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Social Biology and Birth-Control.

THE bearing of the laws of life on the structure and development of human society is a subject which awakened only a faint academic interest in the golden days before the War. Then the production of food, both directly, and indirectly by means of the expansion of our output of manufactures which enabled us to import it, was increasing more rapidly than our population; a large proportion of our people were fairly comfortable and happy, and our surplus population was streaming out in large numbers to North America. Consequently, if the biologist was already noting the beginning of certain tendencies which seemed to him of sinister import, he was listened to with as little interest as was the astronomer when he predicted that the sun would ultimately grow cold and that our descendants would freeze to death.

Now all has changed; our population has very considerably increased, and it is still increasing at about the rate of 1000 per day, but there has been no corresponding increase in output of manufactures. The outlets through which our emigration flowed are gradually being closed. The immigrants from the British Isles into the United States are to be reduced to 60,000 a year; nominally the Dominions are open to our emigrants, but in practice these countries exercise a rigorous selection amongst emigrants and admit only the best, and from their own point of view they are perfectly right. In the most favourable circumstances, therefore, the Dominions would only skim off the cream of our population, consisting of the young, vigorous, and enterprising, whilst the less worthy would be left to accumulate in the mother country. Moreover, the habit of expecting to be supported by the State, which was fostered by universal conscription and the enormous number of temporary civil posts created during the War, has so grown upon masses of the population that they are unwilling to take the risks involved in changing their abode, and desire to throw responsibility for their maintenance on the Government.

It is easy to see the direction in which tendencies like these are leading us: what would any biologist say of the probable fate of a species of animals rigidly confined within a limited area by barriers they are unable to cross, which are increasing at a more rapid rate than their food supply? He would say that the amount available for each individual must steadily grow less, until the strength of each was so undermined that the whole species would be swept by some devastating pestilence, which would reduce the numbers to an economic level. It has been stated that this is the fate which actually befalls the "jack-rabbit" population in the Mackenzie basin of North America

every few years, and something very like it happened to Ireland in 1846.

The noblest human emotion is probably social sympathy, developed, as McDougall has shown, out of the instinct of protective care towards her young which the mammalian mother possesses, and though on paper it would be easy to demonstrate that the physical welfare of our race would be benefited by the wholesale elimination of the sick, the feeble, and the incompetent, yet the injury and affront which any such policy would inflict on our tender emotions would cause us such damage as would far outbalance any physical gain that would result from the operation of unbridled natural selection. For sympathy is, in the last resort, the cement which holds society together: no one would feel any enthusiasm for a nation in which neighbours did nothing to help each other. Yet like all emotions, like hunger, thirst, and sexual desire, it must be regulated by reason if it is not to become devastating in its results.

The increase in our population, which in the absence of emigration is daily rendering our social problems more difficult, is mainly due to the reproduction of the poorest and least competent strata of society. So recently as 1850, when our birth-rate was about 35 per thousand, all classes in society reproduced at about the same rate. Large families were fashionable, and the clergy were pre-eminent in this respect. At present the average clerical family is rather less than two, and this is also true of medical men and other groups which make up a large part of the intellectual section of the nation. The tendency towards limitation of family has spread downward until it has reached the skilled artisan class. Several of our trades unions in negotiating for wages base their demands on the requirements of a man and his wife and three children—a most reasonable basis—since a family of this size is just sufficient to keep their numbers constant. But when we descend to the ranks of the unskilled labourers, then we find far larger numbers of children in the average family. In the middle of the nineteenth century this did not matter, as there was a very high death-rate which prevented the numbers of these people from increasing unduly, but now the emotional, irrational sympathy has reached such dimensions that proposals to grant free higher education, free food, and "motherhood pensions" are seriously put forward, proposals which, if carried into effect, would involve an enormous increase in our national expenditure. This expenditure would be borne largely by the professional and trading classes in the community, by those classes amongst which initiative and perseverance are necessary pre-requisites for success in life, and the members of which have been taught to rely on their own efforts. The result of this increase of burdens would be to restrict still further the reproductive increase of these classes, so that the State would come to consist more and more of those elements which are accustomed to rely on their neighbours rather than on themselves for support.

The fall in the rate of increase of the professional classes has been due to two factors, namely, later and more provident marriage and birth-control, that is, the prevention of conception. Even amongst unskilled labourers there is little desire for large families. Moreover, the poor class of mother is worn out by rapidly recurring pregnancies, and, as Dr. M. Jansen has shown in his "Feebleness of Growth," the youngest children are generally imperfectly developed, feeble in growth, and often deformed in structure. It is, we suppose, futile to advise that later and more provident marriage should be urged on all sections of the community, though it is very difficult to see the justice of the demand that one man should deny himself and abstain from marriage until he is able to maintain a family, whilst another is at liberty to marry improvidently and produce as large a family as he likes, and then call on the State, that is, his neighbours, to support his children. There can, however, be no argument of any weight adduced against teaching to the manual workers the methods of birth-control already used by the professional classes; in our judgment, the most potent cause of misery and poverty is reckless reproduction.

It is sometimes maintained that the children of the working classes are in every way as good intrinsically as those of the commercial and professional classes, and that therefore, so far as the State is concerned, it does not matter from what stratum the bulk of the next generation is drawn. This assertion is, however, the result of an "emotional complex." All the available evidence is completely against it. Since the grading of mental ability by means of the Simon and Binet tests has been introduced, it has been discovered that a large proportion of the slum populations consists of what the American authors term "morons"—that is, of mental defectives of comparatively high grade. These people are lacking not only in intelligence but also in self-control, which is the basis of morality, and they reproduce recklessly. They have just enough wit to be able to sustain themselves in the ranks of unskilled labour, that is, labour which consists in the routine repetition of muscular actions not requiring skill. Those of lower mental grade are confined in asylums and prevented from procreation.

No one would deny that people of superior ability are occasionally carried down into the lower strata by circumstances over which they have no control; but such individuals in the vast majority of cases rise in the social scale. Indeed, as Dean Inge has pointed out.

there were more "emergences" of this kind before the institution of free education than since it has come into force. It has been computed that sixty per cent. of the mill managers in Lancashire began life as mill hands.

It may be said, and with a great deal of justice, that in all ranks of society the prudent would alone practise birth-control and limit the numbers of their descendants, whilst the imprudent and reckless would continue to produce large families. In the old days this would not have mattered, as the death-rate in such families would have been large and their numbers would not have increased relatively to those belonging to the wiser members of the community. But the situation has been radically altered, as we have already stated, by the increase in the emotion of sympathy uncontrolled by reason. All babies of whatever parentage are to be fed, cared for, educated at the expense of the community, and then set free to propagate without restraint. We have not quite surrendered to such demands as yet; and it is to be hoped that we shall fight vigorously against doing so, for if we give in the outlook biologically will be disastrous indeed.

Birth-control therefore alone would not bring about rational selection amongst our population; it is only an indirect step towards that end. If it became generally spread amongst the wiser members of all classes of society, then a public opinion would be created, which would support proposals to sterilise all those who produced families which they were unable to maintain. If it should be said that this would involve an unwarrantable interference with the rights of the individual, then we can reply that sterilisation by modern methods entails not a decrease but an increase in the vigour and intensity of life, in fact, it brings about a certain measure of rejuvenation, and that no right can be conceded to any individual to produce children to be supported by somebody else.

When the historian reviews the history of civilisation, he is struck by the fact that one great State after another has been overthrown by the assaults of wandering and "uncivilised" people from the outside. Biologically, this is an extremely interesting, and at the same time disturbing, fact. One cannot avoid the suspicion that even ancient civilisations with their high death-rates fostered the survival of the unfit, and that wandering tribes in which natural selection had free play consisted to a far greater extent of vigorous individuals than did the States which they overran. At any rate, it must seem to the biologist a futile hypothesis to suppose that natural selection, so necessary to all other species of animals, can be dispensed with in the case of man; the best that can be hoped for is that it should be gradually replaced by rational and painless selection. E. W. M.

The Embryology of Vertebrates.

Vertebrate Embryology. By Prof. Robert S. McEwen. Pp. xi+544. (New York: Henry Holt and Co., 1923.) n.p.

IT is now close on forty years since the publication of Francis Maitland Balfour's great work on "Comparative Embryology," which was the first attempt to establish our knowledge of animal development upon a sound scientific basis. Since that time, and largely as a result of Balfour's work, many investigations have been made on the process and mechanism of segmentation, on the formation and growth of the germinal layers and their derivatives, and on the development of the various organs, in different classes and orders of animals, as well as a vast amount of cytological research dealing with the origin of the germ cells and the phenomena of maturation and fertilisation. A number of text-books partly embodying this material have been issued from time to time, but in most if not all of these the object has been limited to the needs of particular classes of readers. Thus the well-known works of Milnes Marshall, Charles Sedgwick Minot, Sir Arthur Keith, and Prof. T. H. Bryce are directed to the requirements of the medical student, while in those which take a broader outlook, although they deal with a considerable number of species, attention is confined mainly to the earlier stages of development, or else the account given is limited to one or two species. A notable exception, however, is the "Text-book of Embryology," in three volumes, by Profs. MacBride and Graham Kerr and the late Richard Assheton, but of these the last volume dealing with the Mammalia is still in preparation.

In Prof. McEwen's work upon vertebrate embryology, now under review, a fairly complete account is given of the development of two species, namely, the frog and the chick, in which the ontogenetic processes have been worked out in detail, but the accounts given are supplemented for purposes of comparison by chapters dealing with the early development of Amphioxus, the segmentation and gastrulation in the Teleostei and the Gymnophiona, and the early development of the mammal and its embryonic appendages. In this way the author has sought to produce a book adapted to the needs of general students of zoology as well as to those whose interest is mainly medical. Moreover, the strictly embryological part of the book is preceded by a chapter on "The Cell and its Function in Reproduction," in which various important cytological phenomena are described, and the significance of the maturation processes is discussed in the light of recent investigations on heredity in relation to the chromosomes. The

book is well and clearly written and, owing to its broad outlook, should appeal especially to those students of medicine who desire a more comprehensive knowledge of the subject than that obtainable from the embryological sections of text-books of anatomy.

In describing the early development of the frog, the successive stages are grouped under a series of heads, the internal changes being dealt with in alternation with the external ones so that the student might fully realise what events are correlated or occur synchronously. In the later stages, on the other hand, the changes in the organs are dealt with according to the systems to which they belong. In the account of the chick's development, however, the subject-matter is divided throughout according to daily periods after the manner of Foster and Balfour's well-known text-book. Both plans have obvious advantages, for while it is easier both to write and to understand a connected account of the organogeny of a particular system than one which is broken up by lengthy interpolations dealing with totally different parts of the body, it is far simpler to organise the work of the lecture class in relation to that of the laboratory if the developmental changes are studied by periods and not by systems.

The section on mammals is based largely, as the author acknowledges, on the late J. W. Jenkinson's work on "Vertebrate Embryology," published eleven years ago; since when comparatively little research has been done in the development of this class. We should have expected, however, to find a reference to Dr. Willey's researches on the placenta of the beaver, at any rate in the bibliography, which in most respects is ample. Mention might have been made also of the condition of pseudopregnancy (as described by Profs. Hill and O'Donoghue and others), this being a normal feature of animals as widely divergent as the dog and the marsupial cat. Prof. McEwen has done well to include some account of the sexual season and the œstrous cycle, as the study of this subject has important bearings upon many embryological phenomena. We notice, however, certain errors of minor importance. It is stated that the dicestrum (or short period of sexual quiescence occurring within the breeding season) in the rat is ten days, and that the procestrous and œstrous periods may each last from one to four days, whereas Profs. Long and Evans in their monograph on this subject have shown that the entire dicestrous cycle in this animal is only five days. Moreover, the dicestrous cycle in certain sheep is stated to be three weeks, and in a particular race of merinos to be one or two months. The usual dicestrous cycle in the sheep is fourteen or fifteen days (a fact which is not recorded), and we venture to think that the author is mistaken in supposing it ever to be so extended as he states. In his account of the maturation process, Prof. McEwen says that the second maturation division of the ovum resulting in the extrusion of the second polar body is completed after the entry of the spermatozoon. This is true of some mammals but is not so for all species, since in the rabbit and in the mole the two polar bodies are formed while the ovum is still in the ovary, as shown long ago by Mr. Walter Heape, and according to Prof. Arthur Thomson the same is almost certainly the case in man.

