnetic viscosity and on the propagation of magnetisation of iron as effected by the electric currents in the iron. It will be remembered with what interest the experiments on the latter subject were witnessed, and how, when the current was sent round the coil magnetising the block of iron, the ballistic galvanometers attached to the various search coils embedded in the mass deflected with considerable intervals one after the other as the magnetisation reached their respective search coils.

Lastly come papers on the rupture of iron wire by a blow, on the mathematical theory of Tartini's beats, on the effect of internal friction on resonance, on the optical properties of a titano-silicic glass, on the quasi-rigidity of a rapidly moving chain, on the torsional strain which remains on a twisted glass fibre after release from twisting stress, on the stresses caused in an elastic solid by inequalities of temperature, and various others.

At the present time, when so much attention is being given to the development of applied education in this country, it is instructive to look back on this ideal technical teacher, this translator of abstract mathematics into concrete industrial achievements, a man who was so able that he was quite simple and modest—for only mediocrity requires "side"—who sometimes spoke of things as having happened to be carried out by himself, as if it were a matter of mere chance that they had not been originated and accomplished by anyone else. What irony of fate when so many holiday-making Alpine tourists, whose only possible claim to notice consists in their having made some ascent a little earlier in the season or gone a little higher than someone else, return scatheless year after year, that the man who was doing, and had done, great work in

the realms of engineering practice and of pure science should have been lost to the world in his prime.

Vol. i. is prefaced by a memoir written by his son—the present fitting holder of the chair of engineering at Cambridge—and this memoir, which even filial love and reverence have not made too flattering, forms the best review of the life's work of Dr. Hopkinson.

W. E. AYRTON.

## REMINISCENCES.

*Notes from a Diary.* By Sir M. E. Grant Duff. Vol. i., pp. 317; vol. ii., pp. 326. (London: John Murray, 1904.) Price 18*s*.

SIR MOUNTSTUART GRANT DUFF tells us in his preface that in these two, as in the previous, volumes of his diary he has "resolutely kept to the less serious side of life." They contain no thrilling adventures, no sensational revelations, no acrimonious attacks, no profound metaphysical discussions. They give, however, an interesting picture of the life of a distinguished and cultivated man, with side glimpses of many of the most eminent of our contemporaries both in this and other countries.

For this Sir Mountstuart has had unique opportunities. When he was going to his Governorship of Madras his friends gave him a farewell dinner. It was a gathering of which any man might be proud, and in returning thanks for the toast of the evening, he said with no less truth than good feeling that, when he was young, his ambition had been to make friends of the best and highest of his contemporaries, and that, looking round him, he felt that in this object he had succeeded beyond his most sanguine hopes.

It is probable that many of those who read the diary will fancy that some pieces might have been omitted. I remember at one of our modest X club meetings we all thought that the dinner might be shortened, so as to give us more time for talk afterwards. But when we came to details we could not agree. One suggested to omit the soup, another the fish, a third the joint, and a fourth the pudding. Finally we remained as we were: so I fancy from the present volumes one would omit the botany, another the personal details, a third the theological hints, and so on. But if anyone is disposed to regard some of the details as hardly worthy of record, let him remember how interesting it would be now if Mecænas had left us similar details of his everyday life! What a light it would throw on Roman society and Roman history!

He gives us glimpses, moreover, which show the "art of conversation" at its best. He does not condescend to scandal, or attract attention by ill-natured remarks, or while away time by remarks on the weather. As Mr. Norton says in a typical case, "Flaubert's correspondence, a new edition of Æschylus, the Chanson de Roland, the management of the London Library, Bayreuth, the Euryanthe of Weber, were only a few of the many subjects which came up during our conversation."

The book is admirably adapted for a railway journey, a holiday, or a sick room. It is full of bright sayings, of good stories, of interesting reminiscences of interesting people. It carries us from one country to another, from one society to another: from London to Switzerland and Greece, from politics to theology, from The Club to the Athenæum or the Literary Society.

Sir Mountstuart thinks, and I should not be disposed to differ, that the late Lord Derby was the wisest statesman of his generation. At any rate, probably it would be safe to say that of those who took a leading part, probably none made fewer mistakes.

The botanical notes are numerous. He mentions, for instance, on the authority of Lord Plunket, that Westminster Hall is roofed with oak from the forest of Shillelagh.

The references to zoology are less frequent.

On p. 193 he tells us that Prof. (afterwards Sir William) Flower "gave a very interesting account of the shell of a tortoise which stands in one of the passages. Its original owner was a pet of Laud's, and lived in his garden at Fulham. When he became Archbishop he took the creature to Lambeth, where it lived from 1633 to 1753, when it came by its death, thanks to the folly of a gardener, who dug it up in the middle of winter."

He quotes Aubrey de Vere's happy saying that many people mistake downrightness for uprightness, and again that some people seem to "think they serve God but by serving their neighbour right."

Among other amusing bits are Sydney Smith's dream, "I had a very pleasant dream! I dreamt that there would be in future thirty-nine Muses and only nine articles"; the description of the French coinage of 1848 by a Royalist: "Liberté—point. Egalité—point. Fraternité—point"; which was thus varied: "Liberté de faire du mal. Egalité de misère. Fraternité de Cain et Abel"; the story of an Englishman who "was being driven by a carman through some town, when he saw in front of the Post-Office what he supposed to be the Nine Muses. 'What are those?' he asked his driver. 'The twelve Apostles,' was the answer. 'The twelve Apostles!' he rejoined; 'I can only see nine.' 'Oh,' said the man, 'the other three are inside sorting the Epistles:'"

Bradlaugh's saying with reference to the old and new trades unionism: "The motto of the old Trade Unionists was 'We will!' The motto of the new Trade Unionists is 'You shall!'"

One of the most beautiful of epitaphs, that written by Wordsworth (Bishop of St. Andrews) on his wife:

> I nimium dilecta: vocat Deus; I bona nostrae
> Pars animae; moerens altera disce sequi.

The names of Gladstone, Disraeli, Salisbury, Lowe, Coleridge, Newman, Stanley, Tennyson, Browning, Dufferin, Matthew Arnold, Huxley, and Flower are among those which flit through the pages. Sir Mountstuart says that he has dealt only with the less serious side of life. In saying so he meant, no doubt, that he does not deal argumentatively with politics, science or theology. The diary brings out, however, clearly his

sympathy with science, as shown, for instance, by his numerous references to botany and his many visits to the British Museum, his reverence for religion, and his affection for his friends.

He might have made his diary more piquant, no doubt, if he had yielded to the temptation of introducing some touches of that ill-nature which, as Lord Acton once said, makes the whole world kin. It is all the more to his credit that he has made a thoroughly enjoyable book quite free from scandal or bitterness.

Many little indications scattered through the whole diary show how useful and sympathetic a part Lady Grant Duff has taken in her husband's career.

AVEBURY.

## THE METHOD OF NATURE STUDY.

*The Ludgate Nature Study Readers.* Books i., ii., and iii. Edited by J. C. Medd. Pp. 176, 204, and 215.

*The Frank Buckland Reader.* Edited by F. T. Buckland. Pp. 248. (London: Routledge and Sons, Ltd., 1904.) Price 1*s.*, 1*s.*, 1*s.* 3*d.*, 1*s.* 6*d.*

THE subject of "nature study" has occupied a pretty prominent place in educational discussions for the past few years, and now, for good or evil, seems to be established as a part of the routine of most elementary schools. For good or evil we say advisedly, since the subject is pursued with mixed aims and with very varied conceptions of what it can contribute to a child's education. Some people see in the subject a means of increasing the interest in agriculture and staying the migration to the towns, others regard it from a humanitarian and æsthetic side as teaching children to be fond of plants and animals; but the true function of nature study is to provide a convenient means of teaching the child to observe and experiment and so to apply its reason to the things among which it lives. Its only justification is that by its means the child can be made to work its own mind instead of passively accepting the statements of the teacher. As soon as the child's mind ceases to be actively finding out from the real object, as soon as the personal and actual note is lost, nature study becomes a very indifferent school subject.

The want of a clear conception of the spirit in which nature study should be pursued is somewhat apparent in the little series of readers which Mr. Medd has got together; they consist of a number of typical lessons contributed by men and women engaged in teaching all over the country, among whom we recognise the best of the exhibitors at the Regent's Park Nature Study Exhibition in 1902, which was so successfully organised by Mr. Medd. The subjects range over the whole scale of natural phenomena, wind and rain, the life of animals and plants, how to keep pets, rocks and fossils. We can recommend the book thoroughly to the teacher looking round for a subject to make his own, since with a little discrimination he will find examples of how to work and what to avoid. For example, in close proximity come two lessons about rocks; at p. 165, vol. iii., Dr. G. Abbot illustrates how the teacher should proceed to study the quarries in his neighbourhood (compare also Mr. Lewis, vol. ii., p. 192), what he can show from them about the way rocks have been made, and how they lead to general ideas about the structure of the country. A few pages further on we get the contrast—a tepid extract of text-book about strata, folds, dip, strike, &c., illustrated by diagrammatic sections of Kinekulle on Lake Wener, the Bavarian Hills, and the Schiefergebirge of the Eifel! Again, in the same volume, we get a lesson giving a wholly unilluminating account of sun-dials and the apparent motion of the sun, which would leave the ordinary child dazed with east and west, hour lines and shadows. What is anyone to make of an explanation like the following:—

"Now, when the ancients found out that the reason the time of sunrise varies is because the earth's axis is tilted, it occurred to them to make the gnomon lean in the same direction. The result of this was that the shadow fell on the same hour lines at the same time of the day all the year round. What a splendid discovery!"

The next lesson is a good example of the right method; the children learn to follow the change in altitude of the sun throughout the year by marking its height on a window-pane, the motion on the floor of the shadow of a spot on the same window being also recorded at the same hour every day. Little by little, as the child absorbs facts of this kind, the motion of the earth and its consequences as explained by the teacher will begin to live in its mind.

It cannot be too often repeated that as soon as nature study leaves the path of actual observation and experiment it not only becomes valueless educationally, but it is apt to result in howlers. Popular natural histories abound in hoary untruths, some of which are handed on another stage in these pages; some again seem to be newly invented. Take the following statement, vol. iii., p. 52:—

"The experienced eye can detect at once whether any particular soil is, or is not, deficient in iron by the colour of the vegetation. Compare the grass growing on chalk downs with that in a rich, alluvial valley even in the same locality. The former is short and stunted, no matter how wet the season may be, and it never attains the deep, rich green hue of the latter, inasmuch as chalk contains very little iron, and that as an impurity."

Sciolism could not go further; we should like to *viva* the author on the meaning he attaches to the word "impurity" in this connection, but he, alas! is an inspector, born to *viva* other people!

As regards the way to treat natural history proper in the school and how to turn the child's strong instinct for collecting into the right lines, no better lessons could be found than those on insects provided by Mr. W. J. Lucas.

The fourth volume of the series consists of a selection from Frank Buckland's "Curiosities of Natural History," and makes as good a school reading book as one could wish to have. The whole series is well printed and liberally, if somewhat unequally, illustrated.

A. D. H.

## OUR BOOK SHELF.

*On the Location and Examination of Magnetic Ore Deposits by Magnetometric Measurements.* By Eugene Haanel. Pp. ix+132 and plates. (Ottawa, Canada: Department of the Interior, 1904.)

DR. HAANEL, Superintendent of Mines to the Canadian Government, read a paper under the above title at the annual meeting of the Canadian Mining Institute in the spring of last year, which is now published in book form by direction of the Minister of the Interior.

The work is substantially an account of the Swedish method of locating by means of specially constructed magnetometers the presence of magnetic ore deposits, and of determining their strike, direction of dip, and depth below the surface.

Von Wrede, as far back as 1843, indicated the value of the magnetometer in determining the location and extent of such deposits, but the first to turn the suggestion to practical account was Robert Thalén, who, in 1879, published his work "On the Examination of Iron Ore Deposits by Magnetic Measurements." Since that time the method has been greatly developed, and convenient field instruments—the Thalén-Tiberg magnetometer and the Thomson-Thalén magnetometer—are now placed by Swedish mechanicians at the disposal of mining experts. As yet, however, the knowledge and use of these instruments have been almost exclusively confined to Sweden, although scattered references to their employment are to be met with in English mining and scientific literature.

Rücker and Thorpe, in their great magnetic survey of the British Isles, showed the value of the magnetometer in determining the presence and the contour of underground magnetic material, and they were the first to direct the attention of English geologists to the importance of this instrument in geological inquiry.

Dr. Haanel has rendered the mining profession a great service by putting together a concise account of the Swedish method and practice. By the help of this manual a properly trained mining engineer would have comparatively little difficulty in mastering the theory of the field instruments and in acquiring familiarity with their use.

Whether, however, the greater number of English mining engineers are sufficiently well trained to follow the mathematical treatment of the theory, as set forth by Dr. Haanel, may be open to doubt.

*Spokil, an International Language.* By Dr. Ad. Nicolas. Pp. viii+272. (Paris: A. Maloine, 1904.)

THIS work consists of eight pages of preface, of eighteen pages of "grammar," of forty-four pages of exercises, and of 203 pages of a "Spokil"-French dictionary. The language consists of two kinds of words; those borrowed from existing languages with slight modifications and those coined on a system. The system is ingenious, but, in the opinion of the reviewer, quite unworkable. To take an instance:—To the letter "P" is attached various ideas; for example, those of motion, the foot, weight and the preposition "after." Thus we find Pimo, heavy; Pino, light; for the letter n contradicts the letter m; Peme, to lead; Pene, to come; the idea of "leading" being antithetical to that of "coming"; Pleal, wood; and Plealta, absence of wood; the idea of absence or default arising from the affix "ta"; and so on. As in Esperanto, different parts of speech are distinguished by different vowels, as, for example, Arta, dirt, or a dirty object; Arte, to dirty; Arto, dirty; and Artu, dirtily. The language is in what may be termed the agglutinative stage; for we have Apafil, derived from Ap, to lead, af, off, and il, agent; the whole word means an abductor. It may interest chemists to know that the future name of butylene is to be eul vokilo; for e stands for carbon, u for hydrogen, l is terminative; vo means four, ki eight, and lo is the termination of a noun (?). English plurals in s are borrowed; likewise our classification of genders. The definite and indefinite articles are retained in the singular and plural, the latter in the plural in the sense of "the ones"; and the French "du" and "des" also appear in both numbers.

Enough has probably been said to give an idea of the character of the grammar; in conclusion, we will show what is "to serve as a model to future speakers"; it is "Zu erve di teil da les espel zoio." We do not think that that will be the fate of this artificial language. And it may be confidently supposed that the future universal language will not be invented by a Frenchman. There have been a good many attempts; and they all tend far too much towards inflection. Probably the most perfect languages from that point of view are those of the native Australians, who possess singular, dual, trial and plural, who have inclusive "we" and "they," as well as exclusive, and who indicate in half-a-dozen ways the particular position of the object designated by the word "that." The idea of an international language is an admirable one, and it will no doubt be realised, but the end is not yet come, and it is certainly not "Spokil."

*The Non-Metallic Minerals: Their Occurrence and Uses.* By George P. Merrill. Pp. xi+414. (New York: John Wiley and Sons, 1904; London: Chapman and Hall, Ltd.) Price 17*s.* net.