The work is well illustrated, though few of the figures are new, and it is provided with a good index. Students reading for an "honours" course in zoology will undoubtedly find it useful, and to these as well as to others interested in embryological study it may confidently be recommended. F. H. A. MARSHALL.

Oxford and Aristotle.

Aristotle. By Prof. W. D. Ross. Pp. vii + 300. (London: Methuen and Co., Ltd., 1923.) 12*s.* 6*d.* net.

OXFORD has done her part in studying and introducing Aristotle to English readers. The most familiar editions and translations of his works are by Oxford men, and Balliol, in memory of its greatest master, initiated a complete version which is still being issued by the University Press. Mr. Ross, of Oriel, now deputy professor of moral philosophy, has done the greater part of this great work, and it has provided him with the material for the very useful book which we have now before us. He explains its purpose clearly in a short preface; not a criticism or a historical disquisition, but an attempt to present and sum up the philosopher's doctrine in a single manageable volume. It is eminently successful. It would be difficult to name any other thinker for whom the task has been carried out. It is not a little book about Aristotle, but Aristotle himself boiled down, clarified, and arranged in readable and logical shape; an excellent idea to apply to the works of other great men who are too voluminous to be properly digested in the original in our overburdened age.

Kant would be, in our opinion, the next most appropriate subject to whom this method might be applied. Both in him and in Aristotle the core of sound scientific training and thinking is so considerable that in any analysis of the whole, fairly carried out, it would be seen to determine the general bent of the philosopher's mind and to connect his work with the level of scientific achievement in his time. How far this is from being secured in accounts hitherto written of great thinkers may be seen by turning to almost any article or short book on a great philosopher of recent date. They are written by men without scientific knowledge or interest,

and treat of the metaphysical theories of the philosophers, often exclusively, always in complete detachment from their scientific basis. See for a conspicuous example the long article on Kant in the last edition of the "Encyclopædia Britannica."

Mr. Ross is an honourable exception to this practice. He gives a fair space to Aristotle's scientific views and achievements. The chapters on the philosophy of Nature and biology occupy just over 60 out of a total of just under 300 pages. The chapter on biology might with advantage have been rather fuller, and some account given of the varying estimates of the value of Aristotle's work which have been held at various times by quite competent people, arising from the strange contrast of his extraordinary penetration and accuracy in certain observations and his equally striking errors in other, more familiar matters. The error, for example, as to the function of the brain and the set-back to a rational account of animal mechanism which thus arose deserves some prominence, as Prof. Platt has shown in a recent fascinating paper.

However, Mr. Ross is essentially a just man, and his account of the gradual evolution of Aristotle's thought and its relation to that of his master Plato is both true and enlightening. He tells us in the first chapter that the soundest test of the order of Aristotle's writings and the growth of his own thought is the amount of his withdrawal from Plato's influence. This may be traced progressively in his writings. He began by writing dialogues on the Platonic model, but in the latest of these his protest against Plato's separation of the Forms from sensible things is made clear. Then comes a second period in which he publishes his own researches, his works on psychology and biology and his studies of constitutions and other historical matters. Finally, we have the completion and working over of the earlier works. "The general movement was from other-worldliness towards an intense interest in the concrete facts both of nature and of history, and a conviction that the 'form' and meaning of the world is to be found not apart from but embedded in its matter and actual structure."

The general relation of the two great thinkers and the general tendency of scientific thinking could scarcely be better put.

The latter part of the book, dealing with the "Ethics," "Politics" and "Poetics" of Aristotle, the works most familiar to the Oxford man of the past, are very carefully treated by Mr. Ross. His account of the "Ethics" is specially good. He intersperses a shrewd and enlightening account of Aristotle's actual doctrine with just sufficient criticism to put us on the right line of subsequent thought on the subject. Here Aristotle completely reversed the method of Plato. Plato had taken the four cardinal virtues of his day in a general way—wisdom, courage, self-control and justice—and interpreted them so widely that they all overlap, and two—wisdom and justice—seem to be identical with virtue as a whole. Aristotle, starting from the known concrete types of character among cultivated ancient Greeks, described and analysed them individually and narrowly, representing each as the mean between an excess and a defect of the quality embodied. On the subject of this famous mean, Mr. Ross is very good indeed, and very good in indicating the general change which the centuries since Aristotle have effected in widening and spiritualising the moral ideals under which, in the later analysis, these narrow concrete types are subsumed and explained. He always does justice to his great original, but never worships him.

The book is a great service to the popular knowledge of philosophy in England, and we are glad to notice at the same time the announcement of another contribution to the knowledge of the Master due to Mr. Ross, a translation of the "Metaphysics" in two volumes, just about to be issued by the Oxford Press.

F. S. MARVIN.

Physiography of East Antarctica.

British (Terra Nova) Antarctic Expedition, 1910–1913. *The Physiography of the Ross Archipelago.* By F. Debenham. Pp. xiii + 40 + 15 plates. 5*s.* net. *Physiography of the Beardmore Glacier Region.* By C. S. Wright. Pp. vii + 25 + 38 plates. 5*s.* net. *Physiography (Robertson Bay and Terra Nova Bay Regions).* By R. E. Priestley. Pp. x + 87 + 87 plates. 7*s.* 6*d.* net. (London: Published for the Committee of the Captain Scott Antarctic Fund by Harrison and Sons, Ltd., 1923.)

THESE three valuable memoirs on the work of the *Terra Nova* Expedition of 1910–1913 describe in further detail the physiography of especially interesting parts of South Victoria Land. Each part is illustrated by the profusion of excellent photographs and maps characteristic of the *Terra Nova* memoirs. Mr. R. E. Priestley describes the north-eastern corner of South Victoria Land around Robertson Bay and Cape Adare. Mr. Debenham throws fresh light on the Ross Archipelago, now the best-known part of Antarctica. Mr. Wright describes the Beardmore Glacier, the great high road to the Pole discovered by Shackleton. The three memoirs reconsider and discuss some of the earlier conclusions. Mr. Priestley, in his discussion of the physiography of the Robertson Bay region, is disposed to favour for Antarctica the early hypothesis that glaciation was due to uplift. He recognises that this explanation is not applicable to

the best-known glaciated regions, and it is not supported by his own suggestion (p. 57) that the recent uplift of the coast has been due to the removal of the former heavy load of ice. He reduces the estimated thickness of the Drygalski Ice-Tongue and rejects the view that it gouged out the valley from which it flows. Mr. Priestley's monograph illustrates the present tendency to attach greater importance to marine ice than has been usual in recent years. He invokes floating ice to explain the occurrence of the kenyte boulders found 200 miles north from the outcrops of that rock, and says in reference to the deposit that covers the floor of the Ross Sea that it is "in fact the precursor of the boulder clay which will be found everywhere on the Ross Sea bottom if and when it is raised above the level of the sea."

Mr. Wright describes the region around the Beardmore Glacier, of which the geology is mainly known from Dr. Wilson's sketches and notes and from specimens collected at four outcrops. Mr. Wright considers that the Beardmore Valley was due to a fault and that there is no evidence that the valleys of East Antarctica were made by water erosion; the indications are, he thinks, against there having been any strongly marked preglacial drainage system—a conclusion opposed to Prof. G. Taylor's palimpsest theory. He refers to the fact that there are few cwms or corries in that part of Antarctica, which may, however, be due to the persistent severity of the climate and is consistent with the view that those hollows are due to alternate freezing and thawing. The contour on his map at the head of the Beardmore Glacier is misprinted as 3000 feet instead of 9000.

Mr. Debenham's monograph on the Ross Archipelago includes an interesting account of Mount Erebus. It had been thought that this mountain had been greatly altered since Ross saw it in 1841; but Mr. Debenham found no difference since the previous ascent by Sir Edgeworth David. One of the most important modifications he suggests in the interpretation of this area is that instead of the volcanoes, Mounts Erebus and Discovery, being situated along parallel faults, both are connected with a series of radial fissures, the vents along which have formed the parallel-walled peninsulas conspicuous on the maps. The author describes some of the earth movements as still in progress, and he gives a photograph of some slickensides made by one of the still growing faults. Some of the recent lava he represents as poured out over sheets of ice, which by its melting produced subsidence rifts across the flows. Mr. Wright lays less importance on the action of ice in the formation of cwms than some previous authors on this region. The three cwms upon the front of White Island he explains as remnants of volcanic craters. In reference to them he adopts the term caldera in an unusual sense, which is inconsistent with its original use by Lyell. The White Island cwms he regards as "due in the first case to breached or exploded craters, calderas in fact." The explanation of the type caldera by explosion was rejected by Lyell, and his use of the term for hollows formed by infall at volcanic centres has been so widely adopted that it seems undesirable to apply it to explosion craters.

Coal and its Distillation Products.

Coal Tar Distillation and Working up of Tar Products. By Arthur R. Warnes. Third edition. Rewritten and very greatly enlarged. Pp. xv + 511. (London: Ernest Benn, Ltd., 1923.) 45*s.* net.

IN "Coal Tar Distillation" the author has produced a book which will assuredly find a place in the libraries of technologists engaged in the study of the destructive distillation of coal and the working up of by-products. The publishers of this work are serving a most useful purpose in introducing a series of books dealing with the gas and fuel industries, but to keep pace with them entails considerable expense. The third edition of the book under review contains so much additional matter that the two former editions have become of very limited value—a fact which is a little disconcerting when it is realised that a fair proportion of the new matter might have been incorporated in the 1917 edition.

Among the most noteworthy of the new features of the recent edition is the inclusion of a chapter on the classification and constitution of coal. It is, of course, impossible to put to any practical use in coal tar distillation processes the information so presented, and this excellent chapter, gathered as the result of extended reference, leads unfortunately nowhere. It is our lack of knowledge of the interrelation between the products of the destructive distillation of coal and the coal substances from which these originate, and not the author, which is to be blamed. The absence of a bridge connecting Chaps. II. and III. will cause some disappointment, and this will be shared by many who are to-day attempting to gain some insight into the relation between the nature of the coal substance and its distillation products, and perhaps the sooner our students are brought into contact with our lack of knowledge in this direction the better. Although there is a very brave band of investigators engaged upon the subject of coal constitution this generation is still awaiting the advent of the Kekulé of coal chemistry.

It is evident, from the reference (page 196) to the

Interim Report of the Joint Departmental Committee appointed by the Ministries of Transport and Agriculture to investigate the damage to fisheries resulting from rain washings from tarred roads, that the author adopts rather a critical attitude towards the recommendations of this Committee. That any Government Department should produce an interim report giving preference to asphaltic bitumen (an imported product) for the treatment of roads draining directly into fishing waters, without first consulting tar distillers to ascertain their ability to remove the supposed toxic constituents of tar, is a matter which reflects unfavourably on British team practice. It is to be hoped that in their final report the Ministries will either point out the positions in the United Kingdom (if they exist) where the conditions of their experiments may be reproduced, or report that tar distillers have met the objections raised by effecting a preliminary treatment of tar.

With regard to other sections of the book, the author gives insufficient detail of the methods of preparing refined naphthalene and anthracene for use in the manufacture of dye intermediates, as well as upon the subject of removing benzenoid hydrocarbons from gas by means of absorbents, such as activated charcoal and silica gel, etc.

The author is, however, to be congratulated on his treatise, and we should be proud that such a first-class text-book upon coal tar distillation has been produced by a British chemist. In the next edition he should be advised to give more attention to the influence of the method of coal distillation upon the nature of the tar produced, to the effect of a high free carbon content of tar in increasing distillation difficulties, and finally to attempt some correlation of the existing information on the constitution of coal and the tar produced therefrom.

In the preface the author apologises to the publishers and thanks his wife. It is suggested that in view of the considerable ingress into the author's spare time which this compilation must have caused, the apologies might gracefully have been added to the thanks.

Our Bookshelf.

Strength and Structure of Steel and other Metals. By Prof. W. E. Dalby. Pp. xii+176+38 plates. (London: Arnold and Co., 1923.) 18*s.* net.

THE particular object of this book is to describe researches carried out by the author on load strain diagrams of materials, and to relate these to the results obtained from ordinary tests of materials and to use them as indications of the quality of materials.

The ordinary testing machines and instruments used in testing, the author's elegant recorders for specimens in tension and in torsion, and the special hydraulic machine used by him to give easy and rapid control, in which the specimens can be broken in a fraction of a second, are described. The author devotes some attention to the micrographic study of materials, and describes the special apparatus used for obtaining micrographic photographs.

The load strain diagrams as obtained by the author's special apparatus for a number of materials, together with the chemical analyses and micrographic photographs showing the structure of the materials, are given; but the author has not apparently yet been able to relate the particular forms of load strain diagrams to the special structure of the materials. This is disappointing; but if this is ever going to be possible, such researches as are here described will no doubt be of assistance. It is probable, however, that the inner structure of metals can only be satisfactorily analysed by the much more delicate X-ray method.

The phenomenon of slip in metals is briefly discussed. The author suggests that the working stress on a material should be some fraction of the stress at which loops in the load strain diagrams are obtained, and remarks that a working stress of one-third of that at which loops are formed in a particular metal gives a factor of safety of three. This statement is open to very serious objections, as it is very doubtful whether the limit of proportionality in one direction is a safe criterion from which to determine a factor of safety; and, furthermore, the safe range of repetition stress for a material has apparently very little relationship to the stress from which the author defines his factor of safety. The book concludes with a chapter on the strength of screw-threads.

It is doubtful whether the author has quite made out the thesis with which he starts, but the book is one which can be thoroughly recommended to all engineering students for the study of load strain diagrams, and as an elementary introduction to the study of metallography.

Modern Radio Communication: a Manual of Modern Theory and Practice, covering the Syllabus of the City and Guilds Examination and suitable for Candidates for the P.M.G. Certificate. By J. H. Reyner. Pp. xi+208. (London: Sir I. Pitman and Sons, Ltd., 1923.) 5*s.* net.

BY substituting continuous waves for the damped wave trains of the spark transmitter, the author shows that several of the phenomena of radio telegraphy can be explained very simply by vector diagrams. The book is meant for beginners, so whenever a lengthy mathematical proof is required the formula "it can be shown" is used. There are many useful descriptions in the book, but we doubt very much the wisdom of beginning directly with an account of atoms and their component nuclei and electrons. The author spells Kirchhoff's name incorrectly and gives an extraordinary statement about applied E.M.F.'s and back E.M.F.'s as his first law. The definition of charge as an accumulation of electrons due to an applied E.M.F. lacks definiteness. The unit charge is the coulomb, which is 6×10^{18} electrons. "A current of one Ampere is said to flow when the electrons move past a given point at the rate of one coulomb per second." The definition of mutual inductance given does not state why this inductance is called "mutual," while dielectric strength

is apparently measured in volts. If these and several other carelessly worded statements were eliminated the book would be considerably improved.

London on the Thames: a Study of the Natural Conditions that Influenced the Birth and Growth of a Great City. By H. Ormsby. (Studies in Economics and Political Science: Geographical Studies, No. 3.) Pp. xiv+189. (London: Sifton, Praed and Co., Ltd., 1923.) 7*s.* 6*d.* net.

MRS. ORMSBY'S analysis of the geographical conditions which have determined the siting and growth of London virtually ends with Tudor times and does not touch upon the complex problems of modern London. The salient feature of her treatment of the subject, indeed her most valuable contribution to its study, is a skilful use of the indications afforded by the contour lines she has worked out, in conjunction with the system of streams, to interpret such facts as have been handed down from the past or may be observed to-day. Mrs. Ormsby does not agree with the view which holds that London was a pre-Roman settlement. Accepting Mr. Reginald Smith's conclusion that Watling Street originally crossed the Thames at Westminster, she holds that London, except possibly for a few scattered settlers along the river bank, is entirely of post-Roman growth, and originated from the necessity of finding a port for Verulamium, the line of least resistance being the Lea with its broad estuary on the Thames. The purely geographical argument is strong, while, as Mrs. Ormsby points out, the archæological evidence, derived principally from the Moorgate area, is not. The origin of the name, if it could be determined, would probably weigh against a Roman date.

Perfumes and Cosmetics: with Especial Reference to Synthetics. By W. A. Poucher. Pp. xi+462+47 plates. (London: Chapman and Hall, Ltd., 1923.) 21*s.* net.

THE distillation of essential oils and the manufacture of synthetic, odoriferous products are nowadays important branches of the fine chemical industry, and chemists engaged in such work may be interested in finding out from Mr. Poucher's pages how their comparatively crude products are converted into the highly decorated articles which fill the windows of perfumers, hairdressers, and drug stores. They may not be surprised to learn that the odour of "para methyl acetophenone" is similar to that of "para methyl tolyl ketone" (p. 83), but it may strike them as calling for some explanation that "Methyl Para Tolyl Ketone" has "an almondy odour resembling Coumarin, but two or three times as powerful, and also recalling methyl acetophenone" (p. 86). Such curious "facts" as these must have an important bearing on the construction of the psychic perfumes referred to in one of the advertisement pages of this book.

Possessing a copy of this work, it would apparently be possible to make anything from lavender water to blush creams, whatever they may be, and the book will no doubt be most useful to the practical perfumer, for whose benefit it has been compiled. It will also afford much pleasant entertainment to any ordinary human being of a philosophical disposition who may meet with it in his leisure time. T. A. H.

Successful Spraying and How to Achieve it. By P. J. Fryer. Pp. 154. (London: Ernest Benn, Ltd., 1923.) 7*s.* 6*d.* net.

THIS unpretentious little text-book is intended to appeal to the practical fruit-grower. Its author starts from the proposition that the production of fruit is a business operation, and that if it is to succeed it must be run on strictly up-to-date business lines. Insurance against obvious risks is essentially a good commercial proposition. To the grower of fruit there is no sounder insurance policy than adequate spraying against the pests and diseases that prey incessantly upon his produce. The commercial fruit-grower has, however, neither the time nor the opportunity to gain a deep insight into the why and wherefore of the complicated strategy that is being gradually evolved by modern scientific workers who specialise in this field, and their terminology is often beyond him. The author therefore presents in the simplest language most of the things that the grower needs to know to meet with some real prospect of success the enemies that lie in wait for his crops in orchard and garden. Many plant pests and diseases and the methods of coping with them are briefly described. The times of the year when spraying will be effective and when it will not are indicated, and outlines of the conditions, both chemical and physical, that spraying practice must fulfil in order to be successful are given. There are good illustrations.

Everyday Biology. By Prof. J. Arthur Thomson. (People's Library.) Pp. 189. (London and Toronto: Hodder and Stoughton, Ltd., n.d.) 2*s.* 6*d.* net.

PROF. THOMSON'S aim here is to provide "an unconventional introduction to a biological way of thinking." Writing thus for the layman rather than the specialist he very properly keeps constantly in touch with matters of everyday experience, but nevertheless goes deep into scientific concepts, though deliberately avoiding the possible tedium of comprehensive treatment. There is scarcely any important region of biological thought which is not here handled in an attractive and stimulating fashion. Several chapters are concerned with animal physiology under such titles as "The Emergence of Life," "Life in Motion," "Food-getting and Food-using," "Blood," and others; but heredity, habits and environment, individuality, infection and disease, old age, and kindred subjects receive their measure of attention. We heartily recommend the book to the layman who would know something of the content of present-day biology, and are sure no specialist will regret the few hours required for its perusal.

A Course of Experimental Mechanics. By H. J. E. Bailey. Pp. xv+223. (London: Chapman and Hall, Ltd., 1924.) 7*s.* 6*d.* net.

TEACHERS searching for hints in arranging effective experiments in mechanics will find in this book a good deal to interest them. A large part of the volume is taken up with experiments on kinetics, and this section is of special value. Most teachers have experienced the difficulty of illustrating this branch of the subject by experiment, and the methods explained in the book will be of service to both teachers and students.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Isotopes of Mercury and Bismuth and the Satellites of their Spectral Lines.

IN their letter (NATURE, March 29) Messrs. Nagaoka, Sugiura, and Mishima give the wave-lengths of a large number of satellites of Hg 2536 and Bi 4722 measured with wonderful accuracy. I think, however, they have not succeeded in proving that the satellites are connected with the isotopes of mercury and bismuth in the way they indicate. The coincidences of the calculated values of $\delta\lambda$ with the differences of the observed wave-lengths may very well be due to chance. Twenty-three lines, as in the case of mercury, have 253 differences distributed over a space of about 300 units (the unit being 0·001 Ångström). The distribution is somewhat denser for the smaller differences. Hence seven numbers considerably smaller than 300 chosen at random should in any case coincide with seven of the observed differences with an accuracy of about half a unit (the smaller numbers with greater, the greater numbers with less accuracy). It is the same in the case of bismuth, only that here the spacing of the differences is not so close. The allowance for the accuracy of the coincidences has to be somewhat larger.

Take the consecutive letters of the name Nagaoka, and write in a row the numbers giving the position of these letters in the alphabet 13, 1, 7, 1, 14, 10, 1 (*i* and *j* being counted as one letter). Then form 7 numbers by joining three consecutive digits 131, 317, 171, 141, 410, 101 (the number 711 is left out as being larger than all the differences). We find the seven numbers coinciding with the following differences of the satellites of Bi 4722.

$\delta\lambda$ Random.	$\delta\lambda$ Observed.	Lines.
101	102	$b-\mathrm{P}$
114	114	$d'-f'$
131	129 133	$a-b'$ $a'-d'$
141	141	$d-b$
171	174	$b-b'$
317	315 316 317	$d-b'$ $e-a'$ $f-\mathrm{P}$
410	408	$d-d'$ $e-c'$

I can as readily believe in a connexion of Prof. Nagaoka's name with the satellites of Bi 4722 as in the stringency of his proof. C. RUNGE.

The University,
Göttingen.

The Theory of Hearing.

PROF. E. W. SCRIPTURE, in his letter to NATURE of April 26, repeats the criticisms of the resonance theory of hearing put forward by him in his letter to the *Lancet* of November 4, 1922. Prof. Scripture is an authority on phonetics, and his work on the analysis of the speech curves of vowel sounds is of great interest. As to whether he has succeeded in confuting Helmholtz's theory of vowel sounds and establishing the older theory of Willis it is not my province to discuss. I am concerned merely with his deduction that the perception of vowel sounds by the human ear is incompatible with the resonance view of the mechanism of the cochlea.

Now no number of recondite theoretical considerations can outweigh the plain experimental fact that the different vowel sounds are readily reproduced by a series of resonators, even such imperfect resonators as the strings of a piano. The method of demonstrating this was described by Helmholtz for sung vowels, and by Ellis for spoken vowels. "If we suppose the dampers of a pianoforte to be raised, and allow any musical tone to impinge powerfully on its sounding board, we bring a set of strings into sympathetic vibration, namely *all* those strings, and *only* those, which correspond with the simple tones contained in a given musical tone" (Helmholtz's "Sensations of Tone," 2nd English Edition, p. 129).

"Raise the dampers of a pianoforte, so that all the strings can vibrate freely, then sing the vowel *a* in *father* loudly to any note of the piano, directing the voice to the sounding board; the sympathetic resonance of the strings distinctly echoes *a*. On singing *oe* in *toe* the same *oe* is echoed. On singing *a* in *fare* this *a* is re-echoed. For *ee* in *see* the echo is not so good" (*ibid.* p. 61). The experiment with spoken vowels is similar, and is described by Ellis (*ibid.* p. 129, Translator's foot-note), who adds, "The experiment is so easy to make, and so fundamental in character, that it should be witnessed by every student."

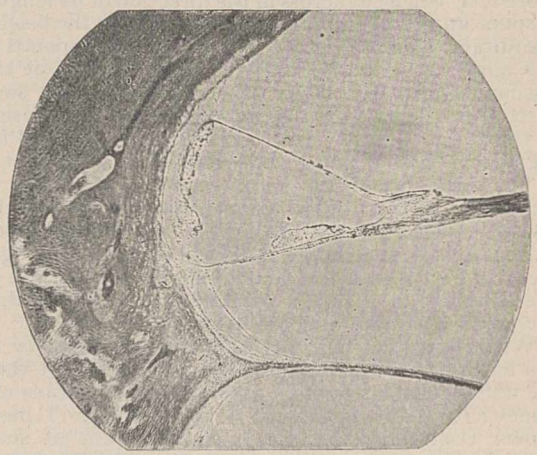

FIG. 1.—Spiral ligament: apical turn of cochlea. ×45.

Prof. Scripture's statement that sounds containing inharmonic partials are incapable of being completely resonated is a new doctrine which cannot be accepted without further proof. If true it would completely dispose of the resonance theory of hearing, as it precludes the possibility of the analysis by resonance of noises, and the cochlea is concerned much more with the analysis of noises than of musical sounds. It is true that a single resonator, such as a single string of a piano, can only completely resonate a compound tone if the fundamental of the string agrees with the fundamental of the tone, and if the partials of the tone all belong to a harmonic series. So far as I am aware, no one but Prof. Scripture has suggested that the same limitation applies to the resonance of sounds by a system of resonators.