THE author of this valuable work is head curator of geology in the United States National Museum, and in 1901 he issued a scholarly guide to the study of the collections in the section of applied geology. Upon this guide he has founded the present work in which he brings together the widely-scattered notes and references relating to the occurrence and use of minerals of value other than as ores. Much of the information he gives is quite new, particularly in regard to the occurrence of American minerals; and the value of the work is greatly enhanced by the well-selected photographs of quarries and of striking specimens. Among these the views of the big vein between the peridotite and gneiss at Corundum Hill, North Carolina; of the quarry of lithographic limestone at Solenhofen, Bavaria; of large spodumene crystals in granitic rock, Etta Mine, South Dakota; and of quarries of bituminous sandstone in California and in Indian territory, are of special interest.

The scheme of classification adopted is as follows:—(1) Elements, (2) sulphides and arsenides, (3) halides, (4) oxides, (5) carbonates, (6) silicates, (7) niobates, tantalates and tungstates, (8) phosphates and vanadates, (9) nitrates, (10) borates, (11) uranates, (12) sulphates, (13) hydrocarbon compounds, and (14) miscellaneous, including grindstones, pumice, moulding sand, road-making materials, &c. Gems, building stones and marbles are not included in the scheme. Under each species will be found an excellent bibliography, and much interesting comment and information regarding its uses. For example, we are told that at Oberstein, on the Nahe, schoolboys' marbles are made in great quantities from limestone. The stone is broken into square blocks, which are thrown into a mill consisting of a flat horizontally revolving stone with numerous concentric grooves on its surface. A block of oak, of the same diameter as the stone and resting on the cubes, is then made to revolve over them in a current of water, the cubes being thus reduced to the spherical form in about fifteen minutes.

Of lithographic stone a series of analyses are given

showing the variation in composition, even in samples from the same locality. The only stone which has as yet been found to fill all the requirements of the lithographer's art is that from Solenhofen, in Bavaria. In the United States materials of the nature of lithographic stone have been reported from a number of localities described by the author. While, however, it was possible to get small pieces suitable for trial purposes, every locality has failed, as a constant source of supply of the commercial article. Very encouraging reports come from Canadian sources, and it is possible that a considerable lithographic stone industry may yet be developed in the Dominion.

*Essais des Metaux, Theorie et Pratique.* By L. Gages, Chef d'escadron d'Artillerie. Pp. 168. (Paris: Gauthier-Villars, no date.) Price 3 francs.

THIS little work, the sixth of the "Aide-Memoire" series on metals, by the same author, is written with much of the charming clearness of diction generally found in French metallurgical writings. There are two parts, the first on the theory of the tests and the second on practice. Considering the size of the page (convenient for the pocket), the matter is wonderfully well treated. Thus, to take the tensile test as an example, there is a general heading, Preliminary Ideas, with paragraphs (1) Period called Elastic, (2) Period of Deformation, (3) Contraction, (4) Curve of Traction. In this last is worked out from the ordinary tensile curve, showing elongation and tons per square inch on the original section, a curve showing tons per square inch on the real section, thus making plain to the student the reason for the apparently paradoxical form of the ordinary curve. The next main heading is the Law of Similitude, treated under six subheadings, the first of which, for example, considers the two permanent elongations produced during tensile testing. These two very distinct elongations are not only made clear, but methods are given for their determination, and the steps in the reasoning are worked out by simple mathematical methods where necessary. In like manner are handled such subjects as elasticity, influence of temperature, repetition of stresses, distribution of deformations, augmentation of elastic limit.

Part ii., on practice, treats in a general way of the tests applied by engineers before accepting cast-iron, steel, steel castings, &c. A short chapter gives a general idea of the kind of tests applied to metals other than the iron family. Two pages on microscopic metallography are full of wisdom, counselling caution in its use alike for specification and deduction, which might well be taken to heart by some present day advanced workers. If one remembers that the little book is of a very general nature and deals with ideas about tests and testing with few details, then it is heartily to be recommended.

A. McW.

*Karl Heumann's Anleitung zum Experimentiren bei Vorlesungen über anorganischen Chemie.* By Dr. O. Kühling. Third edition. (Brunswick: Vieweg und Sohn, 1904.) Price 19 marks.

So long as the lecture system of imparting information is retained, so long will the experimental demonstration remain its necessary accompaniment. It is useless to contend that a student cannot derive the advantage by seeing an experiment performed that he would were he to do it himself in the laboratory. Apart from the costliness of much of the apparatus, the difficulties of manipulation would put it beyond the power of a beginner to obtain satisfactory results, which depend, as they frequently do, on the skill and experience of the experimenter. Provided an experiment is neither merely pretty nor obviously sensational, nor lasts long enough to interrupt the train of ideas, the effect can only be stimulating to the student. But the effective lecture experiment fulfilling these conditions requires a good deal of thinking and working out, and that is why the books on lecture experiments by Heumann and Newth are invaluable to teachers whose time outside the lecture room is occupied with research or the manifold duties of their departments. The third edition of Heumann's "Anleitung zum Experimentiren" will be welcomed by all teachers of chemistry. The author, who is perhaps better known as the discoverer of the indigo synthesis, died in 1894, shortly after the second edition of his work appeared, and the task of revision has fallen to Dr. Kühling. The experiments which he has added relate to electro-chemistry, to the use of liquid air in low temperature experiments, and to Moissan's electric furnace and Goldschmidt's reduction methods for the production of high temperature reactions. Physical chemistry also claims a small share of the new edition. The increasing use of the lantern has induced the editor to introduce a chapter on optical projection which includes an account of an electric installation for the lecture room. The author has had the advantage of obtaining much valuable information from such skilled experimenters as Landolt, Fischer, Buchner, Bunte and many others, with the result that the volume has swelled to a bulk which might dismay any ordinary lecture assistant.

J. B. C.

*Church Stretton.* Vol. ii. *Birds*, by G. H. Paddock; *Flowering Plants*, by R. de G. Benson; *Mosses*, by W. P. Hamilton; *Parochial History*, by H. M. Auden. Pp. 205+xvii. Vol. iii. *Pre-Roman, Roman, and Saxon Archaeological Remains*, by E. S. Cobbold; *Church Architecture*, compiled by E. S. Cobbold. Pp. 124+x. Both volumes edited by C. W. Campbell-Hyslop and E. S. Cobbold. (Shrewsbury: L. Wilding, 1904.) Price 5s. net each.

THE first volume of this instructive guide to Church Stretton, which is now complete, was reviewed in our issue for October 11, 1900 (vol. lxii. p. 571), and, as pointed out on that occasion, the first instalment dealt with the geology, macro-lepidoptera, and the molluscs of the neighbourhood. As might be gathered from the titles of the sections into which the present two volumes are divided, the completed account of Church Stretton contains all that a visitor or resident is likely to want to know. Moreover, as the volumes contain the results of local scientific research and observation by competent workers, they may be used with confidence as a guide to the natural history and archæology of the district.

In the introduction to the catalogue of the birds met with in the district of Church Stretton, Mr. Paddock directs attention to the fact that owing to the persistent persecution by game preservers, some of the larger Raptores, which formerly bred there, do so no longer, and that the smaller species are, from the same cause, rapidly diminishing in number. A similar fate has befallen some members of the Corvidæ, though to a lesser degree.

Mr. Benson's catalogue of the phanerogams of Church Stretton is conveniently arranged and exhaustive in its character. Owing to the ill-health of the compiler, this list was revised by Mr. Hamilton, who deals also with the mosses of the neighbourhood.

*Fundamentals of Child Study.* By Edwin A. Kirkpatrick, B.S., M.Ph. Pp. xxi+384. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) Price 5s. net.

"THIS book," we are told, "is an attempt to present, in an organised form, an outline of the new science of child-study for investigators, students, teachers, and

parents. . . . It was the original intention," of the author, "to summarise all the principal child-study investigations that have been made." But this plan was evidently abandoned at a very early stage, and we have instead the present popularly written volume, which we can heartily recommend both to teachers and parents. Its style is pleasing, and its matter fairly correct, embodying the experience of fourteen years' study and teaching in the subject. Were the contents as widely read as they deserve to be, the immense importance of child-study, as a basis for methodical teaching and rational education, would be more generally realised.

The greater part of the book is devoted to the development of instincts—a word used in an extended sense by the author to embrace the phenomena of imitation, curiosity, migration, and even æsthetics, morality, and expression. These nine chapters, together with those on heredity, individuality, and on the development of the intellect, are all admirably written, containing excellent food for the parent's reflection and stimulating the interest of the teacher in her work. It seems strange that the subject of fatigue should be relegated to the chapter entitled "Abnormalities." This latter contains some useful hints on the mental and physical defects of children, but the accompanying pathological and anatomical remarks are in several instances inaccurate and misleading. C. S. M.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications.]*

### Residual Affinity.

THERE appears to be a tendency among chemists to abandon their own doctrine of definite valency, and to recognise an indeterminate and fluctuating number of links connecting atoms with each other.

The electron theory of the physicist, which assigns one indivisible unit of charge to a monad, two to a dyad, &c., has therefore encountered some opposition, inasmuch as it seems to tend to harden the old doctrine of "bonds" whereby atoms were supposed to be linked only in a simple definite and numerical way, no fraction of a bond being contemplated.

Assuming this rough statement to represent something like historical truth, I have a few remarks to make on the subject.

First, the possession by an atom of a definite charge, numerically specifiable as a simple multiple of an indivisible unit, must be accepted as a physical fact.

Second, this fact corresponds with those other facts which originally led chemists to assert, for instance, that nitrogen was a triad or pentad, carbon a tetrad, &c.—a position which it would seem absurd to abandon. (Incidentally it may be noted that a monad must be either electro-positive or electro-negative, but that a tetrad need not be either, since its pairs of charges may be opposite in sign.)

Third, there is nothing in these doctrines inconsistent with the existence of fractions of a bond and any required amount of "residual affinity."

It is this last thesis that I wish briefly to develop. Indeed, in 1902, in a paper on electrons published in the *Journal* of the Institution of Electrical Engineers, vol. xxxii., p. 103, I showed how it was possible to regard ordinary mechanical cohesion on the electric theory; and likewise that it was easy to regard molecular combination from the same point of view.

In a short conversation with Prof. Armstrong, at the Mansion House recently, I realised more clearly than before where the imaginary difficulty now lies.

It has been an occasional habit with physicists when speaking of lines of force to think of a single line of attraction or elastic thread joining each negative electron to its corresponding positive charge; each unit charge, in fact, being regarded as the cut end of a line of force and nothing else. But so far as I know it has never been considered that these lines of force so interpreted were physical realities, and that one and only one line really appertained to each unit charge; though in his recent remarkable book reviewed in these columns on May 26, p. 73, Prof. J. J. Thomson goes near to assigning so great a physical reality to the lines of force as would make the number issuing from any charge a commensurable number; that is to say he begins hypothetically to regard each line of force as a discrete physical entity. But even so there is no evidence that each unit of charge ought to have assigned to it one solitary line of force, it might have a great number; though it is true that on that view it becomes a definite question how many lines of force a unit charge possesses, whereas on the ordinary vaguer view of a centre of force the influence of which is felt in all directions, any specification of number of lines is either meaningless or a mere question of convenience of measurement, like the number of miles in the circumference of the earth, or the number of cubic feet in a room: a number which is necessarily and always incommensurable.

On any view electrons are supposed to repel and to be attracted with a force varying as the inverse square of the distance, and this is only consistent with a very large number of lines of force radiating from each and starting out in every direction equally.

When opposite charges have paired off in solitude, every one of these lines start from one and terminate on the other constituent of the pair, and the bundle or field of lines constitutes a full chemical "bond"; but bring other charges or other pairs into the neighbourhood, and a few threads or feelers are at once available for partial adhesion in cross directions also, the quantitative distribution of the force being easily calculable from geometrical data.

Briefly, the charge is indivisible, it is an atomic unit (up to our present knowledge); but the lines of force emanating from it are not indivisible or unified at all. The bulk of them may be occupied with straightforward chemical affinity while a few strands are operating elsewhere; and the subdivision of force may go on to any extent, giving rise to molecular combination and linking molecules into complex aggregates, so that a quite gradual change of valency is conceivably possible, the number of wandering lines being sometimes equal to, or even greater than, the number of faithful lines—though this would usually represent an unstable condition not likely to persist.

I state the position in order that physicists who see reason to disagree with it may intervene in good time and prevent any premature acceptance of a harmonising interpretation by chemists; because so long as there is any real outstanding difficulty it is clearly best for the progress of science that diverse views should continue.

OLIVER LODGE.

### On a Dynamical System illustrating Spectrum Lines.

I DESIRE to express to Prof. Nagaoka my regret at my misinterpretation of his letter to NATURE of February 25, which was due simply to my failure to find any mention there of the larger system of which he speaks. No doubt his ring is quasi-stable if the central positive charge is large enough; but is it allowable to leave out of account the rest of the system? Waiving this objection, I would point out that there are upper limits to the central charge which cannot be exceeded without making the whole system positive, or the velocity of the ring greater than that of light. It may very well be that either limit is too low to allow a stable system to be reached; the discussion of this point must be reserved for another time.

G. A. SCHOTT.

Physical Laboratory, University College, Aberystwyth.

### A Correction.

IN my letter to NATURE of June 16 (p. 151) concerning the source of radio-active energy, I should of course have halved the expressions given for the electrostatic energy of an isolated electron, and for energy set free by annihilation of matter. C. V. BURTON.

Cambridge, June 18.

## A WORLD-WIDE BAROMETRIC SEE-SAW.

IN the year 1902, an account was given in this Journal (vol. lxvi. p. 248) of a short period atmospheric barometric variation which appeared to be closely related to the changes in the percentage frequency of prominences as observed year by year on the limb of the sun. In a later article, which appeared in the following year (vol. lxvii. p. 224), it was shown that this barometric variation consisted really of a great see-saw between two nearly antipodal parts of the earth, the one region about India and its neighbourhood behaving in an inverse way to that of South America and the southern parts of the United States. A further study of these pressure changes has recently been communicated by Sir Norman Lockyer and the writer to the Royal Society, the object being to trace the behaviour of these variations in as many regions of the earth's surface for which observations covering a sufficient period of time are available.

For this, so to speak, classification of pressure variation types, the system adopted was to take the pressure variations over India and Cordoba as the chief types of each region, denoting those of the former by the symbol (+), and those of the latter by (−). The pressure curve of any other place was then taken and compared with each. If, for example, it was found that the curve extending over several years exhibited an excess pressure at those epochs when the Indian pressure curve was in excess, then it was classified as being similar to the Indian type and represented by a (+). If it was seen that although it was more like the Indian curve than that of Cordoba, but yet not quite the exact counterpart of India, then it was denoted by (+ ?). In a similar way pressure curves like Cordoba were classified as (−), and those more like Cordoba than India as (− ?).

In some regions the pressure variation curves were distinctly a mixture of both the Indian and Cordoba types, and it was difficult to classify them satisfactorily by the above method. The symbol adopted for these cases was (± ?). Again, there were further some curves, but very few in number, in which even this mixed type of symbol was not sufficient to exhibit the relationship of their variations to the other curves, so a special symbol (?) denoting ambiguity was used.

It may here be mentioned that the pressure curves here utilised for discussion were not always formed from the values obtained by plotting the annual means, but from the means of the groups of consecutive months in which the pressure was above or below the yearly mean value. Such a division of the year can be accurately determined for places which have a regular and pronounced annual pressure variation, such as India, and where the yearly barometric range is of far greater magnitude than any other aperiodic fluctuation. In those regions where the mean yearly curve is more misleading than otherwise, such as the case of the British Isles, the divisions according to the two seasons included in the two groups of months, April to September and October to March, were adopted.

In examining the curves for the similarity or dissimilarity of the pressure changes, it was found that the special types were apparent sometimes in the yearly curves, sometimes in those for one or other of the high or low pressure groups of months, or sometimes in both of these. It did not, however, appear to follow that, because the type was distinguishable in the yearly curves, it was necessarily apparent in both the curves of the high and low pressure months.

On the accompanying map of the world are marked the types of pressure variations in each region included in this barometric survey.

Although the above classification gives a very fair idea on the whole of the types of pressure variations from one region to another, minor peculiarities have been met with which have tended to add a certain amount of difficulty. These remarks apply principally to places in the more northern latitudes. Thus, for instance, Greenland and Iceland have been classified as of the (+ ?) type, the British Isles, Germany, and Spain of the (± ?) type, and the Azores of the (− ?) type.

While the western portion of Europe is of the (± ?) type, the eastern portion gradually assumes the (− ?) type, and this region extends not only probably to Norway and Sweden, but right across European and Asiatic Russia. The European Russian type of curve has an undoubted similarity to those of more western Europe, but there are variations which indicate that the type is more like that of Cordoba than India.

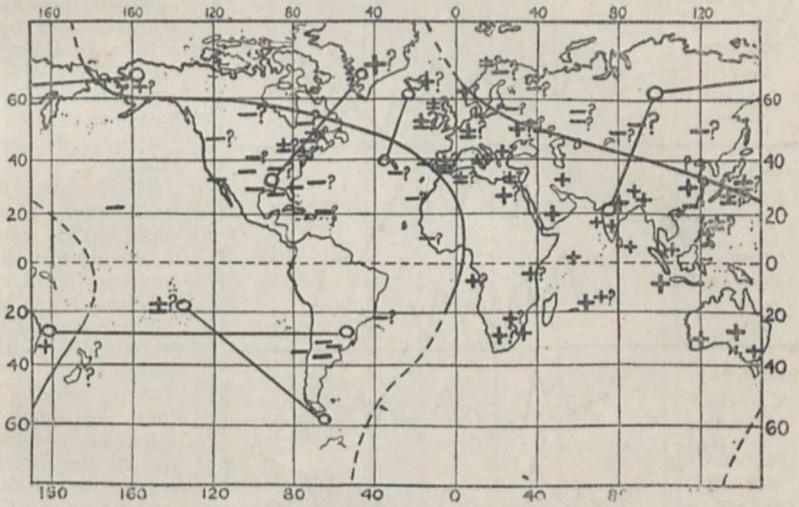


FIG. 1.—Showing the distribution of the different types of pressure variation. The two main regions are roughly separated by the neutral lines. Previously known "see-saws" are shown by the short continuous straight lines connecting the two regions marked with small circles.

Again, another region in which rather mixed types of pressures are met with is that of eastern and north-eastern Canada. Curiously enough, Prince Edward Island and Sydney (Nova Scotia) correspond very closely to the (−) type, if allowance be made for the differences about the year 1877. The inverted curve for the latter with the Adelaide (Australia) pressure curve for comparison is shown in Fig. 2.

In addition to illustrating this reversal between Adelaide (+) and Sydney (Nova Scotia) (− ?), this figure shows also, to serve as examples, curves for two other sets of reverse pressure conditions. Thus, Bombay (+) is compared with the Cordoba (−) pressure curve (inverted), and is an example of the adopted types of pressure variation. Iceland is compared with that of the Azores (inverted), and shows the reverse conditions that prevail between a (+ ?) type and a (− ?) type.

A fact to which attention was very often directed

in attempting to classify the pressure curves was that some curves, after following very closely for many years the Cordoba (−) or Indian (+) type of pressure, as the case may be, would revert back to the opposite type for a period of years. Thus, to take the case of one station alone, namely, Sydney (Nova Scotia), as an instance, the pressure curve follows very closely that of India from 1874–1882, after which, up to 1890, it has a very close resemblance to the Cordoba type. The behaviour of this Sydney (Nova Scotia) pressure curve can be compared with the Adelaide (Australia) curve in Fig. 2, but it must be noticed that the former has here been *inverted*.

The accompanying map (Fig. 1) shows the result of an attempt to indicate the position of a neutral line to illustrate approximately the mean lines of separation of these two chief pressure types, although it

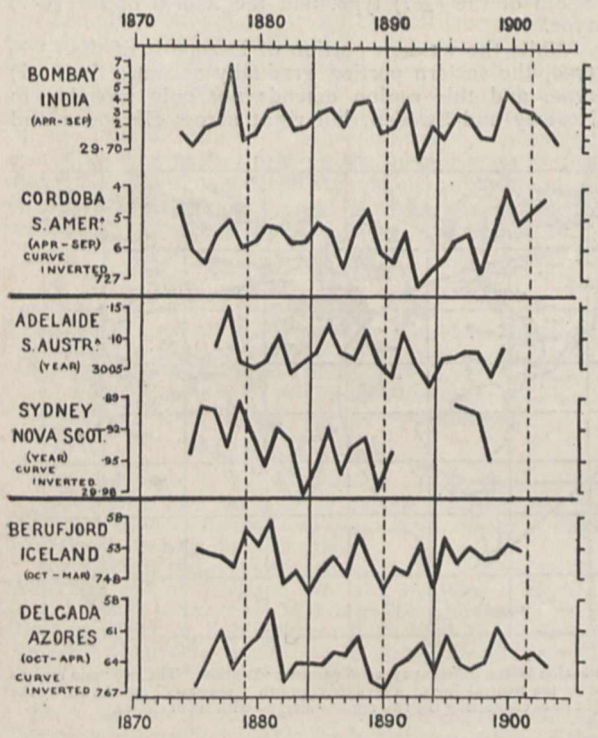


FIG. 2.—Showing the two main types of pressure variation as illustrated by Bombay (+), Cordoba (−), and the barometric relationships between Adelaide and Sydney (Nova Scotia) and between Iceland and the Azores.

must be remembered that this line is liable to a probable small oscillation about its mean position.

So far as can at present be determined, one line commencing to the west of Alaska, separating this region from Siberia, passes easterly along about the 60° parallel of latitude, and runs in a south-easterly direction between south-west Greenland and north-east Canada. It then crosses the North Atlantic, passing to the north of the Azores, and skirts the south-western portion of Portugal. It then strikes down towards the Equator, cutting north-west Africa, so far as can be judged from the scant pressure values available, through the middle of the Sahara. It leaves Africa near the Gold Coast, and passes into the South Atlantic, where it cannot be traced further owing to lack of observations in this southern ocean.

The other boundary or neutral line passes to the north-east of Greenland and north of Iceland, crosses the southern portion of Norway and Sweden, and traverses southern European Russia. It then takes a course somewhat more easterly, skirting the northern part of the Caspian Sea and Turkestan, passes between Tibet and Mongolia, and through China. It then leaves the continent a little to the south of the Yellow Sea, and passes into the North Pacific Ocean. Here its path cannot be traced, but it evidently passes well to the east of the Philippine Islands, and Solomon Islands, takes a new south-westerly course, skirting the eastern side of Australia and passing between Tasmania and New Zealand. Its track is then again lost in the southern Pacific Ocean.

Although too much weight must not at present be given to the positions of these neutral lines throughout their whole length, it is interesting to note that they are fairly symmetrical to one another, although no attempt has been made to make them so. Both lines apparently cross the equator at about antipodal points, and both appear to have a similar trend in northern and southern latitudes.

The result of this survey seems to indicate clearly that there exists a general law relating to the pressure changes which occur simultaneously in these two extensive regions of the globe, separated and defined more or less by a neutral line, this latter forming a fulcrum about which see-saws of pressure from one region to another take place.

Special cases of such reverse pressure variations have previously been noticed, chief among which are those detected by Blandford, Hildebrandsson and Hann.

To illustrate these cases in relation to the present work, there have been drawn on the map (Fig. 1) small circles connected by lines to show their relation to the neutral line. A single glance is sufficient to see that in all cases except one the see-saws occur in places lying on opposite sides of the neutral line.

These results thus agree well in the main with the present distribution of the regions which have been examined.

Quite recently Prof. Bigelow, working on the same lines as those indicated in the present research, published a map of the world on which he has indicated the distribution of the pressure types according as they follow the Indian (or direct type as he calls it) or the Cordoba (indirect) pressure variations. In most of the main features, however, his map suggests a somewhat similar distribution of these pressure types to that given here. Thus, he finds that "the region around the Indian Ocean gives direct synchronism, South America and North America give inverse synchronism, while Europe and Siberia give an indifferent type. Greenland and Iceland seem to have direct type like the Indian Ocean. . . . The eastern hemisphere tends to direct synchronism, except in Europe and Russia where the indifferent type prevails, and the western hemisphere to the inverse type."

It may be mentioned in conclusion that regions which are the reverse of one another as regards these secular pressure variations should very probably experience opposite kinds of abnormal weather, while those over which the same type of pressure variation exists should have weather of an abnormal but similar nature. The intimate connection between pressure and rainfall, allowing for the local conditions as regards situation for the latter, suggests that the variation of rainfall should be closely studied in relation to this barometric surge, and it is in this way that progress may be looked for with regard to monsoon and other seasonal forecasts.

WILLIAM J. S. LOCKYER

## ENGLISH FIELD-ANTHROPOLOGY.[1]

THE first organised mission sent out from this country for purely anthropological research was the outcome of Dr. Haddon's visit to Torres Straits in 1888, when he began to collect materials for a study of the natives. Ten years later, with the assistance of a fully-equipped expedition, he was able to complete the work. The reports will occupy six volumes, of which this is the first to be completed; two parts of volume ii. (Physiology and Psychology) have already appeared.

These savages constitute the ethnological frontier between Australia and New Guinea, but are distinctly Papuan. They have been in contact with white pearl-shellers and missionaries for about thirty years, and most of them are now Christianised. Though they are not a people of striking idiosyncrasy, such as the Arunta of Central Australia, and do not add to the romance of ethnology, yet this careful study of them has enriched science with several unique facts and many variations from type which will have considerable influence upon theory.

The account of the social organisation is based upon carefully revised genealogies, compiled by Dr. Rivers, which form a register of births, marriages and deaths, extending back for a hundred years. The method is an excellent one. The native system of kinship is the classificatory, with three non-essential features, which are developed in a remarkable way. The first of these is the practice of exchanging names, which seems to have been almost as common as, say, our custom of exchanging cards. The task of the genealogist was thus rendered very laborious. Secondly, the number of reciprocal terms is unprecedentedly large. Thus the term *tukoiab* denotes the relationship of brother to brother and sister to sister; it is also used—and here the classificatory system appears—of all men of the same generation in the father's clan, the mother's clan, and the father's mother's clan, also of the sons of a brother and those of a sister, and of the sons of two sisters. Brothers' wives, however, are not called "wives" of *ego*; nor is there any trace of group-marriage. Polygamy was once frequent, but polyandry is unknown. The terms of relationship are also used as terms of address. In the third place we have what is perhaps the best example extant of the regulation of social duties and privileges by kinship. The division both of labour and of rights is thus harmoniously arranged. An apparently unique instance is the power of stopping fights, belonging especially to the relationship of *wadwam* (the reciprocal term for maternal uncle and nephew).

Totemism is very fully developed, both in its social and religious aspects, and has important peculiarities. Besides the principal totem a clan possesses a subsidiary one. Two important totems are crescent-shaped ornaments of tortoise-shell, with no reference to any animal or plant; they are merely decorative relics from the wardrobe of the hero Kwoiam, a warrior whose exploits form a considerable saga and who is more or less definitely apotheosised. These relics resemble in the powers attached to them the *churinga* of the Central Australians. But Kwoiam himself is a totem! Magical ceremonies are performed, as in Australia, to increase the supply of the totem animals as well as of the crops. An interesting feature of totemic society is the way in which the clan members try to live up to the character of their totems. The

FIG. 1.—Performer at the Saw-fish Dance, Waiben.

[1] "Reports of the Cambridge Anthropological Expedition to Torres Straits. Vol. v. Sociology, Magic and Religion of the Western Islanders." Edited by A. C. Haddon, Sc.D., F.R.S., Fellow of Christ's College, Lecturer on Ethnology in the University of Cambridge. Pp. xii+378; plates xxii. (Cambridge: At the University Press, 1904.) Price 25s. net.

Cassowary men, for instance, are pugnacious, long-legged, and good runners.

Though marriage is strictly forbidden within the totem clan, its regulation belongs to kinship rather than to totemism. The phratry system, so common in Australia, seems to have formerly existed. A man sometimes lives with his wife's people, a case apparently due to circumstances which have no connection with maternal descent. The custom of the levirate is known, but it is not obligatory, and there is nothing to show it to be a survival of polyandry. It is wrong to marry an old woman. The eldest daughter is always married first. Young men rub their bodies with "sweetheart medicine" to attract the notice of the girls. It is the universal custom for the women to propose to the men.

The heads of dead persons are cured, painted and kept by the nearest relatives. It is to be noted that no worship is paid to them. Ancestor worship is unknown; the custom in question is solely due to affection. One of their funeral customs is a remarkable parallel to the ancient Roman practice; persons carefully "got up" to represent dead relatives dance at the burial.

Very interesting features are presented by the customs

FIG. 2.—The Cave of Augudalkula in the Sacred Island of Pulu.

which have to do with property. There is no group or clan ownership of land; every inch of ground is owned by some individual. A man's property is divided at his death among his children. In default of male issue, a daughter may inherit. They have a system of leasing their gardens. If a man wants to buy a canoe he can pay by instalments with immediate possession, the *Times'* scheme being here anticipated.

The account of the native religion gives an impression of incomplete study. We are told that there is no supernatural sanction for morality; even the totems are not really worshipped. We hear incidentally that the natives pray to their "heroes." An analysis of their habits of prayer would have been instructive. More information about the chief hero, Kwoiam, would have been welcome. A folk-tale speaks of the first created man: is this idea borrowed from missionaries? The concluding sentence of the volume is, "unless the above-mentioned heroes be regarded as gods, I think it can be definitely stated that the western islanders had no deities, and certainly they had no conception of a Supreme God."

We have only mentioned a few of the many facts which will assist in throwing light on old problems. That so much was done in so short a time speaks well for the energy of the expedition. But could not the hundred odd pages of folk-tales, fully reported, have been reduced? A précis of such seems adequate.

The volume is a fine monument of English anthropology, and reflects great credit on the enterprise and devotion of Dr. Haddon and his colleagues. It is by such work as this that the "science of man" is justified.

ERNEST CRAWLEY.