I am unable to acquiesce in any of the statements which Prof. Scripture makes regarding the structure

of the cochlea. Apparently these statements are made entirely on his own authority, as they do not seem to be drawn from any of the recognised anatomical sources. The basilar fibres are not broad bands, but fine fibres about 3μ in diameter. They do differ in length, gradually increasing from the basal to the apical end of the cochlea in a proportion of at least 1 : 3. He states that the delicacy of these "bands" precludes the supposition that they are tuned under tension. Obviously, the contention that the basilar fibres are graduated by tension is an essential factor in the resonance theory. The evidence was supplied by Dr. Albert Gray in 1900, who gave the first adequate description of the spiral ligament. It is perhaps as well established as any physiological fact can be which depends for its proof on anatomical or histological evidence merely. The spiral ligament attaches the basilar fibres to the outer wall of the cochlear galleries (Figs. 1, 2, and 3). It is a fibrous structure radiating fanwise from the terminals of the basilar fibres to the outer bony wall of the cochlea. It is graduated in a very striking manner in bulk and density regularly and progressively along its length. Moreover, when cut across in the direction of its length, it splits up radially in the same way as does the basilar membrane, showing that its graduation corresponds to the insertion of individual transverse sectors of the basilar membrane. What other function could such a structure have but that of regulating the tension of the basilar fibres? If we were devising a means for regulating these tensions, how else could it be done?

The resonance theory requires a differentiation of some 4000 to 8000 times between the highest and the lowest tension of the fibres. If we compare the extremely sparse delicate radiating fibrils of the ligament in Fig. 1 with the dense wide-spreading bulk of the ligament in Fig. 3, a variation of tension within such extreme limits appears to be not impossible.

With regard to the contention that the delicacy of the basilar fibres precludes the supposition that they are under tension, we may assume that the fibres are somewhat of the nature of a fine tendon. I have shown elsewhere that the breaking strain of such fibres is at least four times as great as the maximum

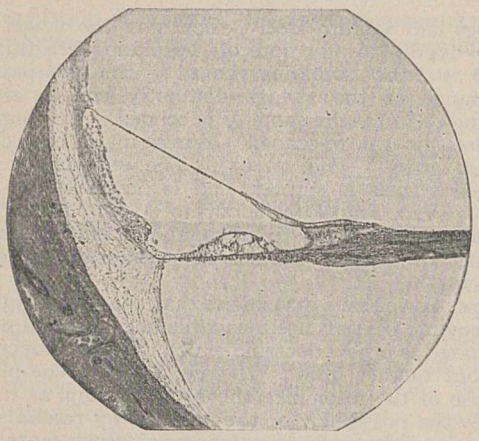

FIG. 2.—Spiral ligament: middle turn of cochlea. ×45.

tension required of the basilar fibres at the basal end of the cochlea, supposing that at this point they are tuned to vibrate to 30,000 d.v. per second, which may be taken as the upper limit of audibility. They are, therefore, well able to support the tension necessary to graduate them as a series of resonators.

We have, therefore, to reckon with the fact that the fibres of the basilar membrane gradually increase in length from the base to the apex of the cochlea, and that it is highly probable that their tension is graduated in a reverse direction, but in the same sense so far as the differentiation of their vibration periods is concerned. They are also loaded by fluid columns gradually increasing in mass from the basal to the apical region of the cochlea. This graduation for mass is in the same sense as the graduation for length and tension. It lies with the opponents of the resonance theory to explain this triple graduation. For myself, I can see no functional significance for it, other than the production of *localised* vibration, at

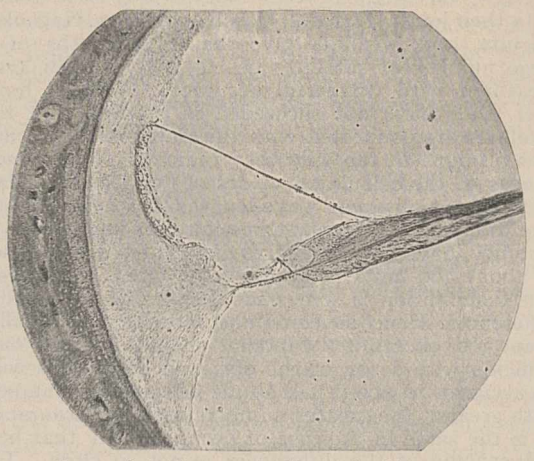

FIG. 3.—Spiral ligament: basal turn of cochlea. ×45.

different levels, corresponding to the *frequency* of the impulses to which it is subjected. The model which I have constructed gives experimental evidence that such localised responses do actually occur in such a membrane.

Prof. Scripture's example of the Savart's wheel which is being speeded up is a good point, but I have dealt with it elsewhere, and I feel that I must not make further demands on your space by going into it again. Dr. Hartridge's pendulum experiment provides an excellent demonstration of what actually occurs in such a case in a series of rather heavily damped resonators, such as one conceives the basilar membrane to be.

GEORGE WILKINSON.

Sheffield.

The Brightness of Lunar Eclipses.

IN *Comptes rendus* of the Paris Academy of Sciences for April 7, pp. 1266-1267, M. A. Danjon replies to criticisms of his theory of the brightness of lunar eclipses as dependent on the solar sunspot cycle, which were abstracted from E. W. Maunder (Jour. Brit. Astr. Assoc., 31, pp. 346-350, 1921) in my recent paper, "The Brightness of Lunar Eclipses, 1860–1922" (Smithson. Misc. Coll., No. 2751; Harvard Reprint, No. 7), and were confirmed within its limitations by the results set forth in my paper.

M. Danjon's reply to Mr. Maunder is not for me to deal with. As to my own paper, he very properly raises questions, (1) as to the coarseness of my scale of brightness, only three steps, and the consequent ignoring of transition phases which are naturally not ignored by his own five-step scale; (2) as to the validity of my criterion of brightness, which is the minimum telescopic aperture required to bring out details on the eclipsed surface. The steps in the scale of brightness are as follows: 0, apertures necessary of 6 inches or more; 1, apertures necessary of 2 inches up to 6; 2, details visible to the naked eye or with hand instruments. M. Danjon denies that the criterion has any validity at all; because it depends too narrowly on the conditions of observation, has no sense unless

the power employed is also stated, and, finally, lunar surface details are visible in the umbra with small apertures when they are invisible with larger. In evidence he adduces an observation of the eclipse of February 20, 1924, when the Mare Crisium was visible in the 40 mm. finder, with low power (not stated), but was invisible in the 486 mm. Strasbourg refractor, (power not stated).

The devising of my criterion was suggested by the data on lunar eclipses; it was not reasoned out *a priori*. In working through these data, consisting of reports published by observers of all grades of experience and interest, who used all sorts of telescopes, under all sorts of conditions, in places from Copenhagen to Cape Adare, it became evident that the subjective element must somehow be eliminated so far as possible. Statements were found depending on the recollections of long experience or on no experience at all, estimates of colour shades and brightness were numerous and various, and it was plain that something approaching a *photometric* criterion must be found, or no order could be educed from an otherwise chaotic mass. It was noted that in many cases observers said they were able to see with larger apertures lunar details in the shadow invisible with smaller; this hint was followed out in the adoption of the scale described.

Of course, we are able in a dim light to see large objects more easily than small, read coarse print more readily than fine; and when we try to see a distant object in twilight we make it look bigger—*not brighter*—with a night glass. In the case of the eclipsed moon, sometimes the seas and the rays of Tycho are so clear that people think there is no eclipse; again, the naked eye cannot make them out, but an opera-glass helps, or a still stronger and bigger telescope must be used to bring them out, making them look bigger—not brighter.

For each aperture there is, too, an optimum power, found by dividing the aperture of the telescope objective by the diameter of the pupil of the eye. For a 6-inch objective, this optimum power is 30, if the pupil measures 1/5 inch; 60, if the pupil measures 1/10 inch, etc. In observing lunar eclipses, what is the diameter of the pupil? If we know that, we can compute the optimum power from the aperture, and then we can compare the power actually used (if we know it) with the optimum power, and judge of the conditions.

On account of pupillary accommodation, the optimum power must depend on the brightness of the surface observed, and change with it. To assign an arbitrary diameter to the pupil and judge by that is, after all, using an arbitrary standard. But the powers used by observers were not ignored, until it turned out that so many observers failed to say anything about powers that a great amount of data must be discarded, or that phase of the criterion must be abandoned. The decision was made, rather tacitly, to assume that an observer used either the only eyepiece he had, or the one which gave him the best results, and to base the scale of brightness on the aperture alone. This, of course, rendered fine grading out of the question, and three steps only were retained.

Even so, many reports had to be ignored for lack of statements about even the aperture. Observers simply saw things "in the telescope"; sometimes one cannot guess whether they saw them "in the telescope" or with the naked eye. I have in mind a report by an observer formerly very famous; several readings have failed to satisfy me whether he was looking through 13 inches aperture or just through the open shutter.

The adoption of this simplified criterion and three-step scale did not remove all the discrepancies and peculiarities, to which M. Danjon's observation of the eclipse of February 20, 1924, adds one. At Strasbourg, when the moon left the shadow its zenith distance was about 81°, the relative air-mass along the ray was about 6, and the sun's zenith distance was about 101°. Hence his observation was made with the moon still lower, in twilight and in its own glare near the horizon. How this affects the visibility of shadowed details with various apertures and powers, I do not know. His omission of the power used prevents an estimate of his approach to optimum conditions. Being an experienced observer, he probably satisfied himself.

Of course, the scale of M. Danjon and my own are intended to express for each eclipse its general character, ignoring the alterations in brightness, colour, etc., which make every eclipse an individual.

WILLARD J. FISHER.

Cambridge, Mass.,
May 2.

On the Spectra and Temperatures of the B Stars.

THE application of the theory of ionisation to stellar spectra by Saha and others has led to estimates of the temperature of the reversing layers of stars. It is shown by Fowler and Milne (Mon. Not. R.A.S., 83, 7, 415) that the effective temperature at a given point in the stellar sequence may be deduced, on certain assumptions, from the knowledge that a line of known series relations there reaches its maximum intensity. For stars of type earlier than Ao the lines available for such estimates are those associated with Si^{+++}, He, and C^{+}. The intensities of these lines have recently been measured on a number of objective prism spectra at the Harvard College Observatory.

The maximum for Si^{+++} occurs at Oe5; a discussion of the silicon intensities has recently been given in Harvard Circular No. 252. Helium and ionised carbon reach their maximum strength at B3. On the basis of the known series constants for the helium arc lines, and of the relations recently published for C^{+} by A. Fowler (Proc. Roy. Soc. A, 105, 299, 1924), a temperature of about 16,000° is derived for stars of spectral class B3. This is not incompatible with the temperature scale derived from the provisional discussion of the silicon maxima for the hotter B stars.

The accompanying diagram (Fig. 1) gives the change of intensity with spectral type shown by the helium lines of the diffuse singlet series. The lines of the diffuse doublet series have the same maximum, and behave in the same way. All the stars measured are included in obtaining the mean intensities for the different types, with the exception of ϵ Orionis. This star invariably gave discordant measures, probably owing to the width and haziness of its lines.

The change of intensity of the helium lines with spectral type seems to be well marked, and this is to be anticipated, as the intensity of these lines was used as a criterion of type for the purely empirical classification given in the Henry Draper Catalogue. In a recent investigation (Edwards, "Spectroscopic Parallaxes of the Hotter Stars," Mon. Not. R.A.S., 81, 47; Edwards, "The Distances of the B Stars," *Observatory*, 47, 596, 19) the difference between the intensity of the lines belonging to the $1P - mD$ series of helium and the hydrogen lines at 4101, 4340, has been used for the determination of spectroscopic parallaxes. The method, as used, appears to be questionable.

The hydrogen lines increase slowly in intensity from Bo to Ao. Thus, if we assume the strength of a line to depend on spectral type alone, the difference in intensity between a helium and a hydrogen line will increase from about Bo onwards towards Ao. The reduction curves which Edwards uses connect high absolute magnitude with a small value

of this intensity difference. Accordingly the use of his reduction curves would lead to a decrease in the measured absolute magnitude with advancing type, an effect actually shown by the B stars.