## *PROGRESS IN WIRELESS TELEGRAPHY.*

IT is eighteen months or more since Mr. Marconi succeeded in establishing wireless communication across the Atlantic. On that occasion a few congratulatory messages were exchanged, a great deal was written on the subject in the Press, and the more timorous of cable shareholders were reported to be much troubled. A little later the attempt was made to demonstrate that this achievement was not merely a firework display, but was capable of direct commercial application; the Marconi Co. entered into a contract to supply the *Times* with news from America by wireless telegraphy, and for a day or so there appeared items of news in that paper under the heading "By Marconigraph." But after a few messages something went wrong, and the public were given to understand that a piece of auxiliary machinery had broken down. It is to be presumed that this piece of machinery has at length been repaired, for Mr. Marconi has once again come very much to the front with long-distance transmission work. The announcement, which we published last week, that he had been successful in maintaining a supply of news to the *Campania* on her voyage across the Atlantic with a regularity sufficient to allow of the publication of a daily paper on board that vessel affords evidence that he is still steadily pushing forward the practical development of wireless telegraphy. We have repeatedly urged in these columns that the real work of wireless telegraphy lay in communication with ships, and it is therefore a greater pleasure to record this latest development than it would be to announce the reopening of Trans-atlantic communication.

The experiments on board the *Campania* appear to have been thoroughly successful in all respects. Not only was the vessel never out of touch either with one or other of the three large power installations, but she was also for a considerable period in touch with both sides. It seems, however, that the communication was only one sided; this is, of course, only what was to be expected, but it is to be hoped that Mr. Marconi's efforts will be directed to making it reciprocal, and that before long we shall hear the announcement of this further success. It is stated that the other ships of the Cunard line are to be installed with apparatus similar to that on the *Campania*, and that a regular news service will be established to all of them. There can be no question but that this will tend very greatly to enliven the voyage across the Atlantic, and that in many other respects it will be of great practical utility.

In other directions wireless telegraphy is showing that it has won the right to consideration as a thoroughly practical means of communication. The extract from a letter from the "wireless" correspondent of the *Times* in the Far East which was printed in last week's NATURE shows to how great an extent it is being used in the Russo-Japanese war. The letter also shows that, whatever may be said to the contrary, syntonisation in the true sense is still a problem awaiting solution. The most that can be done at present seems to amount to this: a receiving station can be syntonised sufficiently well to enable it to pick up messages from a particular transmitting station in preference to, or with greater ease than, those from any other, and thus it may be enabled to work over greater ranges. It does not, however, seem in the least possible so to tune the transmitter that interception of messages is impossible, nor does it seem likely that this will ever be accomplished until experimenters have succeeded in producing continuous trains of undamped oscillations, a direction in which many are working. It is noteworthy that Dr. de Forest recently expressed the opinion that without this syntonisation is only partially possible; in this limited sense we believe all systems are making use of the principle with more or less success. The system designed by Dr. de Forest appears from many accounts to be the most efficient of those at work at the seat of war, as it has already been one of the most successful of those tried in America. The lengthy wireless messages transmitted with marked regularity in trying circumstances from the *Haimun* to the *Times* afford evidence of this, and it is noteworthy also that a speed of about thirty words a minute seems to be easily attained, which is a high speed for wireless telegraphy. The comparisons which the *Times* correspondent makes between the working of his system and that on the British warships at Wei-hai-wei, though much to the detriment of the latter, are hardly fair to the Marconi system, as the naval installations are not of the latest date.

As to the prospect of attaining thorough syntonisation, it is to be noted that Dr. de Forest is working on the lines of producing continuous oscillations on the principle of Duddell's singing arc, a method which, we pointed out in NATURE (vol. lxviii. p. 248), seemed the most promising. Others, we believe, are also working on the same lines. It is noteworthy also that much progress has been made on the scientific side, and that we are in a better position now to make quantitative measurements of the energy transmitted and received. In this connection also Mr. Duddell has contributed towards our advance; he recently exhibited before the Physical Society an instrument (which we hope to describe on another occasion) which gave considerable deflections with the currents received in the aërial wires. As this affords the first means we have of accurately measuring these currents, it may prove of great value in the development of the science.

MAURICE SOLOMON.

## *REPORT OF THE METEOROLOGICAL GRANT COMMITTEE.*

IN December, 1902, a committee was appointed by the Treasury "to inquire and report as to the administration by the Meteorological Council of the existing parliamentary grant, and as to whether any changes in its apportionment are desirable in the interest of meteorological science, and to make any further recommendations which may occur to them with a view to increasing the utility of that grant." The committee was composed of Sir Herbert E. Maxwell, Bart., M.P. (chairman), Mr. J. A. Dewar, M.P., Sir W. de W. Abney, K.C.B., F.R.S., Sir F. Hopwood, K.C.B., C.M.G., Board of Trade, Sir T. H. Elliott, K.C.B., Board of Agriculture, Mr. T. L. Heath, Treasury, Dr. R. T. Glazebrook, F.R.S., and Prof. Joseph Larmor, F.R.S.

The report of the committee has just been published as a Blue-book (Cd. 2123, price 2½*d.*), and a summary of some of the points of scientific interest in it is subjoined.

### SCIENTIFIC RESEARCH.

The committee of 1877 recommended that "the council should be at liberty to appropriate a part of their annual grant to the purposes of any special researches which they may think important, and in such cases it should rest with them to select the investigators and fix the remuneration."

The council, as might be expected of a body appointed by, and reporting annually to, the Royal Society, has never lost sight of this part of its functions; but the expansion of the routine work of the office, including therein the receipt, discussion and reduction of observations, the preparation and issue of forecasts and warnings, the supply of instruments and the annual inspection of observatories, &c., has absorbed nearly the whole of the grant, leaving a comparatively trifling sum—700*l.* to 800*l.*—to be devoted to meteorological research. The council has made a strong representation that, for the effective performance of this part of its duties, the staff requires strengthening by the addition of "a few assistants specially qualified by a knowledge of mathematics and physics for undertaking the investigation of such questions as are contemplated." The additional annual cost of three such assistants, with the incidental expenses, was estimated at 225*l.* It appears from the evidence that it would be desirable for the council to have access to a meteorological laboratory properly equipped, which would serve as one of the first-order observing stations.

We believe that the time has arrived when one of two alternatives must be taken, viz. either to provide the Meteorological Office with the additional funds necessary for the effective prosecution of independent and cooperative research, or practically to confine the functions of the Meteorological Office to the ordinary routine work. In this latter case it would be necessary to rely upon members of the council who are appointed by the Royal Society to keep abreast of the advance in meteorology which may be achieved by British and foreign scientific societies and by the Governments of foreign countries independently of the office.

We do not believe that a middle course can be pursued with any advantage. The present grant is little more than enough to maintain the office, the five observatories depending thereon, and the library, and to provide for the superannuation of the staff. It would be better to circumscribe the operations of the council to routine than to expect them to undertake investigations for which they have not adequate means.

An example of the difficulty arising under present conditions may be cited in the invitation forwarded by the Foreign Office to the council in 1902 to join in an international scheme for investigating the upper atmosphere by means of kites and balloons. The invitation had to be declined for want of the requisite 500*l.* a year.

It is clear that, from the first, it was intended that the directors of the Meteorological Office should be chosen with a view to their capacity for directing experiment and research; otherwise their appointment would not have been committed to the Royal Society. On the other hand, we perceive strong objections to granting money for scientific research in meteorology, except on the direct responsibility of a Minister of the Crown. This brings us back to the repeated recommendation of the Royal Society that the Meteorological Office should form part of one of the Government departments—a recommendation which we have included among those now submitted to your lordships.

It appears that the present constitution of the Meteorological Office was never regarded by the Royal Society as a permanent one, but as "a temporary measure till some other organisation should be carried out." We regard this as a favourable opportunity for placing the Meteorological Office upon a permanent footing.

RECOMMENDATIONS.

We are of opinion that the registration of the Meteorological Office as a company under the Joint Stock Companies' Acts should be cancelled, that the company should be wound up, and the office reconstituted as a department under the control of the Board of Agriculture and Fisheries.

The necessity for a council of seven having thus been got rid of, we recommend that the office be placed under the control of a man of science as director of meteorology, appointed after consultation with the Royal Society, but responsible to the Board of Agriculture and Fisheries, and making his annual report to that department. We recommend also the appointment of an advisory board, consisting of the hydrographer to the Admiralty, a representative of the Board of Trade, and one of the Board of Agriculture and Fisheries, and two members nominated by the Royal Society. The functions of the advisory board should be consultative only, the director being responsible to the Board of Agriculture and Fisheries for administration.

We recommend also that a second officer be appointed to act as scientific assistant to the director, to assist him in the general management of the office and in the discussion of such scientific problems as may arise.

The mean annual cost of this arrangement, as compared with that for the present council, we estimate thus :—

| *Present Arrangement* | | *Proposed Arrangement* | |
|---|---|---|---|
| Council ... ... ... ... | £850 | Director £800 rising to £1000 | |
| Secretary ... ... ... | 625 | Scientific Assistant ... | 450 |
| | £1475 | Mean ... ... ... | £1350 |

The fixed parliamentary grant of 15,300*l.* should be transferred to the vote for the Board of Agriculture and Fisheries.

Under such an arrangement the anomaly would cease of what is practically a department of the public service, though nominally a joint stock company, paying for postal and telegraph services money out of its fixed income. The charge for these services would not appear in the estimate, though undoubtedly the revenue would be the loser by the amount now repaid out of the parliamentary grant. The director of meteorology would not then feel, as the council now does, that the more complete and rapid the distribution of forecasts and warnings is made, the less money remains for scientific research and for overtaking arrears in the statistical work of the department.

Further, we judge it important that the Post Office should make arrangements at the twenty-seven reporting stations in the United Kingdom for the transmission of daily telegraphic reports one hour earlier than the present one of 8.15 to 8.30 a.m., and that storm warnings should, if practicable, have priority over all private messages at all hours.

We would direct attention to the expediency of testing the efficacy of wireless telegraphy in providing advance news of weather in the Atlantic. Such news would incalculably strengthen the forecast and warning service, and might, we believe, be obtained regularly over an experimental period by cooperation either with the Admiralty, the ocean steamship companies, or both. We would urge that no unnecessary delay should take place in organising this experiment.

We recommend that in future the cost of instruments supplied to His Majesty's ships be borne upon the Navy votes, except where such instruments are intended for use in research or observation specially called for by the director of meteorology.

We consider that the premises now rented by the council are neither suitable in character nor adequate in space for the present requirements of the office, and that others should be provided wherein the staff might perform their duties under more favourable hygienic conditions, and necessary accommodation for the rapidly growing library might be secured.

We recommend that the staff employed in the library, the statistical branch and observatory branch, should be augmented. The steps necessary to give effect to this and the preceding recommendation can best be determined when the future of the office has been decided upon.

We have carefully considered the effect of our recommendations upon the apportionment of the present grant of 15,300*l.*

Our recommendations would involve a net increase of 449*l.* Another effect would be to reduce the Post Office revenue by the sum of about 2000*l.*, and to transfer to Navy votes, for instruments supplied to the Royal Navy, about 500*l.*

In default of an increase to the grant, the small increased expenditure which we have recommended would have either to be postponed or to be met from economies on other branches of the work of the office.

We have not included in the figures above given any increase in the average amount of the grant allocated to scientific research, nor have we found means of providing for increased telegraph expenditure which the adoption of the recommendations as to the transmission of earlier daily telegraphic reports, and of storm warnings, will very probably entail on the Post Office.

The evidence before us has shown conclusively the importance of further scientific research, for which we trust that funds may be forthcoming in the near future.

In minority reports Sir Herbert Maxwell and Sir William Abney express disagreement with that part of the report which deals with the action of the Meteorological Council in deciding to discontinue the annual payment to Fort William Observatory, involving the abandonment of the observatory on Ben Nevis.

Mr. Dewar objects to the action taken by the council in connection with superannuation; and Sir Francis Hopwood and Mr. T. L. Heath are unable to concur in the recommendations made by a majority of the committee (*a*) in so far as they would necessarily involve an increase in the annual grant, and (*b*) in so far as they relate to the transfer of this grant from the vote for scientific investigations, &c., to that of the Board of Agriculture and Fisheries.

## NOTES.

THE following announcement of a munificent gift for scientific research appeared in Monday's *Times* :—Mrs. Percy Sladen, of Northbrook Park, Devonshire, in the desire to perpetuate the memory of her late husband, Mr. W. P. Sladen, sometime secretary and vice-president of the Linnean Society, has undertaken to devote the sum of 20,000*l.* to the promotion of scientific research, particularly in the subjects in which he was chiefly interested. She proposes to assign this sum under the name of the Percy Sladen memorial fund to certain trustees, in the first place of her own appointment, who are directed to employ the income arising therefrom, in their uncontrolled discretion, to "any research or investigation in natural science, and more especially in the sciences of zoology, geology, and anthropology." They are also empowered, if they think fit, to accumulate the income for the purpose of fitting out, or assisting to fit out, any expedition designed to further such research. The following gentlemen, whom Mrs. Sladen has requested to be the first trustees, have consented to serve :—her brother, Dr. Tempest Anderson, of York; Mr. Bailey Saunders, Mr. Henry Bury, Dr. Henry Woodward, F.R.S., Prof. Howes, F.R.S., and Prof. Herdman, F.R.S. On the occurrence of any vacancy among these trustees, Mrs. Sladen reserves to herself the right to nominate their successors; but by the deed of endowment it is provided that eventually five trustees shall be severally nominated for a period of five years each by the following bodies in rotation, so far as they may have signified their acceptance of the power of appointment :—the Royal Society, the Linnean Society, the trustees of the British Museum, and the Universities of Oxford and Cambridge.

As a result of a petition in 1902 from the Johannesburg branch of the South African Association for the Advancement of Science to the Governor of the colony, a Govern-

ment observatory is now in course of erection near Johannesburg. Mr. Theodore Reunert, as honorary secretary of the South African Association, has been specially active in securing the observatory, and he is to be congratulated on the success of his efforts. His representations led to the decision to form a meteorological department as a sub-department of the Colonial Secretary's office, and Mr. R. T. A. Innes was appointed its director. The site near Johannesburg selected for the observatory is at an elevation of about 200 feet above the Bezuidenhout Valley on the south, to which it dips almost precipitously. On the north the slope is considerable, the difference in height between the summit and the northern boundary of the observatory property being about 100 feet. The summit, which includes some two acres of fairly even ground, is 180 feet higher than Johannesburg, or about 5900 feet above sea-level. The prevailing winds ensure freedom from smoke and dust. The site covers 10·6 acres, and is estimated to be worth, at the market price, 10,000*l.* at least, though the actual cost was, owing to successful negotiations, only 2500*l.* While the observatory is being built the meteorological department is lodged in the New High Court Building in Johannesburg. Arrangements have been made for the establishment of 150 observation stations at various centres of the Transvaal under volunteer observers, and from these stations observations are regularly transmitted to the director of the Government Observatory, Johannesburg.

In addition to a number of skins of small mammals, the Hon. N. C. Rothschild has recently presented to the British Museum the entire skeleton and skin of a Nubian wild ass, obtained by himself during a sporting trip to the eastern Sudan. The skin of this wild ass (*Equus asinus nubianus*) has been set up by Rowland Ward, Ltd., and is the first entire specimen of its kind exhibited in the museum. A second specimen is, we believe, being mounted for Mr. Walter Rothschild's museum at Tring.

An announcement of special interest was made at the meeting of the Zoological Society of London held on June 7. So long ago as 1870 the late Prof. C. Peters described, under the name of *Dinomys branicki*, a remarkable paca-like rodent of which a single example had been found some time previously wandering about the courtyard of a house in Lima. From that day until a few months ago nothing more had been heard of this strange creature, which is regarded as representing not only a genus, but likewise a family by itself. Now, however, Dr. Goeldi announces that he has specimens of this rodent living in the museum under his charge at Pará. His description of these specimens will be awaited with great interest.

At a meeting held recently in Trinity College, Dublin, it was agreed that the great eminence of the late Provost, and his life-long connection with the university, demand a permanent commemoration in the form of some suitable memorial. A general and an executive committee have therefore been formed, and they invite the support of all graduates of Trinity College and other friends and admirers of Dr. Salmon in establishing a memorial to him. The exact form of the memorial will be decided at a meeting to be held later. In the meantime, subscriptions will be received and acknowledged by the honorary secretaries, Messrs. T. T. Gray, E. J. Gwynn, W. E. Thrift, and W. Kennedy, or the treasurers, the Right Hon. Mr. Justice Madden and the Right Hon. the Lord Justice Fitzgibbon.

A mural tablet erected by the Royal Institute of British Architects to the memory of the late Mr. F. C. Penrose, F.R.S., was unveiled in the crypt of St. Paul's Cathedral on Saturday last. Sir L. Alma-Tadema, who performed the ceremony, remarked that Mr. Penrose's accurate measurements revealed how far the Greeks had gone beyond the use of the straight line into comprehension of the hidden curve. He showed, for instance, that the lines of the base of the Parthenon were curved in order to appear straight, and that columns on the same plane were made different in size in order to create a more perfect and harmonious impression of uniformity. It was Mr. Penrose who directed the strengthening of the Parthenon after the earthquake of 1894. His knowledge of astronomy led him to make valuable researches concerning the orientation of ancient temples; and work of the highest importance being done to-day in Greece by a band of young excavators, who had, among other achievements, caused Crete to yield her buried treasures, was directly due to Penrose, through whom the British School of Archæology at Athens came into being.

The death is announced of Prof. Victor de Luynes, director of the laboratory of the French Minister of Finance.

The *Daily Chronicle* announces that Prince Albert of Monaco has taken the lead in a movement for another North Pole expedition on a plan prepared by Ensign Charles Benard, late of the French Navy. The cost of the expedition is set down at 60,000*l.*, two ships being employed.

Upon the authority of the St. Petersburg correspondent of the *Journal*, of Paris, the *Times* announces that the installation of a service of wireless telegraphy at Lake Baikal is almost complete, and will be in working order by the end of the week. It will consist of three stations, one of which will be on board the ice-breaker, which will thus be enabled to communicate with both shores during its passage across the lake.

At the first meeting of the 1904 session of the Canterbury Philosophical Institute, held on May 4, the president, Dr. Charles Chilton, congratulated Captain Hutton on the publication of the "Index Faunæ Novæ Zealandiæ," and presented to him an album containing congratulatory addresses on the subject from the Canterbury Philosophical Institute, the Otago Institute, and from the various specialists who assisted Captain Hutton in the preparation of the "Index."

At the seventieth annual general meeting of the Royal Statistical Society on Tuesday, June 21, Sir Francis S. Powell, Bart., M.P., was elected president for the ensuing session. It was announced that the Guy medal (silver) had been awarded to Mr. D. A. Thomas, M.P., for his paper on the growth and direction of our foreign trade in coal during the last half century, the presentation to be made in November. It was also announced that the subject of the essays for the Howard medal, which would be awarded in 1905, with 20*l.* as heretofore, was: a critical inquiry into the comparative prevalence of lunacy and other mental defects in the United Kingdom during the last fifty years.

The annual general meeting of the Palæontographical Society was held on Friday last, June 17, Dr. Henry Woodward, F.R.S., president, being in the chair. In the annual report of the council special reference was made to the activity at present prevailing among British palæontologists. The society has received more offers of monographs than it can accept for immediate publication, but it has expended more than 200*l.* of its accumulated funds in issuing an unusually large volume for 1903. Dr. Henry Woodward was re-elected president, Dr. George J. Hinde, F.R.S., was elected treasurer, and Dr. A. Smith Woodward was re-elected secretary.

AT the Royal Agricultural Society's show, which was opened on Tuesday, there were in the building devoted to agricultural education and forestry a number of exhibits of interest. These came, for the most part, from the colleges where agricultural matters are taught. The Rothamsted Experiment Station sent a series of specimens of wheat and of loaves made from the flour of various samples. The results obtained, though illustrating the general experience that wheat containing much gluten yields "strong" flour that makes a big loaf, served rather to disprove the view that the quantity of nitrogenous matter present which is soluble in alcohol, or the ripeness or greenness of the corn, had any particular effect. In the bacteriological exhibit from the Midland Agricultural Institute were specimens which showed that Mr. John Golding has been able to confirm Mr. Charles Marshall's discovery (*Centralb. für Bakteriologie*, vol. xi., April) that if in a "milk starter" an alkali-forming germ is associated with one that produces lactic acid, "ripening" of the cream takes place much more rapidly. From the same institution came a large number of hybrid potato seedlings raised by Mr. E. Miles. The agricultural section of the Essex Technical Laboratories showed some charts proving that even if the application of sulphates to the soil does not result in a larger crop, it increases its feeding value, the result being due to the larger proportion of amides which are formed. There were also specimens illustrating some new experiments showing the beneficial effects of manures upon "clover-sick" and derelict land. Very striking were the results of applying pinches of sulphate of ammonium to a lawn containing plantains; while the latter were killed, the grass and clover were affected for the better. The chief feature of the Wye College exhibits were living specimens of plants infested with fungoid and insect pests. The Agricultural Department of Cambridge, Reading College, and Harper-Adams College were also well represented, as was the Royal Agricultural Society itself. The forestry exhibition was a new feature, and in it was a representative series of specimens of timber illustrating the healing of wounds and the life-history of plants and animals injurious to trees. There were also a large number of photographs illustrating various points in forestry, together with the examples of the tools used and plots laid out with young trees.

IN the Harveian Oration delivered on Tuesday at the Royal College of Physicians, Dr. Richard Caton described some results of an inquiry into the earliest records of medicine in ancient Egypt, particularly as regards the circulation of the blood and diseases of the circulation. The most interesting figure among the early physicians of Egypt was a priest of Ra, the sun god, named I-em-hotep, who lived during the third dynasty, nearly 6000 years ago, and was succeeded by a cult of priest-physicians who carried on his work of healing. Temples for the worship of I-em-hotep, which were also hospitals for the sick, arose first at Memphis, and then extended to other parts of Egypt. Here the priests not only treated the sick, but also embalmed the bodies of men and the sacred animals. In this process the heart and viscera were removed, and the priests had thus an opportunity of learning something of anatomy and of the changes produced by disease. These priest-physicians were probably the first to acquire a rudimentary knowledge of the movement of the blood. It was clear that medical science was cultivated and had advanced considerably in Egypt long before it arose in Greece. In Egypt the evidence of this fact was decisive, and in the writings of the pseudo-Apuleius it was interesting to note that Hermes told the youthful Asklepios of his predecessor, the first inventor of medicine, the Egyptian god I-em-hotep. When, in later times, Greek colonists came to Egypt, they recognised I-em-hotep as a sort of pre-existing Asklepios, and spoke of his temples as Asklepieia. The views of the circulation of the blood entertained by the Greeks were almost exactly those of their predecessors, the Egyptians; and, in view of the frequent intercourse between the two countries at that time, it was highly probable that the Greek physicians obtained their knowledge of the circulation, such as it was, from the Egyptians. The Egyptian priests seemed, in fact, to have been the first to engage in that momentous inquiry which was finally solved by Harvey, and on which the progress of medicine depended.

IN the article on geodesy which appeared in NATURE of June 2, referring to a contribution on the subject in the *Revue générale des Sciences*, it appears that, inadvertently, the author hardly did justice to the scientific investigations of MM. Benoit and Guillaume, the director and assistant director of the Bureau international des Poids et Mesures. The apparatus represented in Fig. 1 of our article is entirely new, and is due to the inventive faculty of those gentlemen, and not to that of M. Jäderin. That useful combination of metals known as invar is also the result of researches instituted at the Bureau International, the officers of which department may well congratulate themselves on the successful results of those investigations which they have initiated in all branches of research connected with geodesy.

THE *British Journal of Photography* has just completed its fiftieth year. To mark this occasion, the editor has issued a special (jubilee) number of the journal, containing not only "the story" of the journal from its commencement to the present time, written by himself, but a series of most interesting articles by different authors on a great number of photographic topics. The *British Journal of Photography* is the outcome of the photographic energy displayed in Liverpool in the 'fifties, the first number, entitled the *Liverpool Photographic Journal*, appearing on January 14, 1854. In the "story" are given facsimiles of the title-page and the first page of this journal, and also that of the first page under the present title. Short biographical sketches of the editors and assistant editors are also included.

DR. J. HANN recently submitted to the Vienna Academy of Sciences a work on the decrease of temperature with height up to 10 kilometres, deduced from the results of the international balloon ascents so far as they have been published. He found that the monthly means were too much influenced by the weather conditions of the days on which the ascents were made to show a tolerably trustworthy yearly range. But dealing with the *differences* of temperature for intervals of 1 kilometre, that is, with the values of the decrease of temperature with height, he was able to obtain more satisfactory and somewhat striking results. The yearly range of the differences for 1 to 3 kilometres exhibited the quickest decrease of temperature between May and June. At altitudes of 3 to 5 and 5 to 7 kilometres, the quickest decrease occurred in March and April, while at the height of 7 to 9 kilometres it occurred quite unexpectedly about the beginning of July. As first pointed out by M. Teisserenc de Bort, the decrease of temperature with height in the lower strata of air is slower in anticyclones than in cyclones, while at great heights these conditions are reversed.

DR. VIDI, in a popular article, gives some interesting details with regard to cancer houses and districts (*Le Journal*,

Paris, May 5). One striking instance is given of a cancer district, viz. at Luckau, a small town in northern Prussia, where Behla has investigated the incidence of cancer from 1878 to 1899. The town consists of two portions, one on higher ground, which is well drained and consists of 415 houses, the other low-lying, damp, and surrounded with canals, consisting of 115 houses. In the latter, during the twenty years, seventy-five cases of cancer occurred, while in the former, nearly four times as large, only sixty-five cases occurred during the same period.

ON a previous occasion reference has been made in our columns to the investigations of Dr. C. H. Eigenmann into the structure of the eye of the blind fishes (Amblyopsidæ). A fuller and more detailed memoir by the same investigator on the eye of Amblyopsis has recently been published in *Contributions* from the Zoological Laboratory of Indiana University (No. 50). The author finds that although the foundations of the eye are normally laid, instead of developing with the aid of new material, the superstructure is completed out of that provided for the foundation, and that in the end complete disintegration takes place.

WE have received from the U.S. National Committee of Audubon Societies a batch of leaflets (published at New York) on bird protection and on the teaching of ornithology in schools, and likewise the combined report of that body and the A.O.U. Committee on the Protection of North American Birds for 1903, extracted from the *Auk* for January. The leaflets contain excellent portraits and descriptions of some of the most beneficial of North American birds, one being specially devoted to the snowy heron, or egret, and to the oft-told tale of the iniquity of wearing "aigrettes" and "ospreys." The report, which is illustrated with reproductions from photographs of bird life in protected localities, emphasises the satisfactory results which have accrued from the special protection extended to gulls and terns by means of the Thayer fund.

IN his usual interesting style, Mr. E. T. Seton, in the June number of the *Century Magazine*, gives an account of the labours of the little burrowing rodents commonly known as pocket-gophers, and their effect on the soil. According to the author's personal observations, true earth-worms are unknown in Manitoba, and, indeed, in all that part of North America lying to the south of the Saskatchewan and west of the Mississippi, with the exception of a narrow humid belt along the Pacific coast; and it would seem that the work performed by those annelids in other parts of the world is accomplished in western North America by pocket-gophers. In Manitoba the surface soil consists of a layer of black humus from a foot to two feet in thickness, and there can be little doubt that this layer, which is not a solid bed of decayed vegetation, has been thoroughly mixed up with the subjacent loam by the action of burrowing rodents, foremost among which are pocket-gophers.

APPENDIX iii. to the Kew *Bulletin* has been received, which contains a list of the new garden plants of the year 1903.

IN the *Journal* of the Asiatic Society of Bengal, No. 4, vol. lxxii., Sir George King, F.R.S., in conjunction with Mr. J. S. Gamble, F.R.S., continues the "Materials for a Flora of the Malay Peninsula." The contribution contains the order Caprifoliaceæ (three species of Viburnum), and those species of the Rubiaceæ which possess numerous ovules in each cell of the ovary. This tropical order is well represented, and the authors have added a number of new species, including fourteen for Argostemma, nine for Randia, and four for the morphologically interesting genus Mussænda.

THE subject of nuclear fusion in vegetative cells is treated in three papers by Dr. Nemec which have appeared in the *Sitzungsberichte* of the Royal Scientific Society of Bohemia (1902, 1903). By the action of such irritant solutions as copper sulphate or chloral hydrate, it is possible to induce anomalous developments in the cells of the meristematic region of seedling roots whereby the formation of the cell wall consequent to cell division is suspended, and a bi-nuclear condition is established. Fusion of the two nuclei follows, and the resulting nucleus in the succeeding division shows twice the ordinary number of chromosomes. This number is maintained for a time, but eventually a reduction takes place, and the ordinary number of chromosomes appear on the spindle.

WE have received from Messrs. Armbrecht, Nelson and Co. a fine example of flexible sandstone, known also as itacolumite, from its occurrence on Itacolumi, a mountain near the town of Ouro Preto, in the State of Minas Gereas in Brazil, where it was first discovered. This variety of rock has been found in several localities in the United States, and also in India. Examples were obtained by the late General C. A. McMahon from Kaliana, a hill near Dadri, about 60 miles west of Delhi. He regarded it as a local and modified form of the quartzite of the district. Certain beds of earthy cellular quartzite are there quarried for millstones, and the stone-cutters come abruptly upon the flexible stone when engaged in quarrying. This stone occurs in irregular patches, and its flexibility appears to be due to the partial removal of the felspathic cement to which the rigidity of the mass of the adjacent rocks is due. The rock does not possess a schistose structure, and the flexibility is not due to the presence of talc or mica, the peculiar character being due to the decomposition or dissolution of portions of the matrix of the quartzite.

PROFESSIONAL paper No. 9 (forestry series) of the United States Geological Survey deals with the forest conditions in the Cascade Range Forest Reserve, and forms the sixth paper of the series. A description of the first five papers will be found in NATURE, vol. lxviii. p. 406. The Cascade Range Forest Reserve covers an area of 7254 square miles, and is the largest of all the reserves. The introduction deals with the general topographical, geological, and climatic features of the area, the classification of lands, such as forested, burned, open, &c., together with the total stand of timber, which exceeds 50,000,000,000 feet. The species are varied, although the timber consists almost entirely of conifers. The reserve is divided into thirty-seven townships, which are again subdivided into ranges. The bulk of the report deals with the classification of lands, stand of timber, species, and forest conditions in the several ranges. The value of the report is greatly enhanced by the forty-one illustrations, consisting of photographs, maps, and diagrams.