The spectral types of the stars used at the Norman Lockyer Observatory were determined from the intensity of the $1\pi - m\delta$ lines of helium. The $1P - mD$ lines, which were used for estimating the absolute magnitudes of the stars between Bo and B8, treated

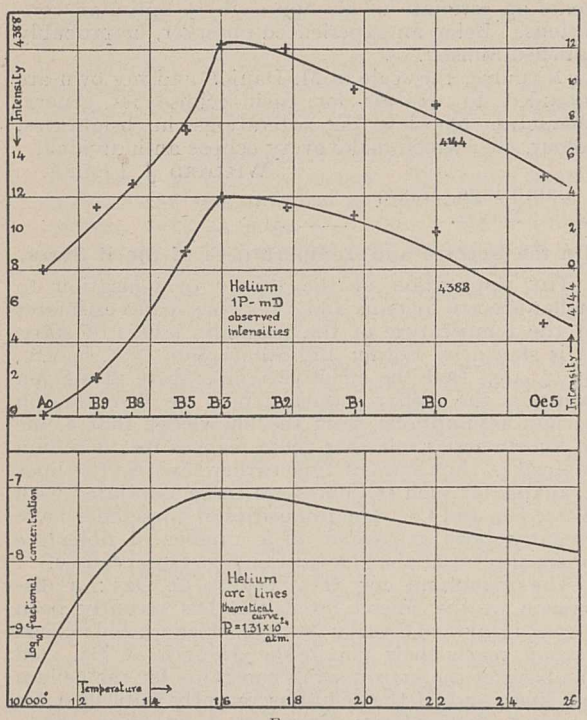

FIG. 1.

as a single group, show intensity changes identical with those of the $1\pi - m\delta$ lines. It therefore appears that measures made on these lines give the spectral type, and that the general decrease of absolute magnitude with advancing type, as shown by Edwards's measures, is the result of the well-known statistical correlation of type and luminosity in the B stars.

The parallaxes used by Edwards in forming the reduction curves do not appear, in all cases, to have the best values usually adopted for the stars in question. For stars belonging to the Pleiades, for example, $\pi = 0{\cdot}009'' \pm 0{\cdot}002''$, a value considerably smaller than the various parallaxes which Edwards assigns to individual stars belonging to this group. Such uncertainties, and the fact that the helium lines give only a measure of type, tend to cast doubt on the value of this method for the determination of luminosities within a given spectral class.

CECILIA H. PAYNE.

Harvard College Observatory,
Cambridge, Massachusetts,
April 9.

Physics and Relativity.

THE preoccupation of philosophers with relativity, to the exclusion of all other branches of science, is very puzzling to a physicist; but most puzzling of all is their continual assertion that relativity has had a profound influence on physics. May I place on record certain facts, well known to all physicists, which appear to me to dispose of this delusion.

"Science Abstracts" A (Physics) for 1923 contains 2542 abstracts. Of these 43 are indexed under "Relativity," but 30 more should have been so indexed. Of these 73, 51 deal with relativity and nothing else; they would be wholly meaningless to one who rejected its conceptions. Thus there are left 22 papers, or 1 per cent. of the total, in which the effect of relativity on the rest of physics may be manifested. The remaining 99 per cent. are exactly what they would be if relativity had never been heard of.

The 22 papers include all those on the experimental evidence for relativity, but they do not include all those which involve facts explained by relativity. Thus, papers on the scattering of charged rays and on the "relativity doublet" are not really concerned with relativity. They are concerned with the fact that the mass of a charged body varies with its velocity, but not with the explanation of that fact. The fact was actually known before any theory of relativity was propounded, and would of course remain a fact if relativity were abandoned.

If it is urged that these 22 papers are peculiarly important, I can only offer a denial. I had not noticed many of them until I looked them up in "Science Abstracts," and I am sure there are very many papers on other branches much more widely read.

Perhaps an even more convincing fact can be cited. Many writers on relativity confine their attention to that subject. But there are two outstanding exceptions. Both Prof. Einstein and Prof. Eddington, during the period of their work on relativity, have published other work of the highest value, lying on the main track of physics (or astrophysics) and forming the starting-points of researches well known and interesting to all students. But this work is wholly independent of relativity; there is nothing in it that might not have been published by an opponent of that doctrine.

The gulf between relativity and physics will probably be bridged in the future, possibly by a wide extension of relativist conceptions. But prophecies of the course that scientific inquiry will take are seldom fulfilled; and philosophers might do well to consider whether it is worth while to discuss at such length the consequences of a development which has not yet occurred.

NORMAN R. CAMPBELL.

Sunshine and Health in Different Lands.

THE statement, that from the health point of view we cannot have too much sunshine, is very commonly made, but I agree with Mr. Bonacina that it should not be accepted as axiomatic without investigation. It seems to me to rest on a very slender foundation and to be opposed to many well-known statistical facts.

In European countries the death-rate is highest in the south and lowest in the north, the British Isles and the Scandinavian countries being especially favoured. Though the time of possible sunshine is nearly the same in both parts, the intensity is far greater in the south.

I happen to have by me records of the summer sunshine in England and the death-rate of the summer quarter during the period 1881 to 1912, and they show the following facts. The summers of 1888, 1894, 1910, 1912 were the four most sunless summers of the group, and all four had an exceptionally low death-rate. The sunniest summers were 1887, 1899, and 1911. The summer of 1887 had a death-rate slightly above the average, 1899 had the highest death-rate in the group, and 1911 the third highest (the death-rates have all been corrected to allow for the secular decrease).

These statistics do not support the supposition we are discussing, but very much the reverse. The fact that ultra-violet rays are beneficial in certain diseases does not, in my opinion, prove that an excess of

sunlight is of general benefit. Certain poisons and X-rays are used as curative agents, but both would do great harm if applied indiscriminately.

It is scarcely credible that sunlight alone should be prejudicial to health; the explanation probably is, that sunshine is usually associated with heat, and it is the heat that is deleterious. This is borne out by the treatment of the question by the statistical method of partial correlation, some particulars of which will be found in the Quart. Jour. Roy. Met. Soc. for October 1919, vol. 45, No. 192. W. H. DINES.

Benson, May 12.

The Band Spectra of the Oxide and Nitride of Boron.

WITH further reference to the origin of the band spectrum which is developed when BCl_3 vapour is admitted into active nitrogen, I have now made one of the tests mentioned in my previous letter (NATURE, May 24, p. 744), namely, the observation of the uncondensed discharge through a mixture of oxygen and BCl_3 vapour, flowing continuously through the discharge tube. Previous observations of similar discharges with mixtures of oxygen and CCl_4, $SiCl_4$, and $TiCl_4$ respectively, have shown that the conditions are particularly favourable to the development of band-spectra of the oxides, and it was expected, therefore, that in the present case the discharge spectrum would be characterised by the bands of boron oxide.

The expectation has been fully realised. The well-known boron oxide spectrum in the visible region is even better developed in the discharge than in the sources in which it is ordinarily observed. While in the boric acid arc in air, for example, the oxide spectrum appears as a headless alternation of maxima and minima of intensity, the discharge develops the heads well enough for measurement with the view of studying their distribution in the oxide system.

The band spectrum of which the origin is in question, however, is definitely absent. This fact is irreconcilable with Dr. Mulliken's conclusion that the spectrum is due to boron monoxide—a conclusion which could be sustained only if the spectrum were strongly developed in the discharge. The original view that the spectrum (which has been observed only in sources in which both boron and nitrogen are present) is to be attributed to a nitride is, on the other hand, in accord with the present result.

W. JEVONS.

Artillery College, Woolwich.

The Spectrum of Helium in the Extreme Ultra-violet.

THE investigation of the spectrum of helium in the extreme ultra-violet, on which I have been long engaged, and which had pretty nearly come to a standstill for want of an untarnished diffraction grating, has recently been set in motion again by the energy and kindness of Prof. R. W. Wood, who has furnished me with several instruments from the engine at Johns Hopkins University. As a result I am able to make some additions to the facts already announced.

In the first place, several new terms have been added to the $oS - mP$ series, the first member of which lies at λ584·4, making seven lines in all. Moreover, a continuous spectrum extending from the limit of this series toward the extreme ultra-violet has been observed; the phenomenon was obtained with a disruptive discharge and its reality is subject to all the uncertainties which accompany this form of excitation. However, as this type of spectrum is of some theoretical interest its appearance is worthy of note.

Secondly, I have found two members of the first, and probably the most important, enhanced series, $4N\left(\frac{1}{1^2} - \frac{1}{m^2}\right)$; they occur, as they should, at λ303·6 and λ256·3.

Lastly, there is a new line at λ591·5 which fits the relation $oS - 1\pi$, interesting because it furnishes the first experimental evidence for radiation from helium involving a so-called inter-system combination—that is to say, a jump from a doublet energy level to the fundamental singlet level.

These results have all been checked with two or more gratings. THEODORE LYMAN.

Jefferson Laboratory, Harvard University, April 18.

Styrax and its Refractive Index.

IN the issue of NATURE for February 2, Mr. A. Mallock requests information on styrax. I am able to supply the following information:

The styrax best suited for the mounting of diatoms is obtained from the Oriental sweet gum tree (*Liquidambar orientalis*). This tree is native to the south-western portion of Asia Minor. The balsam is a pathological secretion from the wood and inner bark. After the tree has been injured and the secretion has collected on the injured surface, the inner bark is removed and boiled in sea water—the balsam being skimmed from the surface.

Nearly all the samples of commercial styrax are adulterated. One should choose a sample that is light greyish-brown in colour with an aromatic odour similar to benzoin. The styrax after being prepared for microscopic mounting should be tested to see that the refractive index is close to 1·58. As Oriental styrax has been difficult to secure since the War, American styrax (*Liquidambar Styraciflua*) has been suggested as a substitute, due to its very similar composition. I have not, however, used it for microscopic mounting.

I have devised a new method for the preparation of styrax and balsam of Tolu for use as microscopic mounting media of high refractive index. This method will be published in the May number of the Journal of the American Pharmaceutical Association, and I shall be glad to send Mr. Mallock a copy of this article after its publication.

GEORGE H. NEEDHAM.

College of Pharmacy, University of Washington, Seattle, U.S.A., April 15.

Induced Asymmetry of Unsaturated Radicals in Optically Active Compounds.

IN their interesting letter in NATURE of April 19, Prof. T. M. Lowry and Dr. E. E. Walker made no reference to the work of Erlenmeyer upon induced optical activity in cinnamic acid (various papers in the *Biochemische Zeitschrift* during the last fifteen years). Erlenmeyer's results, if substantiated, would be of fundamental importance, and in view of the desirability of further investigation, I have been engaged for some time, in collaboration with Dr. S. I. Levy, in a repetition of those experiments in which Erlenmeyer claims to have obtained optically active cinnamic acid by the fusion of the acid itself, its anhydride and chloride, with *d*-tartaric acid. We hope to communicate the results of our investigation to the Chemical Society during the present year.

E. J. HOLMYARD.

Clifton College, Bristol, April 22.

The Relation between the Masses and Luminosities of the Stars.

By Prof. A. S. EDDINGTON, F.R.S.

A THEORY of the physical conditions in the interior of a star should, if sufficiently complete, lead to formulæ determining the total radiation emitted, and hence the absolute brightness. In the simplest case—that of a star in the condition of a perfect gas—considerable progress appears to have been made towards the solution of this problem. It appears that in the main the total radiation is a function of the mass. Stars of equal mass but different density, and consequently different spectral type or effective temperature, will show minor differences of brightness which will be ignored in the present brief account of the results; they have, however, been duly allowed for in the comparisons of theory and observation referred to below and illustrated in the diagram. With this understanding we shall regard the absolute brightness as a function of the mass only—always provided that the star is not too dense to be treated as a perfect gas.

The theory divides itself into two parts, (1) the determination of the internal temperature-distribution leading to a knowledge of the temperature-gradient which causes the outward flow of radiation through the star, and (2) the determination of the coefficient of absorption or opacity obstructing this outward flow. The first part now presents no serious difficulty; the solution follows the classical researches of Lane, Ritter, Emden, and others, modified by introducing radiative instead of convective equilibrium and taking account of radiation-pressure. It is necessary to know the average molecular weight of the material; owing to ionisation this is *smaller* than the atomic weight, because each atom is split up into a number of independently moving particles (nucleus and electrons). By actual calculation we find that in all ordinary stars the molecular weight is nearly 2—a result practically independent of the chemical composition of the material. The second part of the theory leads us to one of the most fundamental problems of modern atomic physics, the absorption of X-rays by matter, and the capture of electrons by ionised atoms—in fact, the general problem of interaction of radiation and material systems. Although the theory of these processes is as yet scarcely definitive, very general considerations lead to the result that the coefficient of absorption k will be proportional to $\rho/T^{\frac{7}{2}}$, subject perhaps to a small correcting term which may be ignored in a first approximation. The important theory recently published by H. A. Kramers (*Phil. Mag.*, November 1923) agrees with this law.