WE have received from Messrs. A. and J. Smith, of Aberdeen, a descriptive catalogue containing full particulars of Prof. Hay's apparatus devised for the investigations conducted by Dr. Leslie Mackenzie and himself for the Royal Commission on Physical Training. In addition, the list contains information of other appliances suitable for the measurement of children.

THE most recent addition to the Patent Office Library Series is the "Subject List of Works on Electricity, Magnetism, and Electro-Technics, in the Library of the

Patent Office," which costs sixpence. The list consists of two parts; first, a general alphabet of subject headings, with entries in chronological order of the works arranged under these headings, and, secondly, a key, or a summary of these headings shown in class order. The list comprises 2374 works, representing 3792 volumes.

THE series of eight lectures on "Physical Chemistry and its Applications," delivered some time ago by Prof. J. H. van 't Hoff at the invitation of the University of Chicago, has recently been translated into French by Prof. Corvisy (A. Hermann, Paris). No higher tribute to the intrinsic merit of these most readable lectures could be desired, and they will no doubt be warmly received by a large circle of French readers.

SOME noteworthy experimental results communicated by Messrs. van Calcar and Lobry de Bruyn to the current volume of the *Recueil des Travaux chimiques des Pays-Bas*, vol. xxiii. p. 218, show that considerable changes take place in the concentration of solutions under the influence of centrifugal forces. The concentration increases from the axis of rotation towards the periphery, and the changes have been accurately measured in the case of potassium iodide and cane sugar. Portions of a solution of potassium iodide of 0·2035 normal concentration, removed respectively from points near the axis of rotation and some distance away, were found to be 0·1065 normal and 0·325 normal. These portions of solution were removed after centrifuging for three hours at the rate of 2400 revolutions per minute. A saturated solution of Glauber's salt, containing 8·8 per cent. $Na_2SO_4$, deposited 57 grams of solid $Na_2SO_4.10H_2O$ at the periphery after being rotated for five hours, and the remaining solution was found to contain only 5·5 per cent. of sodium sulphate. It is calculated that the applied force acting on the molecules at the periphery (radius of rotation=6 cm.) in these experiments was more than 400 times greater than gravitational force.

IN the *Revue de Metallurgie* for April, M. H. Le Chatelier re-states and explains his views on the constitution of the carbon-iron alloys. He points out the importance of classifying the constituents of heterogeneous bodies, and again directs attention to the similarity between alloys and igneous rocks. In chemical classification it is necessary to give the chief place to the conception of phases, and to regard chemical composition as of secondary importance. If chemical composition alone were used for purposes of classification, there would be no distinction, for example, between crystallised granite and fused granite, although the former contains three phases, quartz, felspar and mica, and the latter contains only one phase. Moreover, it is desirable to give names to the phases, even when they are solid solutions of variable composition. One of the great difficulties in determining the phases in the steels is that the individual crystals are generally so minute that they cannot be isolated, and their properties and chemical composition cannot be exactly determined. Nevertheless, some progress has been made in the recognition of the various phases that may occur. M. Le Chatelier believes that these phases include iron in its various allotropic forms; carbon in the form of graphite; cementite, or $Fe_3C$; and many solid solutions containing iron and either carbon, nickel, manganese, phosphorus, silicon, or other elements. Most of these phases have not yet received names, but the highly important carbon-iron solutions have been called troostite, martensite, and austenite. The homogeneity of these phases has been called in question, but the attempts to prove that they are heterogeneous have not yet been successful. Difficulties are occasioned by the similarity of the properties of these three solutions, and the evidence that they are distinct rests mainly on their appearance under the microscope after treatment by different reagents. It is scarcely necessary to add that these views are not shared by some students of metallography.

## OUR ASTRONOMICAL COLUMN.

THE GOVERNMENT OBSERVATORY, BOMBAY.—The report of the Bombay Observatory for the year ending December 31, 1903, signed by the director, Mr. N. A. F. Moos, gives an account of the many and varied observations carried out there. The instrumental equipment is extensive and in good order, the records of failure by the automatic registering instruments being very few.

The rainfall for the year was 84·49 inches, a surplus of 9·33 inches above the average of the twenty-four years 1873–1896. The daily wind pressures and temperatures were recorded regularly, and many magnetic and seismographic observations were made daily. Routine observations with the transit instrument, to check the standard clocks, were made at regular intervals, and a very good time service was maintained at the docks and other public places. The rating and adjustment of chronometers and deck-watches for Government departments and ships, and for private ship owners, formed an important part of the year's work.

NEBULOUS AREAS OF THE SKY.—In an article published in *Popular Astronomy* (No. 6, vol. xii.), Prof. H. C. Wilson, of the Goodsell Observatory, discusses the subjective existence of the large nebulous areas of the sky as described by Sir William Herschel. He fully confirms Herschel's observations, and considers that the negative results obtained by Dr. Roberts last year must have been due to unfavourable observing conditions. Further, he shows by a reproduction of one of his own beautiful photographs of the Pleiades region, which was taken with a 6-inch Brashear star-camera, that at least one of the regions described by Dr. Roberts as containing no nebulosity is in reality filled with nebulous matter, covering as many square degrees as Herschel allotted to the whole of the nebulosities in his fifty-two regions.

Profs. Wilson and Payne intend transporting their photographic equipment to a station situated in the western Montana mountains at an altitude of about one mile, so that during July and August they may test the suitability of the atmosphere at that altitude for photographing the nebulous patches of the Milky Way, and, if possible, obtain further confirmatory photographs of Herschel's regions.

LIGHT CURVE OF δ CEPHEI.—From an exhaustive discussion of the available data concerning the magnitude variations of δ Cephei, M. Beliawsky, of St. Petersburg, has derived the following elements:—

Minimum o=1840 September 24·833d. M.T. Bonn.
Period=5·36642 days.

The period between a maximum and the succeeding minimum, according to the curve, is 1d. 11·184h., and this value is very near the mean of the values obtained by five previous workers. The light of the star varies between magnitudes 4·37 and 3·57, and M. Beliawsky gives the estimated magnitude for every 0·1 day between two succeeding minima (*Astronomische Nachrichten*, No. 3952).

POSITION OF THE AXIS OF ROTATION OF MARS.—*Bulletin* No. 9 of the Lowell Observatory gives the results of a new determination of the position of the axis of rotation of Mars, made by Mr. Lowell. The direct method was employed, the position angle of the tangent to the limb at the nearest point to the polar cap being measured with a micrometer. The varying inclination of this tangent to the horizontal renders necessary the tilting of the observer's eyes in some positions; presuming that this might affect the resulting measures, Mr. Lowell has differentiated the results accordingly, calling them "expurgated" or "unexpurgated" as the time of observation was less or more than three hours after the horizontal position of the tangent.

This was found to make less difference to the final result than that caused by observing the different oppositions.

The results obtained for the position of the pole of Mars are as follows:—

| | R.A. | Dec. |
|---|---|---|
| Position upon the earth's equator... | 315° 32′ | 54° 51′ |
| Intersection of the Martian equator and Martian ecliptic ... ... | 85° 56′ | 24° 32′ |
| Inclination of Martian equator to Martian ecliptic ... ... ... | — | 22° 55′ |

## THE STRUCTURE OF METALS.[1]

THE subject of the lecture was the structure of metals, mainly as revealed by the microscope. The first serious application of the microscope to the study of metallic structure was made in 1864 by Dr. H. Sorby, of Sheffield, but the lead then given was not followed for nearly a quarter of a century. In the last fifteen years or so, however, it had been taken up with the greatest zeal and success, nowhere more than in Dr. Sorby's own town. There and elsewhere, in France, Germany, and America, as well as at home, a band of enthusiastic workers had been engaged in creating what might be described as a novel branch of physical science, as interesting on the physical side as it was important in its practical aspect. In this work Cambridge had done its share. The lecturer referred especially to work done in the engineering laboratory by Rosenhain, Humfrey, and other of his own former research students, and to the admirable investigation of alloys carried out by Neville and Heycock in the laboratory of Sidney Sussex College.

It was only possible to give in a single lecture a very brief account of part of this work. Photography had lent its powerful aid in recording what the microscope made visible. By means of lantern slides showing micro-photographs of polished and etched metallic surfaces, the lecturer proceeded to exhibit the characteristic structure of a pure or nearly pure metal, where the whole mass is made up of irregular grains with well marked boundaries more or less polygonal in form. The grains could be distinguished from one another not only by the presence of the boundaries, but by differences of texture which were especially conspicuous under oblique lighting. Each grain was a true crystal made up of similarly oriented particles in a perfectly regular tactical arrangement, such as might be exemplified by imagining it to be built up of minute brickbats all of the same form and size. When a polished surface was etched the facets of the elementary brickbats were exposed, and the manner in which these reflected the light into or away from the microscope determined the appearance which the grain presented under oblique illumination. A slight change in the direction of the incident light would greatly affect the brightness of the grain, making it shine out or grow dull, but over each grain there was a uniform degree of brightness due to the uniformity of its tactical formation. Each grain had grown as a crystal, starting from a chance nucleus, and the boundaries were determined by the casual interference of grain with grain in the process of growth. In general, the growth was at first dendritic, skeleton forms shooting out until they met similar growths in neighbouring grains, and the interstices of the skeleton were filled in later. In some metals the grains were products of crystallisation from the liquid state; in others, notably in iron, a re-crystallisation took place long after the metal had solidified, and in such cases the grains, as we knew them under ordinary conditions of temperature, were the result of an internal re-arrangement which took place while the metal was solid. In such cases they were characterised by less regular boundaries, and there was evidence of more intimate interlocking between grain and grain. The structure might be fine or gross; in specially pure metals, and under specially slow conditions of cooling, it was apt to become specially gross. An instance was exhibited of a piece of lead of exceptional purity allowed to solidify by very slow cooling, in which the grains were so large as to be visible to the audience without magnification. Their appearance under oblique lighting was projected on the screen, and by tilting the block of lead the striking changes of brightness due to change in the incidence of the light were exhibited. Other evidences of the crystalline character of the grains were referred to, namely, the pits and geometrical forms developed on the surface by etching, and the geometrical forms assumed by very minute bubbles of gas or air imprisoned in the process of solidification.

Coming next to the consideration of effects of stress, the lecturer described the experiments by which, in conjunction with Mr. Rosenhain, he had demonstrated that the plastic yielding of metals when severely strained is due to a multitude of slips occurring along cleavage planes in the several grains of which the metal is a conglomerate. The appearance of "slip-lines" in various metals was shown, and the character of the lines was discussed. As Rosenhain had recently pointed out, the slip-lines were comparatively straight in grains formed by solidification from the solid (as, for example, in cast lead, silver, and gold), but were broken up into steps which gave them the appearance of being curved in metal which had undergone re-crystallisation while in the solid state. This was ascribed to the more intimate interlocking of the grains in the latter case. That the slips showed themselves by steps or sudden slight changes in the level of the surface was clearly demonstrated when the slip-lines were examined under oblique light. All the parallel slips on a given grain would then flash out simultaneously when the direction of the incident light suited the particular slope of the planes in which the slips had taken place. The form of slips in twin structures was exhibited, and also in an example (due to Humfrey) of lead with a structure so gross that the relation of the slips to the geometry of the grain could be readily traced.

A question of immense practical interest was the "fatigue" which metals underwent when exposed to many repetitions of a straining action. The microscope threw valuable light on this by showing how, under repetition of pulls or pushes or bendings, a piece began to give way, first by slips appearing on isolated grains, and then by some of these slips gradually developing into cracks. Instances were cited from a joint research by the lecturer and Mr. Humfrey. Mr. Rogers, who had pursued this subject with much zeal, had recently found that breakdown by fatigue was much more liable to occur in steel which had been thermally treated in such a manner as to develop a comparatively large structure than in the same steel when the treatment was such as to make the structure normally small.

Going on to speak of alloys, the lecturer described shortly the various ways in which two constituents might combine, or rather act together, in the composition of a binary alloy. In the liquid state each dissolved in the other, in the solid state one might remain wholly or in part dissolved in the other, forming what was called a solid solution. Thus with two constituents A and B, if A were present in small quantity only it might be found wholly contained as a solid solution in B. More generally, however, a solid solution would crystallise out first, leaving a mother liquor richer in A, which, by throwing down more and more solid solution, finally reached the proportion of the "eutectic" alloy, and then solidified as a eutectic mixture, showing under the microscope the zebra-like marking which characterised eutectic alloys. This process was explained by means of freezing-point curves, and was exemplified by a beautiful series of photographs taken by Mr. Stead, showing alloys of various proportional composition in which iron and phosphide of iron were the two constituents. When very little phosphorus was present, the whole solidified as a solid solution showing grains undistinguishable in general appearance from those of a pure metal. With a little more phosphorus the solid still consisted mainly of large grains, but the interstices (or in one case the inner parts of a dendritic skeleton) showed traces of the eutectic, which was the last part to solidify. With more phosphorus still the solid solution showed itself as incomplete skeleton grains interspersed with large quantities of eutectic. With more still the eutectic proportion was reached, and the whole solidified as a eutectic mixture, showing zebra markings all over the surface. With more still—that is to say, with an excess of phosphide—crystals of phosphide were first

[1] Abstract of the Rede lecture delivered before the University of Cambridge, June 11. By J. A. Ewing, LL.D., F.R.S., Hon. Fellow of King's College, Director of Naval Education.

deposited, and the remainder froze as a eutectic in which these crystals were encased. The phosphide crystals showed sharp geometrical outlines, in marked contrast to the outlines of the crystals of solution, because the phosphide was deposited as a definite constituent in which the other constituent (iron) was not soluble.

To explain the zebra markings characteristic of eutectics, Dr. Ewing briefly referred to the phenomenon of surfusion, and gave it as his opinion that the formation of a eutectic occurred by alternate surfusion or supersaturation of each constituent in the other. A eutectic in the fluid state and about to freeze might be defined as a saturated solution of A in B which was at the same time a saturated solution of B in A. On the temperature falling, an alternating condition of instability results. By surfusion, A is at first supersaturated with B, until some of B is thrown down, leaving, in the liquid that remains, B supersaturated with A. Consequently, some of A is in turn thrown down, and so on alternately. In the appearance of a eutectic alloy there was much that was suggestive of alternate deposit of the two constituents, and it was in some such way as this that Dr. Ewing conceived the alternation to take place.

Eutectics in which the constituents were not of the same crystalline system appeared to be mechanically weak. A very small quantity of bismuth added to copper or silver or lead was shown by Arnold to produce great brittleness, owing to the weakness of the cement which the eutectic formed in the joints between the grains, although the individual grains themselves preserved their original malleability. In other eutectics no such weakness, as a rule, was found, and the intergranular cement was as strong as the grains themselves—often, indeed, it was distinctly stronger.