The result of the theoretical discussion is that we obtain for the absolute magnitude m of the star a formula of the form

$$m = f(\mathrm{M}) + \text{constant},$$

where $f(\mathrm{M})$ is a definite function of the mass M which can be tabulated, and all the doubtful constants and theoretical uncertainties are segregated in the value of the additive constant. The predicted value of this constant is certainly of the right order of magnitude as compared with astronomical observation, but we cannot at present see the way clear to reach satisfactorily the exact value. We shall shelve this difficulty by determining the value of the constant from the astronomical observations of Capella, for which accurate values of m and M are known. The results for all other stars will then depend differentially on Capella. The theoretical curve connecting absolute magnitude and logarithm of mass is shown in the diagram (Fig. 1). All the observed data that could be collected are inserted for comparison with it. The circles and crosses correspond to direct determinations, the circles being the more accurate. The determinations from eclipsing variables, represented by triangles, are less direct but involve only obvious theoretical inferences; owing to practical difficulties they are not in all cases quite satisfactory. The squares depend on a definite theory of the mechanism of Cepheid variation which would perhaps not commend itself to every one, and the value of their evidence may be a matter of controversy.

The curve shown is a first approximation and involves only two disposable constants, (1) the additive constant deduced from Capella, and (2) the molecular weight here taken to be 2·1 for the reasons already stated. Certain refinements leading to a second approximation would leave the greater part of the curve unaltered, but would raise it about 1½ magnitudes at the extreme left of the diagram, giving a slightly better accordance with observation. Taking the first approximation as it stands, the average discordance is $\pm 0^{m}\cdot 56$, the greater part of which may well be attributable to observational errors. The only stars rejected are two "white dwarfs" which are clearly in a state quite outside the conditions postulated in the theory.

The remarkable thing is that although the theoretical curve corresponds to stars in the condition of (*i.e.* having the compressibility of) a perfect gas, all ordinary stars agree with it very closely. All the stars in the left half of the diagram are dwarf stars with a mean density comparable with water. Consider, for example, the sun—represented by the circle on the vertical line through 0·0 in the diagram. According to the current giant and dwarf theory, a star of mass 1 and effective temperature 5800° has two possible luminosities, (1) that of the sun in its present condition, (2) that of the sun at an earlier epoch when it passed through the same temperature on the upgrade as a much more diffuse star. It has generally been supposed that there would be about 4 magnitudes difference between these two stages corresponding to the change of surface-area. The theory is intended to predict No. 2, but actually predicts No. 1.

In making the comparisons for these dense stars the writer had no anticipation that they would agree with the curve; his object was rather to obtain exact data as to the diminution of brightness attributable to the reduced compressibility to be expected in gas at high density, and he felt the temporary disappointment which naturally arises from a negative result. If we are to accept these results at their face value it would appear that these stars have the luminosity predicted for a perfect gas because their material actually has

the compressibility of a perfect gas—notwithstanding that some of them have mean densities as great as that of platinum.

Such a conclusion may perhaps appear incredible, and point to some false step in the rather intricate theoretical investigation. But I think, on the other hand, that we have only been led in a very round-about way to a conclusion which is almost obvious from modern physical theory, though it does not seem to have occurred to any one. An ordinary gas becomes comparatively incompressible at high density because of the finite volume occupied by its atoms or molecules; these behave like rigid spheres with radii of the order 10^{-8} cm., and a limit to the possible compression is reached when the spheres become tightly packed. terrestrial conditions; the ions, or broken atoms, can be packed much more tightly. For a complete discussion it is necessary to calculate the effect of the strong electrostatic forces acting between the charged ions and electrons in the star; it appears, however, that these forces will not have an appreciable effect in any of the stars under consideration.

Our results, therefore, may well be acceptable to physicists; they are less welcome to astronomers on account of their conflict with the giant and dwarf theory of evolution. As already mentioned, the latter theory requires that absolute magnitude should be a double-valued function of mass; the observational evidence summarised in the diagram (considered without regard to the theoretical curve) strongly

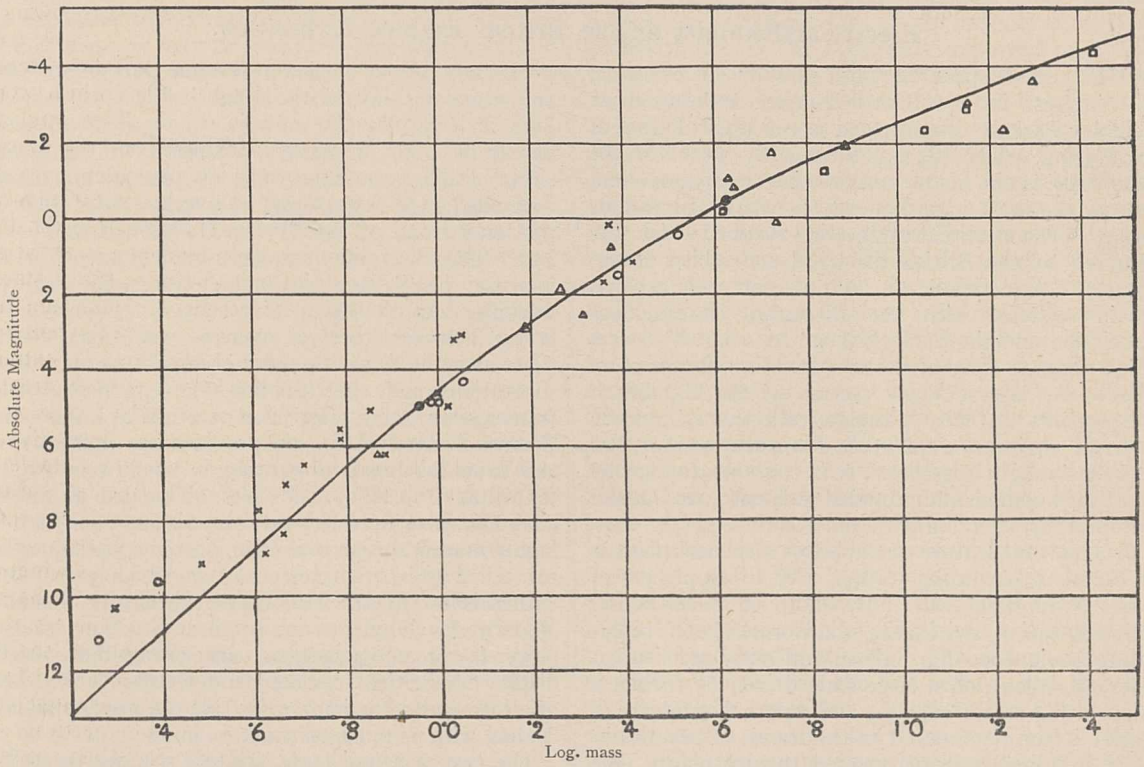

FIG. 1.—Curve showing the relation between absolute magnitude and the logarithm of the mass. o, first class; x, second class; □, Cepheids; △, eclipsing variables.

But at the high temperature within a star these spheres are completely destroyed, and this limit to the compression disappears. The stellar atom is highly ionised, and the peripheral electrons which determine its effective size have been detached. For elements of moderate atomic weight (*e.g.* iron) only the two K electrons remain, and the lighter elements (*e.g.* oxygen) are ionised down to the bare nucleus. If the effective size of the atom is still determined by the orbits of the outermost electrons remaining, the stellar atom cannot have more than 1/100,000th of the bulk of the atom in terrestrial conditions. Consequently, we should expect deviations from the laws of a perfect gas to begin at densities about 100,000 times higher. At any rate our preconceived idea that stellar material of the density of platinum cannot be compressed like a perfect gas, seems to rest on an entirely false analogy between stellar ions and the atoms met with in suggests a single-valued function, as has also been indicated by recent investigations of Hertzsprung and of Russell, Adams, and Joy. Although data as to masses of stars are scanty, it is unlikely that a second branch would have been unrepresented if it existed. There is thus a strong case for a fundamental modification of the giant and dwarf theory of evolution. On the other hand, important advances in our general knowledge of the stars are associated with the giant and dwarf theory, and it has been fertile in conclusions clearly confirmed by observation. The astronomer will no doubt wish to convince himself that these undoubted advances can be retained in the reconstructed theory of evolution before committing himself to acceptance of the result here reached.

If stellar material can still be a perfect gas when compressed to the density of platinum, the maximum density must be a great deal higher. There might

thus exist stars far more dense than any material yet known to us. This may be the key to a puzzle presented by the companion of Sirius and a few other stars known as "white dwarfs"; the newly discovered companion of Mira Ceti is (according to preliminary accounts) another example. The faint companion of Sirius is classed as of spectral type F; if this means that it has the surface-brightness ordinarily associated with type F, its radius is about 20,000 kilometres—which seems absurdly small for a star. Its mass is well-determined and is about $\frac{4}{5}$ that of the sun. The resulting mean density is 50,000 gm. per c.c. This conclusion has probably been regarded hitherto as a *reductio ad absurdum*, showing that the star must manage in a mysterious way to produce the F type of spectrum without the intensity of radiation ordinarily required for it. But the deduced density cannot now be considered impossible, and the companion of Sirius may be an actual example of the high density attainable by matter when ionised by the enormous temperature in a star. Fortunately it will be possible to test whether this is so by determining the Einstein shift of the spectral lines, which would be large enough to be measured if the high density is correct. If the result of the test should prove favourable and establish the existence of matter having density of the order 50,000, we shall have fewer qualms in accepting perfect gases of the density of platinum.

Electrical Exhibits at the British Empire Exhibition.

THE greater part of the exhibits of electrical interest in the British Empire Exhibition at Wembley Park is concentrated in the great Palace of Engineering, which, during these early weeks of the Exhibition, is one of the most complete portions—and perhaps the most imposing—of the whole stupendous display. The electrical engineering section, which was organised by the British Electrical and Allied Manufacturers' Association, in conjunction, as regards certain sections, with the Electrical Development Association and the Cable Makers' Association, covers no less than 4½ acres of the vast building, forming, we believe, the largest single section of the Exhibition and probably the most complete collection of modern electrical engineering plant and apparatus that has yet been brought together. It is concentrated in one end of the building, and provided with entrances named appropriately after Faraday and Kelvin.

An important feature of the heavy electrical plant is the complete generating station, used to supply power to the Exhibition, with fully equipped boiler-house, turbo-generators, switchgear, transformers, etc., representing some 6000 h.p., all in full view of visitors. Generating plant, on a large scale driven by turbines, reciprocating steam engines, and internal combustion engines, is also represented on the stands of practically all the well-known British makers of such plant. We do not propose to refer here to more than two or three examples of the exhibits of those firms the names of which are household words to every electrical engineer, including, besides those mentioned below, such firms as the English Electric Co., Ltd., the Metropolitan-Vickers Electrical Co., Ltd., the General Electric Co., Ltd., the Brush Electrical Engineering Co., Ltd., Crompton and Co., Ltd., Bruce Peebles and Co., Ltd., Mather and Platt, Ltd., the British Electric Transformer Co., Ltd., Electromotors, Ltd., and many others.

From the steam side, one of the most interesting of these exhibits is the 12,000 kw. turbo-generator of the latest type of C. A. Parsons and Co., Ltd., marking the culmination of many years of development in generating plant. From the point of view of hydro-electric power development, an outstanding exhibit is a 30,000 h.p. twin impulse turbine to run at 375 r.p.m. under a head of 1630 ft., with the Seewar patent governing device shown in action by means of a separate, electrically driven oil-pump, forming part of the comprehensive display of the English Electric Co., Ltd. Five such turbines are now in course of manufacture for India. An interesting exhibit on the purely electrical side is the display of a complete, automatically controlled, 500 kw. rotary converter substation on the large stand of the British Thomson-Houston Co., Ltd. This exemplifies a modern tendency much on the increase, particularly in high-tension D.C. railway working. Another sign of recent developments, relating, however, more to overseas conditions than to those at home, is the presence of apparatus for outdoor substations and switch-points of very high tension transmission lines. Here it is interesting to note that Electric Control, Ltd., has provided an alternative to the usual oil-break apparatus in air-break switches for voltages up to 130,000 volts. This firm also shows air-break fuses for overhead open-air positions for such high voltages, and an interesting fuse, enclosed in a glass tube filled with carbon tetrachloride, which immediately extinguishes the arc without the glass tube breaking. Modern developments in another direction, that of power-factor compensation, are exemplified in the display by British Insulated and Helsby Cables, Ltd., of electrostatic condensers for this purpose, capable of dealing with as much as 300 kva. in one unit.

The two principal large exhibits relating to electric traction are a train exhibited by the Metropolitan Railway in the Palace of Engineering and the electric locomotive attached to the South African train in another part of the grounds. Electric working in collieries, including a complete winding plant, will be found in operation in the model coal mine. These features we have not space to describe here.

Switchgear and motor control gear are exhibited by firms too numerous to particularise. Perhaps the finest display of this kind is that of iron-clad switchgear by Reyrolle and Co. Turning from large to small apparatus, a very convenient type of commutating rectifier may be mentioned on the stand of the Lancashire Dynamo and Motor Co., Ltd., associated with the Crypto Electrical Co., Ltd. This is for charging small accumulators, running cinema arc lamps, or other D.C. apparatus from A.C. circuits, and comprises, all in one compact little machine, a transformer and a synchronous motor, with an external commutator provided with suitable brush gear and arranged with a self-starting

device needing only the closing of a single switch. The cable industry is represented by a fine combined exhibit organised by the Cable Makers' Association, and it is interesting to see on the stand of Callendar's Cable and Construction Co., Ltd., cables and accessories for pressures up to 66,000 volts. Domestic applications of electricity are demonstrated by a well-arranged combined exhibit under the auspices of the Electrical Development Association.

Practically all the well-known incandescent lamp makers are represented, and a glance at their exhibits shows how the gas-filled tungsten lamp is supplanting all other forms of electric lighting except for special purposes. Particular attention should be directed in this connexion to the lamps in special bluish glass bulbs giving, by selective absorption, the nearest possible approximation to daylight for colour-matching, picture-lighting, etc. It may be remarked here that these are used with quite remarkable results in the artificially lighted tanks, etc., in the new aquarium of the Zoological Society. Among lamps for special purposes, a complete range of "Pointolite" lamps, in which a minute but brilliant arc is produced between tungsten electrodes in a glass bulb, is shown on the stand of the Edison and Swan Electric Co., Ltd. These lamps, which are specially valuable for small projector and other focus work, now range from 30 to 1000 c.p.

Measuring instruments, both of the switchboard and portable types, are shown by such well-known firms as Evershed and Vignoles, Ltd., Elliot Brothers, Ltd., and Everett Edgecumbe and Co., Ltd. Special features of the stand of the last mentioned are the display of synchronising apparatus and portable photometers. Another instrument display of interest is that of the Cambridge Instrument Co., Ltd. Here is shown a new pattern of metal cased recorder for carbon dioxide and temperature records, with which several records can be made on one drum, and a recent pattern of carbon monoxide recorder, in which the carbon dioxide in the gases to be tested is first removed by an electrically heated catalyst. Another new instrument is a substantially constructed distance thermometer with multiple contact switch, whereby temperature readings can be taken on the same instrument from as many as 72 distant points. The firm also shows the electrically worked Thomson gas-meter, particularly suited to large capacities, which measures the gas flowing through the meter by warming it with an electric heater by a fixed amount adjusted by the balance between entrance and exit thermometer resistances, forming arms of a Wheatstone's bridge, and measuring the amount of energy required. Mains testing sets of a very complete form are also shown. Another stand, largely devoted to electrical temperature measurement, is that of the Foster Instrument Co. Direct reading thermo-couple and resistance thermometers are included together with an interesting pattern of optical pyrometer, in which the filament of a lamp is viewed in the field of a telescope directed to the hot body and the current through it adjusted until the filament is invisible. This filament forms one arm of a Wheatstone's bridge, and the variation of its resistance controls the current in a milliammeter in the galvanometer circuit attached to the instrument, which is graduated so that temperature can be read directly. A radiation pyrometer, in which the rays from the hot body are focussed on to a thermo-couple, is also shown.

A considerable section, involving some striking exhibits, is devoted to telegraphy and telephony. The methods of ordinary land telegraphy can be studied in the special display by the British Post Office in the fine building housing all the official exhibits of the British Government. Here is exemplified high-speed Wheatstone automatic working, land line repeater stations, Baudot multiplex printing telegraph apparatus, and many other standard systems in everyday use. A variety of telegraph instruments can also be seen on the stand of Elliot Brothers, Ltd., in the Palace of Engineering.

In the field of cable telegraphy one of the most interesting and complete displays is that of the Eastern Associated Telegraph Cos. This includes a working demonstration of the apparatus employed on a long cable route with one intermediate station. Starting from the transmitting end we have the latest pattern of keyboard perforator, the paper strip from which, punched in the ordinary code, is passed to a new pattern of motor-driven transmitter with a magnetic tongue arrangement, causing the moving contact to remain over on whichever side it has been moved by the mechanical action controlled by the peckers, until the next movement. At the intermediate station the feeble signal currents received from the cable are first dealt with by a jockey relay of the moving coil type, automatically corrected for stray earth currents by an arrangement analogous to a shifting zero, in which the "fixed" contacts are caused to drift or change their position according to the earth currents. In this instrument, owing to the sluggishness of the cable, the "dots" are practically lost, but the action of the next piece of apparatus, a Gulstad relay coupled to the jockey relay by a bridge connexion, is to interpolate the dots again. The signal currents thus produced are passed to a "translator" of similar construction to the P.O. pattern of relay, which acts as a transmitter to the second length of cable. This is supposed to be of greater length than the first section, and therefore an electrolytic magnifier is used at the terminal receiving station as well as the jockey and Gulstad relays, from which the current impulses pass to a P.O. relay which feeds a Creed electro-pneumatic receiving perforator of a pattern fitted with a special correcting device ensuring isochronous working. The punched strip from this instrument is passed through a Creed type printing apparatus of the pattern described in NATURE (December 9, 1920, p. 472), whence the message finally emerges in printed characters. Other interesting items on this large stand include a big map of the Companies' cable routes throughout the world, any section of any cable route on which can be illuminated from behind by neon tube lamps bent to follow the positions of the cables.

Among historic instruments is a Kelvin siphon recorder dating from 1877, by the side of the latest form of this type of instrument; an early speaking galvanometer is also shown. A number of samples of cables made by the Telegraph Construction and Maintenance Co., Ltd., are shown, ranging from pieces of the first submarine telegraph cable laid between Dover and Calais in 1851, and picked up fifty-six years later, to a modern

cable in which continuous inductive loading is supplied by an iron-nickel strip lapped round the conductor. A number of models of old and new cable ships are shown, and several items of their equipment, including a deep-sea sounding machine and the latest form of grapnel used for picking up cables, are exhibited. Another fine display, not, however, so complete at the time of our visit, is made by the Pacific Cable Board. Submarine cables of a considerable number of patterns are also shown by Siemens Brothers and Co., Ltd. Of particular interest are those provided with brass tape protection against the ravages of the Teredo; the possible extent of which is shown by interesting samples of cables damaged by the ship-worm. The Company is also exhibiting a variety of telephone cables including paper-insulated cables for land telephone lines, containing as many as 1000 pairs, and a four-core loaded submarine telephone cable cut open at a loading point to show the four Pupin coils, one for each core, side by side.

In the domain of telephony generally, the exhibits are too numerous to particularise. Of special interest are the displays of apparatus for automatic exchange working, forming part not only of the G.P.O. exhibit in the British Government building, but also on various stands in the Palace of Engineering, where the differences in the methods of working of the Strowger, Siemens, Western Electric, Relay, and other systems can be compared.

Attention should also be directed to the demonstration of up-to-date features of long-distance telephony on the stand of the Western Electric Co., Ltd., including loading coils for land lines and a full working example of a telephone repeater station. Loud-speaking telephones are shown on several stands, including the well-known apparatus of Alfred Graham and Co., Ltd., and a particularly effective system known as the electro-megaphone, shown by S. G. Brown, Ltd., the principal feature of which is the use of a compound differential microphone, in which the increase of pressure on one side of the element attached to the diaphragm and the decrease of pressure on the other are both made use of. Another special type of telephone is shown on the large and varied stand of the Telephone Manufacturing Co. in the now well-known laryngophone, in which a pad pressed against the side of the throat takes up the voice vibrations, and much extraneous noise is eliminated.

A great deal of interest will be aroused by the fine and varied exhibits of wireless telegraph and telephone apparatus, probably the most complete collection of modern apparatus of this nature ever brought together. It is only possible here to direct attention to a few of its more notable features. The foundation of practically all modern developments is the thermionic valve, and very appropriately Prof. J. A. Fleming, to whom its use for wireless telegraph purposes was originally due, has arranged in the British Government Pavilion a collection of about fifty typical valves with admirable descriptive labels tracing the history and development of the use of this class of apparatus. The valves shown range from the original experimental valves used by Prof. Fleming as rectifiers in 1904, and others soon following used as wireless detectors, to high-power transmitting valves in glass bulbs up to 600 watts and in silica bulbs up to 2500 watts used with anode voltages ranging up to 12,000 volts. Many types of amplifier valve are shown and special four-electrode valves, as well as the latest developments in "dull emitter" valves permitting of great economy in filament current consumption by the incorporation of thorium into the filament during manufacture. One stand in the Palace of Engineering, that of the Mullard Radio Valve Co., Ltd., is entirely devoted to valves, and here also large silica transmitting valves are to be seen. Another valve exhibit is that of the Marconi Osram Valve Co., forming part of the display of the General Electric Co., Ltd., and its allied concerns. It has hitherto been usual to employ multicell dry batteries for the anode circuit of receiving valves, but it is interesting to observe on the stand of several of the accumulator makers compact multicell accumulator batteries for this purpose. Attention may also be directed to a very successful attempt to avoid the use of valves and their paraphernalia altogether in small sets in the "Crystavox" of S. G. Brown, Ltd., in which a loud speaker is combined with a self-contained microphone amplifier. This enables a loud speaker to be added to any ordinary crystal set without the use of valves.

The largest stand devoted exclusively to wireless apparatus is that of the Marconi's Wireless Telegraph Co., Ltd., and its associated companies. In the centre are two large 80 kw. valve transmitting equipments built up of units and employing 16 valves in parallel each, such as have been used together for direct experimental communication with Australia, and of the same type as proposed for the Imperial Wireless chain stations. A complete 6 kw. valve transmitting equipment for broadcasting, a duplicate of that employed at the London Broadcasting Station, 2 LO., is shown, and an example of the new electro-magnetic "microphone" used with such success at the London broadcasting studio and elsewhere. In this instrument a variable E.M.F. is induced in an aluminium ring caused to vibrate in a powerful magnetic field, and the fact that the E.M.F. produced is inversely proportional to the frequency is corrected by an induction-capacity arrangement in the circuit of the first amplifying valve, by which the voltage fed to the next valve varies directly as the frequency. Wireless sets for special purposes include ship sets, lifeboat sets, and a very compact trench set with a short aerial not projecting above the parapet with a range of about 5 miles. There is also a most interesting collection of aircraft wireless telephone apparatus, including specially light and durable aeroplane sets and aerodrome ground station equipment arranged for switching through to exchange lines, so that any subscriber can communicate with a machine in the air. The Marconi V.4 set for broadcasting reception may be described as a good example of such apparatus with modern refinements. This is arranged in a convenient cabinet, and can be worked on wave-lengths from 300 to 3300 metres without any exchange of coils. The upper panel contains equipment for a two-valve reflex set (*i.e.* with one of the valves performing high and low frequency amplification simultaneously, equivalent therefore to three valves) with reaction so adjusted that oscillation cannot take place, tuned anode, variometer tuning, and a strength switch for adjusting the loudness of

the telephones by a resistance. There is also a rejector circuit for tuning out near stations (acting as a wave filter). The valves are of the dull emitter type, with their filaments in series on the same battery that supplies the filaments of the two further power amplifier valves, the equipment for which is on the lower panel. A strength switch is here provided for the loud speaker, and a convenient switch for using one, two, three, or four valves at will and connecting or disconnecting the loud speaker by moving the knob in and out. This is so arranged that the head telephones cannot be connected to the higher numbers of valves, to avoid risk of damage. A set of this kind supplied to the President of Poland is said to pick up in that country all the British broadcasting stations.