From the engineering point of view, by far the most important alloys were those in which the chief constituents were iron and carbon, or rather iron and carbide of iron. By help of Roozeboom's diagram, the lecturer explained briefly the characteristics of high and low carbon steels, and the transformations which occur in the process of cooling at temperatures far below that at which the metal becomes wholly solid, which had formed the subject of much study by Osmond, Roberts-Austen, and others. By the process of quenching these changes might be to some extent arrested, and the mechanical properties secured which characterise hardened steels. The evolution of heat in the transformation was illustrated by means of cooling curves, and by experiments in which steel wire was allowed to cool after being electrically heated above the transformation points. While passing through the region in which transformation occurs, the steel is specially plastic; this was illustrated in the cooling from bright redness of a steel wire coiled into the form of a spring and carrying a light weight. The spring extended in a conspicuous way while the process of re-crystallisation associated with "recalescence" was going on. The phenomenon of recalescence was further illustrated in an automatic record obtained during the lecture with a Callendar recorder which was exhibited by the Cambridge Instrument Company. The recent results of Carpenter and Keeling, in their research at the National Physical Laboratory, were referred to as giving in most particulars a general confirmation of Roozeboom's views. Other examples of transformation occurring in the solid state were illustrated by photographs selected from Neville and Heycock's series for the copper-tin alloys.

The gradual changes of structure which go on even at atmospheric temperatures in lead and other metals after the structure has been broken up by severe straining were next described, photographs by Rosenhain and the lecturer being exhibited to demonstrate the progressive character of these changes, and the manner in which they would be accelerated by elevating the temperature.

In conclusion, the lecturer referred to the analogous case of glacier ice. It had for long been known to possess a granular structure, and each grain was a crystal just as in the case of metals. Photographs by Principal Skinner, illustrating this granular structure, were shown. In the upper névé the grains were vague and comparatively small; as the glacier slowly travelled down the grains became consolidated and large, and their outlines became well defined. It was clear that a slow process of crystal growth was going on, and in the lecturer's opinion it was to this very process of growth that the plasticity of the glacier as a whole was to be ascribed. How ice came to be plastic in large masses was a question to which physicists had suggested more than one answer. But the plasticity was intelligible enough when one realised that the whole mass was in the act of structural change. Just as the spiral spring in the experiment with steel showed during its transformation a special plasticity, so the glacier showed a general plasticity throughout its course, inasmuch as it was undergoing a slow and probably continuous structural change in the crystallisation of its individual grains. Alike in the metal and the ice, nature was apparently following one structural process, and the consequences as to plasticity were alike in both. In neither case was any constancy to be found save the constancy of change. Nothing was more striking to a worker in this field than the evidence he found that those substances on which we were most accustomed to rely as constant were undergoing, sometimes comparatively fast and sometimes very slowly, a process of internal flux. A monument more enduring than brass might be a lofty ideal, but it was seen at least to be an ideal easy of conception when one realised how far from constant the inner structure of brass and other metals was apt to be.

## THE GAS SUPPLY OF THE METROPOLIS.

A committee was appointed by the Board of Trade in January last to inquire and report as to the statutory requirements relating to the illuminating power and purity of the gas supplied by the metropolitan gas companies, and as to the methods now adopted for testing. The report of this committee has now been presented, after hearing evidence from the metropolitan gas referees, from representatives of the London County Council, the Corporation of the City of London, and each of the three gas companies concerned.

The supply of gas in the metropolis being a monopoly, provision is made in the private Acts of the various companies for securing the maintenance of certain standards of purity and illuminating power. Three gas referees are appointed by the Board of Trade, with power to prescribe and certify the situation and number of testing places to be provided, and to lay down the conditions under which the testings are to be made. By the insertion of clauses in recent Acts obtained by the gas companies bearing on the mode of testing, these powers have been somewhat curtailed. The testing places are usually fitted up in houses owned or leased by the gas companies, the tests being made by officials appointed by the controlling authority, either the London County Council or the Corporation of the City of London. A comparison of the tests made at the official stations with tests made with a portable photometer in the neighbourhood of those stations having shown considerable discrepancies, attempts have been made by the controlling authority to legalise the portable photometer, but these attempts have been successfully resisted by the gas companies before Parliament, and the present committee in the report is not prepared to recommend the adoption of such tests. As, however, these results have given rise to doubt as to whether the gas supplied to the testing stations really represents the gas supplied to the public, the gas referees have laid down a requirement that the gas to be tested is to be brought direct from the main to the testing place by a single service pipe, without tap or branch or provision for connection of any kind outside the testing place. This has been strenuously resisted by one of the companies, and has led to the curious result that, although the referees have powers to prescribe testing places, they have no powers to enforce their prescription, and owing to the deadlock thus created two testing places have remained closed for some years.

The committee is of opinion that this requirement is a reasonable one, and that it might with advantage be made a statutory requirement not dependent on the prescription of the gas referees.

In the case of any deficiencies being found by the official examiners, action is taken by the controlling authority before a magistrate, with a view to the recovery of the forfeitures specified in the Acts. If any technical objection is raised by the gas companies, the question is referred to

the chief gas examiner (Lord Rayleigh), and unless the appeal is sustained the case is referred back to the magistrate for the assessment of the amount to be paid. The gas companies have always strongly objected to these police court proceedings, and the committee recommends a modification of the existing provisions whereby, in future, police court proceedings will not be required when the chief gas examiner shall certify that the default is not substantial, or that it is not due to careless conduct at the works, the forfeitures in all such cases being left for assessment to the chief gas examiner. The committee also recommends that in the case of any disputes arising between the gas referees and the gas companies, they should be referred to the chief gas examiner, and that his decision should be conclusive and binding on both parties.

Important concessions to the companies are recommended by the committee with regard to the amount of sulphur impurity allowed. In addition to a relaxation of the stringency of the tests to be applied for the detection of sulphuretted hydrogen, it is suggested that the standards for the amount of sulphur present in the gas, other than sulphuretted hydrogen, should be abolished. The committee has been influenced in this decision by the consideration of the nuisance created near the works by the use of lime purification, and the danger to the men employed in connection with the process. At the same time, however, it is proposed that the official tests should continue to be made, and that the amount of impurity in each form contained in the gas should be ascertained and recorded.

In view of the increasing amount of gas used in incandescent burners and for heating and power purposes, it is considered desirable that the calorific value of the gas should be determined and recorded, but no standards are proposed, and photometrical data with flat flame burners, in addition to those already made with the standard Argand, are also suggested as desirable.

The report has been issued within five months of the date of appointment of the committee, and it is to be hoped in the interests of the public that the legislative action necessary to carry these suggestions into effect may be made with equal promptness.

## SEISMOLOGICAL NOTES.

IN the *Bollettino della Società Sismologica Italiana*, vol. ix., No. 7, Dr. A. Ricco gives an interesting paper on the relative values of gravity in the vicinity of Etna, Sicily, the Æolian Islands, and southern Italy. The results are shown in two sketch maps, on which a series of lines having the appearance of isomagnetics pass through places at which the difference between the expected and the observed values for $g$ are equal. The smallest values for the anomaly or $g-\gamma$. are found round the summit of Etna, whilst maxima occur in the proximity of deep water about 80 km. to the south-south-west and 150 km. at Stromboli to the north. A similar but not so marked gradient is found in the vicinity of the Bay of Naples. Along the Apennines and in central Sicily the anomaly is small, and the gradient is gentle. These observations are discussed in relation to volcanic and seismic activity, orographic and geotectonic conditions. An obituary notice of Dr. Mosé Contarini, who died at the early age of twenty-eight, at the commencement of a promising career, and a catalogue of disturbances for July, 1902, complete the number.

In vol. ix., No. 8, of the same publication, Dr. A. Cancani describes and analyses five seismograms relating to earthquakes with known origins. The peculiarity of these seismograms, copies of which are given, is that they were obtained on a high speed (72 to 97 mm. per minute) smoked paper record receiving surface.

The diagrams are therefore sufficiently open to read periods of half a second, which periods refer to the preliminary tremors. From the interval in time between the commencement of these first movements and the commencement of the large waves, the distances of origins from Dr. Cancani's station in Rome are calculated. The accuracy of the results obtained therefore depend upon the accuracy with which these two phases of motion can be identified upon the seismograms. In the first earthquake considered these identifications are clear, but if the figures for the remainder are exact reproductions of the original seismograms, it seems extremely likely that very different results might be arrived at by different investigators. For writing pointers with a minimum of friction, Dr. Cancani uses the hanging aluminium indices of his colleague, Dr. Grablovitz. The cost per annum for the recording materials, which include 730 sheets of paper, gas or oil for smoking, and varnish for fixing the same, &c., is about 3*l.* 15*s.* At the end of the number the earthquake registers are brought up to the end of August, 1902.

The Austrian Earthquake Commission publish in No. 22 (new series) observations made by Dr. W. Láska in 1902 in Lemberg. They refer to records obtained from Reubeur-Ehlert horizontal pendulums.

In the *Mémoires* of the Geological Committee of St. Petersburg, No. 9 (new series), Dr. V. Weber gives a detailed account of the earthquake which on January 31, 1902, destroyed Chemaka. The epifocal area appears to lie along the major axis of a series of elliptical isoseists, and a map on which these are shown also indicates the different degrees of destruction in various villages within the disturbed district.

The phenomena observed are similar to those noted with many large earthquakes.

Another publication received from Russia is the *Bulletin* de la Commission Centrale Sismique Permanante. It refers to records obtained in the months April, May, and June at Tiflis, Taschkent, Irkutsk, Dorpat, and Krasnoiarsk, at each of which stations there are one or more seismographs.

The contributions to seismological knowledge received from Japan are as usual both varied and interesting.

Following in the footsteps of Dr. C. G. Knott, Mr. A. Imamura, in the reports of the Physico-Mathematical Society of Tokyo, vol. ii., No. 8, discusses certain earthquake registers, with the result that he finds that seismic disturbances have not only been most frequent at the times of conjunction and opposition of the sun and moon, but also at the times of quadrature. The extent to which barometrical pressure may effect seismic frequency is to be found in the same journal, the author being Dr. F. Ōmori. Another note by the same writer describes a horizontal pendulum controlled by an inverted pendulum. The former is 1 m. in height, and has a boom 1 m. in length which carries 50 kg. With its control a period of one minute is obtained without difficulty.

Dr. Ōmori's most important work is contained in No. 15 of the *Publications* of the Earthquake Investigation Committee. It relates to the measurement of the vibrations of railway carriages as recorded by seismographs. For years past the balancing of locomotives and the state of the permanent way have in Japan been determined by means of these instruments, and the practical advantages leading to the saving of fuel and the detection of faults which have accrued are generally known. Here we have an elaborate extension of previous work which railway engineers may read with advantage.

At the end of this number an index is given to the contents of the sixty-three profusely illustrated series of volumes and parts which, since 1893, have been issued by the Tokyo Earthquake Investigation Committee. Unfortunately for European readers, forty-seven of these publications are in Chinese idiographs. Amongst the latter we find reports upon seismographs, observations made in deep bore holes, notes upon magnetic disturbances which have preceded certain large earthquakes, many observations made for the purpose of determining the transit velocity of earthquake motion, observations relating to subterranean sound phenomena, observations upon sea waves, investigations relating to seismic frequency, reports upon faults, landslips and volcanoes, and a mass of material, all the result of patient investigation, which is of great importance to modern science. Many of the papers are of immediate value to those who have to construct in earthquake countries. Not only has the Japanese Government encouraged its engineers to study the effects of earthquakes upon structures within its own territory, but lengthy reports upon the damage which took place in Assam in June, 1897, indicate that it was considered advisable to derive lessons from misfortunes in foreign countries, and for this reason missions of

engineers and men of science have been sent not only to India, but to Manila, Italy, and other places. One set of instructive reports refers to destruction and shattering produced by movements closely approximating to those of actual earthquakes given to a platform on which masonry and other structures had been erected. This platform is in no sense a toy, but a large piece of apparatus actuated by powerful machinery. To say that these investigations have during the last ten years cost the Government of Japan 50,000*l*. is a modest estimate. The return for the same is seen in the new types of structures which are growing up in Japan, replicas of which have been adopted in British possessions and other places, the meaning of which is that danger to life and property resulting from seismic disturbances, if not averted, has been markedly mitigated.

Add twenty volumes issued by the Seismological Society to those published by the Investigation Committee, and we have eighty-three publications, the greater number of which are volumes, as Japan's contribution to recent seismological progress.

In consequence of not being acquainted with researches carried out in the Far East—and we do not refer to those which Japan for the benefit of her own people has published in Chinese characters—it is not uncommon to find seismologists in Europe reproducing as novelties the *faits accomplis* of past history. Had Prof. Odone read the *Transactions* of the Seismological Society of Japan, it is not likely that in a recent number of the *Bollettino* he would have given, with drawings almost identical with those published in Japan, a description of a method by which the relative motion of two points of the earth's surface might be measured; neither should we find in the last number of the same journal a description, quoted from the *Comptes rendus*, January 26, 1903, of a new system by which record receiving surfaces could be set in movement, and therefore ready to receive the record of an earthquake before the earthquake itself arrived to actuate the indices of a seismograph. In 1884 in Japan nine stations were electrically connected, so that an earth movement at one of them resulted in the release of clockwork at all the others (*Trans.* Seis. Soc., vol. x.).

Since then the system has been greatly extended, and at stations considerable distances apart record receiving surfaces are set in motion before the pointers resting on the same have been actuated by earth movements. That work of this description, which was referred to over and over again in publications issued twenty years ago in Japan, should in 1904 be reproduced in Europe as original indicates that the work has at least had some slight recognition. The main point at issue, however, is that the veil of Chinese cryptograms which has hidden so very much of the work done in the Far East has by means of an index been partly raised, and if at Strassburg or at any other institution this work can be rendered available to seismologists who read a European language, the same will from "many an error free us," and be most gratefully received.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—The following appointments of university lectures are announced:—Chemistry, Messrs. W. J. Sell, F.R.S., and H. J. H. Fenton, F.R.S.; organic chemistry, Mr. S. Ruhemann; petrology, Mr. A. Harker, F.R.S.; invertebrate morphology, Mr. A. E. Shipley, F.R.S.; physical anthropology, Mr. W. L. H. Duckworth; palæozoology, Mr. H. Woods.

The new Balfour student is Mr. R. C. Punnett, of Caius College. A grant of 50*l*. from the Balfour fund has been made to Mr. L. Doncaster, King's, in furtherance of his researches on sex and heredity.

Messrs. C. Shearer and W. E. Agar have been nominated to occupy the university's table at the Naples Zoological Station.

The special board for biology proposes that Mr. J. W. Clark should be re-appointed a manager of the Balfour fund for a period of ten years.

The original researches of Messrs. R. Hosking, W. Makower, G. Owen, and F. Rogers, advanced students in experimental physics, and in engineering, have been approved by the special board for physics and chemistry as of distinction; they will receive certificates qualifying them for the B.A. degree for research.

Five candidates have gained the university diploma in agriculture; seven have qualified in the first part of the examination.

Mr. H. M. Chadwick, Clare, Mr. C. H. W. Johns, Queens', Dr. A. Macalister, St. John's, and Dr. F. H. H. Guillemard, Caius, have been appointed members of the new board of anthropological studies.

Dr. D. MacAlister, St. John's, has been appointed assessor to the regius professor of physic. Prof. Darwin, Trinity, and Prof. Larmor, St. John's, have been appointed electors to the Isaac Newton studentship in astronomy and physical optics.

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MR. PERCY F. KENDALL has been appointed professor of geology in the University of Leeds, and Dr. J. B. Cohen has been appointed professor of organic chemistry in the same university.

MRS. AMANDA W. REED has, says *Science*, provided in her will for the foundation of an institution at Portland, Oregon, to be known as Reed Institute, in memory of her husband, the late Simon G. Reed. The bequest will amount to about 400,000*l*. Her will specifies that the institute shall combine instruction in the fine arts, sciences, and manual training, and that it shall be conducted with especial regard to the needs of young men and women compelled to earn their own living.

NEW science buildings, which by special permission of Lord Kelvin have been called the Kelvin Science School, are to be opened by Sir Douglas Fox at Trent College, Derbyshire, on June 29. The new science school contains six large rooms and three small ones; these include a room for manual instruction in wood and iron, a physical laboratory, a lecture theatre to seat eighty, a balance room, a chemical laboratory for twenty-four students, and a biological laboratory for sixteen students.

A PAPER read by Prof. Israel C. Russell before the Research Club of the University of Michigan in January last is printed in *Science* for June 3. After referring to the triumphs of science in the last century, Prof. Russell remarked:—"The intellectual tide-gauges of the world give no suggestion that the nineteenth century wave of discovery has culminated. On the contrary, there is abundant evidence to show that the rate of intellectual development is still on the increase, and that yet more important conquests in the domain of the unknown than have illuminated the past will be made in the future." The recognition of the importance of research by the United States is naturally emphasised in the paper, and three important steps in this direction are marked by what Prof. Russell called "enduring movements," viz. the *American Journal of Science*, which appeared first in 1818, the Smithsonian Institution, and the Carnegie Institution. Speaking of the place of research in the university, Prof. Russell expressed his agreement with the dictum of Sir Norman Lockyer, that "research is now generally acknowledged to be the most powerful engine of education that we possess."

THE twenty-eighth annual exhibition of work executed in the public elementary schools founded by the late London School Board, and now administered by the London County Council, was held from June 13 to 18 at the Medical Examination Hall, Victoria Embankment. As in previous years, one section of the exhibition was devoted to the science work done in these schools. The exhibits were chiefly pieces of apparatus and working models made or arranged by pupils and teachers. It was satisfactory to notice that the work of pupils and teachers was this year kept separate, and the confusion which in some former years resulted from an indiscriminate intermingling of the exhibits of teachers and taught was fortunately avoided. Much of the work shown was the joint product of the science

departments of the schools and of the manual training centres, and the standard of excellence attained may be taken as proving that good results follow the correlation of the instruction in science and in manual work. The total number of exhibits was unusually small, and it is difficult to find a reason for the inclusion among them of scientific instruments obtained from manufacturers. The collection of exhibits, though interesting and from some points of view satisfactory, did not succeed in conveying an adequate idea of the work in science accomplished in the schools. The man of science interested in education would have obtained a better general idea of the scope of the science work in the council's day and evening schools had typical laboratory note-books and typical syllabuses of work done been exhibited. There was, however, evidence enough to show that the claims of science to a place in the curriculum of the public elementary schools of London are recognised by the London Education Committee.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, June 2.—"On the Magnetic Changes of Length in Annealed Rods of Cobalt and Nickel." By Shelford **Bidwell**, F.R.S.

The magnetic changes of length in annealed iron were described by the author in 1894 (*Proc.* Roy. Soc., vol. lv. p. 228). When subjected to a longitudinal field gradually increasing from a small value, an ordinary iron wire is at first extended, then it recovers its original length, and finally becomes shorter than when unmagnetised. In annealed iron the maximum extension is diminished, and contraction begins in a weaker field, the change-of-length curve being lowered. In the case of a thoroughly well annealed specimen, contraction began in a very weak field without any preliminary extension. Similar experiments have now been made with cobalt and nickel. Cobalt in the ordinary condition behaves oppositely to iron, contracting in weak fields and lengthening in strong ones. It was found that a well annealed rod of cast cobalt contracted uniformly in fields up to 1360 units (the highest reached), the retraction curve being a straight line. This confirms an observation published last year in Japan by Honda and Shimizu. For a specimen of rolled cobalt, however, the change-of-length curve retained its general form, but was considerably lowered; in a field of 1750 the ascending limb was still below the axis of H and nearly parallel to it; probably, therefore, there would never be any elongation, however strong the field. The most noteworthy effect of annealing upon the retraction curve for nickel is an increase in the abruptness of its descent, which may be due merely to greater magnetic susceptibility. Thus it appears that well annealed specimens of iron, cobalt and nickel all undergo contraction when longitudinally magnetised.

**Mineralogical Society**, June 7.—Dr. Hugo Müller, president, in the chair.—The Rev. Mark **Fletcher** contributed a note on mispickel from Sulitjelma Mine, Norway, containing about 1·32 per cent. of cobalt, and showing the forms {011}, {012}, {110}.—Mr. G. F. Herbert **Smith** exhibited a hand-refractometer of the Bertrand type, in which the curvature of the focal surface had been reduced by means of a correcting lens, with a consequent improvement in the definition of the shadow edges.—Prof. H. A. **Miers** gave an account, illustrated by numerous lantern slides, of the development of the Kimberley Diamond Mines. He traced the changes in the methods of working from the first surface diggings to the time when the blue-ground was brought to the edge of the pit by a "cobweb" of wire ropes stretching from the numerous independent claims into which the mines were split up, and showed how the increasing difficulties involved in this method led to the final consolidation of the mines under Beit and Rhodes, and to the initiation of the present system of mining, which consists in sinking shafts on the edge of the pit, and running cross-cuts into the blue-ground. He referred finally to the recent discovery of blue-ground in the neighbourhood of Pretoria.

**Faraday Society**, June 9.—Dr. J. W. Swan, president, in the chair.—The electric furnace: its origin, transformations and applications, part i.: M. Adolphe **Minet**. The paper discusses the growth of the furnace from the historical point of view, and then proposes a new classification, which is worked out in minute detail in the form of a table. A full bibliography of the electric furnace completes this section of the paper.—A form of porous diaphragm convenient for laboratory use: Dr. F. M. **Perkin**. It consists of two perforated concentric porcelain cylinders packed in between with brown paper, asbestos, or other material, depending on the use to which the diaphragm is to be put.—The hard and soft states in metals: G. T. **Beilby**. The views advanced by the author are based on his earlier observations on surface flow in crystalline solids. The evidence afforded by the micro-structure has been supplemented by observations on the other properties of metals in the hard and soft states, and the view is now advanced that these states are perfectly distinct phases. This is shown by the mechanical, electrical, optical, and thermochemical properties, as well as by the micro-structure.

**Royal Meteorological Society**, June 15.—Capt. D. Wilson Barker, president, in the chair.—Effects of a lightning stroke at Earl's Fee, Bowers Gifford, Essex, April 13: Rev. C. F. **Box**. A thunderstorm occurred during the early morning hours, and about 3 a.m. there was a blinding flash, lighting up the whole neighbourhood for miles around, followed immediately by a crashing explosion. One person stated that he saw what appeared to be a cylinder, and another person a ball of fire, descend and then explode, "casting darts" in all directions. On careful examination in daylight, it was found that in an oatfield, which had recently been dredged, there were three distinct sets of holes ranging from 9 inches down to about 1 inch in diameter. The holes, which were perfectly circular, diminished in size as they went downwards, and remained so on to the perfectly rounded ends at the bottom. Upon digging sectionally into the soil, which is stiff yellow clay, it was found that the holes were "as clean cut as though bored with an auger." An interesting discussion followed the reading of this paper.—An instrument for determining the true direction and velocity of the wind at sea: A. Lawrence **Rotch**.

### PARIS.

**Academy of Sciences**, June 13.—M. Mascart in the chair.—Muscular displacement applied to carrying a load without displacement, the statical work of muscle. The comparison of this internal work with the resulting expenditure of energy, and influence of the magnitude of the load: A. **Chauveau**. Use was made of the respiratory coefficient in measuring the energy expenditure, and this was found to increase faster than the load sustained, although for small loads these were found to be nearly proportional.—The influence exercised by small variations of external actions on a system affected by hysteresis and defined by two variables: P. **Duhem**.—On the property possessed by a considerable number of bodies of projecting a ponderable emanation spontaneously and continuously: R. **Blondlot**.—A photographic study of the spectrum of the planet Jupiter: M. **Millochau**. The photographs were taken with a spectrograph attached to the large telescope of the Observatory of Meudon (84 cm. diameter), and the spectra obtained extended from the F line to the C line, means being taken to allow of a comparison of the spectra from the bands with that from the other parts of the disc. The presence of water vapour is clearly proved.—Remarks on the preceding communication: J. **Janssen**.—On a class of differential equations with multiform integrals: Pierre **Boutroux**.—Energy in statical reactions: Eugène **Lebert**. A discussion of the results of M. Chauveau on the "statical work" of muscle.—On the index of refraction of solutions: C. **Chéneveau**.—Contributions to the study of the $n$- and $n_1$-rays: Jean **Becquerel**.—On the forms of high frequency lighting between platinum wires of small diameter: André **Broca** and M. **Turchini**.—The action of the $n$-rays on pure water: Julien **Meyer**. Experiments are described leading to the conclusion that pure water, submitted to the action of the $n$-rays, becomes itself a source of $n_1$-rays.—On the measurement of the mobility of the ions in gases by a null method: Eugène **Bloch**. The method of MacClelland, improved by Zeleny, is modified by conversion into a null method, which much extends the field of its application.—The atomic weight of nitrogen: the analysis of nitrogen

monoxide by weight: Ph. A. **Guye** and **St. Bogdan.** The ratio of nitrogen monoxide to the oxygen it contains, determined gravimetrically, gives a value 14·007 for the atomic weight of nitrogen.—On the decomposition of a mixture of calcium carbonate and an alkaline carbonate under the action of heat in a vacuum: P. **Lebeau.** The decomposition by heat in a vacuum of mixtures of calcium carbonate and the carbonates of cæsium, rubidium, potassium, and sodium was complete. The amount of carbon dioxide obtained corresponded exactly to the amount of carbonates taken, and in all cases pure calcium oxide was left behind.—On some cuprous salts: A. **Joannis.** Details are given of the preparation of cuprous formate and benzoate.—On a basic ferric phosphite: E. **Berger.**—On the alloys of magnesium with bismuth and magnesium: Hector **Pécheux.**—Iodine compounds obtained with metanitraniline: P. **Brenans.**—On a spontaneous alteration product of oxalacetic ester: L. J. **Simon.** A sample of oxalacetic ester which has been kept for some time gives a violet colour reaction when placed in contact with an alkaline solution. This is not given by the freshly prepared substance, and is probably due to a dioxyquinone, formed by the elimination of one molecule of water between two molecules of oxalacetic ester.—Polyacid salts of rosanilines: Jules **Schmidlin.**—On the variations shown in the composition of seeds during their maturation: G. **André.**—The distribution of some organic substances in orange flowers: Eug. **Charabot** and G. **Laloue.** The petals contain the greater part of the essential oil.—On zymase and alcoholic fermentation: P. **Mazé.**—On *Mitsukurina Owstoni*: Léon **Vaillant.** This only differs from the elasmobranchs, with which it has been compared, by characters of the second order, and the author regards it as belonging to the family of Lamnidæ. This is not in accord with the views of Jordan, who regards it as a distinct type.—On a transformation of the tentacular apparatus on certain species of Madrepora: Armand **Krempf.**—Some polytaxic characters in species in the wild state: G. **Coutagne.**—Chains of force: M. **Hartog.** A description of a model reproducing certain phenomena of cell formation by the motion of magnetisable particles placed in a magnetic field in a viscous medium.—On the morphology of the root of plants with mutilated embryo: P. **Ledoux.**—The discovery of fossil-bearing layers in Djoua, to the east of Timassanine, Sahara: F. **Foureau.**—On the fauna of the Cretacean Ceratodus layers of Djoua, near Timassanine, Sahara: Émile **Haug.**—On the fauna of the Lydian of the Vosges sandstones: C. **Nöel.**—The survival of a negroid type in the modern populations of Europe: Eugène **Pittard.** The examination of skulls from the Rhone Valley, dating from the thirteenth century up to the commencement of the nineteenth century, shows evidences of a well marked negroid type, which may be a simple survival or a case of atavism.—The structure of the muscular fibres of the heart in molluscs: Pierre **Vigier.**—On the muscular fibres of the heart in *Nassa reticulata*: M. **Mader.**—The effect of the chromatism of the eye in colour vision: A. **Polack.**—A new example of physical adaptation between a natural stimulus, a sound vibration, and a central perceptive organ: Augustin **Charpentier.** By the use of phosphorescent screens a third example is given of an influence exercised directly by a natural agent upon the corresponding nervous centre.—The action of the *n*-rays upon an isolated nerve trunk: Paul L. **Mercanton** and Casimir **Radzikowski.** The sciatic nerve of the frog is not excitable by exposure to the *n*-rays.—Researches on the physiological effects of radium: C. J. **Salmonson** and G. **Dreyer.**—The relations between intraorganic combustions and the proportion of oxygen contained in the arterial blood: J. **Tissot.** Intraorganic combustions, measured by the values of the respiratory exchanges, are independent of the proportion of oxygen contained in the arterial blood.—Researches on the blood of Selachians. The toxic action of the blood of *Torpedo marmorata*: E. **Gley.**—The use of calcium sulphide against dodder and other injurious parasites: F. **Garrigou.**

NEW SOUTH WALES.

**Linnean Society,** April 27.—Mr. Thomas Steel in the chair.—Descriptions of new species of Australian Coleoptera, part vii.: A. M. **Lea.** Thirty species are described as new. Three previously unnoticed blind species from Tasmania are recorded—*Annomatus 12-striatus*, Müll., introduced from England, probably with pot plants; *Phycochus graniceps*, Broun, found also in New Zealand; and *P. sulcipennis*, n.sp. The number of blind species known from Australia and Tasmania is thus brought up to a total of eight.—Contributions to a knowledge of Australian Entozoa. No. iii. On some species of Holostomidæ from Australian birds: S. J. **Johnston.** Five species, all parasites of Australian birds, are described as new.—Australian fungi, new or unrecorded. Decades vii.–viii.: D. **McAlpine.** Of the twenty species recorded, seventeen, referable to thirteen genera, are described as new. Myriangium, formerly classed with the lichens, is represented by two species, and a new genus, Amphichæta, allied to Monochæta, Sacc., is proposed. The favourable condition of the specimens examined has made it possible to give a description of the spores of a species of Hexagonia—apparently the first to be recorded.

## DIARY OF SOCIETIES.

*FRIDAY*, JUNE 24.

PHYSICAL SOCIETY, at 5.—Chemical Dissociation and Electrical Conductivity: A. E. Garrett and Dr. R. S. Willows.—The Magnetisation of Iron in Bulk: Dr. W. M. Thornton.

*MONDAY*, JUNE 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Anglo-French Boundary Commission in Nigeria: Colonel G. S. McD. Elliot, R.E.

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