A certain amount of miscellaneous scientific apparatus is shown in the British Government Pavilion in sections organised by the National Physical Laboratory, the Royal Society, the Science Museum, South Kensington, and the Royal Institution. Those of electrical interest include some early types of incandescent lamps, historic apparatus used by Faraday, a collection of early Crookes' and X-ray tubes, mass spectrum apparatus of Dr. F. W. Aston, and Prof. C. G. Barkla's apparatus by which the polarisation of scattered X-rays and characteristic X-rays were discovered.

Exhibition of the Royal Academy of Arts, 1924.

THE late Mr. Clutton Brock claimed with eloquent and reasoned insistence that, for its perfection, man's intellectual development needs to be duly tinged with æsthetics, the love of beauty for its own sake, as well as with philosophy, the science of conduct, on an equal footing with the love of truth; and his doctrine is supported by other apostles of the new Trinity of truth, goodness, and beauty. Assuming that a modicum of philosophy is the common heritage of them all, we may agree that the denizens of Burlington House have need of one another, and that the student of science is an imperfect creature unless he has a love of beauty for its own sake, which it is the first duty of the Royal Academy to expound and encourage. It is, indeed, not difficult to agree. Scientific discoveries differentiate themselves in ways other than the mere sum and substance of the improvement of natural knowledge. Some expositions of discovery are really beautiful, others are really not.

For good or ill, there is nothing on the scientific side that exactly corresponds with the annual exhibition of the Royal Academy. Artists are not exactly invited once a year to come and look, and then say what they think, from the point of view of beauty, of our exposition of science. There would be something worth saying if they were; we might at least learn something about what illustrations ought to be and save thoughtful readers untold worries.

This year's academy comprises 674 paintings in oil, 185 in water colour, 152 miniature paintings, 141 drawings and engravings, 196 architectural drawings, and 215 sculptures — an extensive expression of the natural demand for the cultivation of the sense and power of beauty. And as one passes through the rooms and is faced with the question, "Well, what do you think of it all?" one is tempted to speculate on the canons or motives which guide the artist's mind in the exercise of his function of being inspired by and in turn inspiring his environment.

Perhaps the most prominent motive is the aid to the memory of the beautiful, which, at the best, is changing and evanescent, and which the layman might never realise at all without the artist's aid. To judge by the pictures of the year the human "form divine" clothed in various ways is the most appealing feature of their environment for the artists of the twentieth century, sometimes recalling Solomon in all his glory and sometimes with nothing on.

The appeal is more on the biological and psychological side than the physical. The studies of inanimate nature are less numerous and less striking than those of men and women, and animals, tame or wild. Even the portraits of the scientific bear out this suggestion. To set against those of Sir Donald MacAlister, Bt., of Tarbert (No. 187), by George Henry, R.A.; Lieut.-Gen. Sir John Goodwin, K.C.B., F.R.C.S. (217), by Maurice Greiffenhagen, R.A.; Sir Charles Sherrington, G.B.E., P.R.S. (630), by Augustus E. John, A.R.A.; and Prof. A. C. Seward, F.R.S., Master of Downing College (632), by William O. Hutchison, there are, it is true, portraits of Sir J. J. Thomson, O.M., F.R.S. (341), by René de l'Hôpital, and Sir Maurice Fitzmaurice, C.M.G., F.R.S. (305), for the Institution of Civil Engineers, by George Harcourt, A.R.A.; but they are two against four, and the Master of Trinity seems a little more "cornered" than one is accustomed to. To get a good view of the president of the Royal Society it is well to choose a bright day, otherwise the canon, *ars est celare artem*, may seem to have been rather roughly disregarded by Mr. John. The contrast of "art" between that and its near neighbour the Master of Downing is almost painful.

Passing from the variously adorned to the unadorned, bathing scenes are numerous and occasionally curious (22), and perhaps the student of biological statistics might find on investigation that the correlation between the absence of adornment and bobbed hair has actually changed its sign from the negative to the positive since Adam and Eve left the Garden of Eden, or even since Tennyson "waited for the train at Coventry."

Not many of the landscapes are very impressive. For a layman the best are those of Adrian Stokes, R.A., Cypress and Olive (143), San Vigilio (212), A Ring of Cypresses (54); Sir D. Murray, R.A., pictures of Wells (272, 493, 464), and those of the neighbourhood of London by Mr. W. L. Wyllie, R.A. (333 and 587), to which is added one like unto them, (171) Scarborough Castle. Artists apparently still insist on going to medieval painters instead of to Nature for their clouds, except Mr. E. L. Lawrenson (16, 261, 627), who is adventurous but not quite happy with the colouring of his cloud-margins. There is a tendency among the landscapes to bury the scene in a murky atmosphere, not at all void, but without form. Mr. Wyllie finds the London atmosphere convenient for that, and Mr. Oliver Hall, A.R.A. (124, 242), finds the same kind of dingy sky in Dorset and the Lake District. It will be rather unfortunate if the artists make the murky atmosphere of cities a fashionable form

of beauty. A curious form of protest against such a misadventure is to be found in 598, in which Mr. George H. Day uses the smoke of a channel steamer as a background for most brilliant coloured dresses; but that is compensated on the other side by 674, Isabel Codrington, in which cultivation of dirtiness as a fine art is pressed as far as it will go, and a little farther.

Of the motive to discern beauty which the layman would never think of there is not much evidence, unless we include idealised forms or surroundings such as the sculpture of an angel for a memorial (1361), Charles Wheeler, or (33), Angela Gibbons, for the decoration of a church. In their idealised unreality they make the student whose first aim is truth wonder about art as the handmaid of religion, whether, after all, the Second Commandment has not a claim for serious consideration.

Incidentally one may learn from the exhibition how important lighting is for art. The place of honour in Room VIII. is occupied by (402) Amaryllis, by George Harcourt, A.R.A.; it is brilliant when the sun is shining outside, but Amaryllis in the shade loses a good deal of its appeal. No. 42, by James Durden, suggests a physical or physiological problem—why does a grey sky appear intensely blue when seen in the twilight from an interior?

Some artists apparently conceive it to be their duty to stimulate our artistic sense by notes of interrogation. No. 594, Stamford Brook, is no brook but a junction of railway lines; that question, however, is mainly verbal and easy; but what "the Devil's Chess Board" means (275), Otway McCannell, or even what Past, Present, and Future (367) is intended to convey, the visitor is left to make out for himself, and perhaps will have improved his sense of beauty when he knows.

The Toronto Meeting of the British Association.

(From our Toronto Correspondent.)

THE British Association, as has been announced already, will hold its ninety-second annual meeting in Toronto, Canada. The invitation was proffered by the University of Toronto and the Royal Canadian Institute, but the whole of scientific Canada is co-operating to ensure that the meeting shall be one of the most successful in the history of the Association, and that the visitors from overseas shall have an enjoyable and profitable experience. For several months past, committees and associate committees, under the general chairmanship of Prof. J. C. McLennan, have been working in co-operation with the central organisation in England, and the success of the meeting seems certain. The British Association is no stranger to Canada, its first overseas meeting having been held in Montreal in 1884. It came again in 1897 and 1909, the meeting-places being Toronto and Winnipeg.

The dates for the Toronto meeting this year are August 6-August 13, and almost coincident with the meeting of the Association an International Mathematical Congress will be held, also in Toronto, on August 11-16. Various Canadian educational and professional organisations have arranged to hold gatherings in Toronto during the same week. Entertainments, garden parties, receptions, and excursions have therefore been arranged to include both Association and Congress visitors.

Fortunately there will, in August, be ample accommodation available for the visitors in the homes of citizens, the many convenient hotels, clubs, college and university residences, and the fraternities contiguous to the grounds of the University where the meetings will take place.

The University of Toronto is the provincial University of Ontario, and is financed almost entirely by the Government of the Province. It was founded in 1827, and has now a student body numbering about 5000. It ranks, therefore, as one of the largest universities in the British Empire.

The University is formed by a federation of four colleges, and students from other affiliated colleges are registered for courses leading to degrees. It is one of the chief centres for graduate work in the Dominion, and students from all parts of Canada come to the University of Toronto for the purpose of working in advanced courses and research leading to its higher degrees.

The University is located centrally in the city, and its ample buildings and campus provide an ideal meeting-place for such a congress. The social side of the meetings is especially well provided for, and the visitors will find in Hart House, which is the social and recreational centre of the male University life, a building which has few equals in the world for the beauty of its interior architecture and its lavish provision of comfort and convenience. Adjoining Hart House is the beautiful tower erected as a war memorial by the alumni of the University.

Close to the University grounds are several institutions which will doubtless be of interest to the visitors. Among these are McMaster University, which is maintained by the Baptist Church; the Royal Canadian Institute, founded in 1849 and the oldest scientific body in Canada; the Royal Ontario Museum, directed by members of the University staff, and containing among its notable collections that illustrating the ethnology of the American Indians, Chinese art and pottery, and a magnificent collection of fossil deinosaurs; the Connaught Antitoxin Laboratory, one of four institutions of its kind in the British Empire, which among its many activities manufactures and distributes insulin; the Toronto General Hospital of 750 beds; the Sick Children's Hospital, and the Provincial Parliament House, situated in Queen's Park, which is adjacent to the University grounds.

Toronto is situated in the southernmost part of the Dominion. It has an important harbour for the Great Lakes and St. Lawrence traffic, and it has direct railway connexions with all the important cities in Canada and the United States. One may, for example, leave Toronto by train at night and arrive in New York City shortly after breakfast next morning. Within a few hours of Toronto is the Muskoka lake district, one of the many great summer holiday resorts of the continent. For the information of those of the visiting scientific workers who may wish to recuperate after the strenuous exertions of the meeting, the steamship and railway

companies have been requested to send descriptive pamphlets of Muskoka Lakes and Algonquin Park to the central offices of the British Association in London.

Within two hours' steamship journey of Toronto is the Niagara Peninsula, one of the most famous fruit-growing districts of the world. Similarly, within two hours' steam in magnificent boats is the Niagara Falls. Arrangements will be made for excursions to the Falls on August 9 and August 16. Many other excursions will be arranged to points of interest to the various sections, and a longer excursion will afford an opportunity to visit all the important points of scientific interest throughout the province of Ontario.

A longer excursion has been organised to take a limited and selected party through the western provinces to the Pacific coast in two special trains which will accommodate about 190 persons on each train. The excursion will leave Toronto on the night of Sunday, August 17. The outward journey will be made via the National Railway, and the return journey by the Canadian Pacific Railway. The whole transcontinental excursion will occupy approximately three weeks.

Owing to the liberality of the railway systems, the cost of the journey, including sleeping accommodation, has been reduced to 100 dollars. The only extra expenditure necessary is for meals, which will cost about 60 dollars for the whole excursion. Ample opportunity will be afforded on this excursion for the visitors to see all the most important scientific and agricultural interests of the western provinces, as well as the natural features of the country. Special sessions of the Association will be held at two of the stopping-places, namely, Edmonton, where a Botanical Conference has been arranged, and at Saskatoon, where the Chemistry Section will hold a special meeting. At other points along the route, lectures will be given by members of the Association. District committees have been formed for the various districts through which the excursion will travel, and these have charge of the local arrangements for the entertainment and instruction of the visitors.

The president of the Toronto meeting is Major-General Sir David Bruce, and the list of vice-presidents is headed by His Excellency the Governor-General, Rt. Hon. Lord Byng of Vimy. The chairman of the local General and Executive Committees is Prof. J. C. McLennan, and the local hon. secretaries are Prof. J. C. Fields and Prof. J. J. R. Macleod. The local assistant secretary is Major J. M. Mood, who will be glad to answer inquiries about local arrangements.

The inaugural general meeting will be held on Wednesday, August 6, when Major-General Sir David Bruce will assume the presidency in succession to Sir Ernest Rutherford.

Obituary.

Alfred Angot.

SOME weeks ago, in an English newspaper there appeared an announcement of the death of Alfred Angot at his residence in Paris on March 16, at seventy-six years of age, as a prelude to a story about his always carrying an umbrella. The announcement marked the close of a long career devoted to the geophysical sciences—meteorology, terrestrial magnetism, and seismology. For thirteen years, in succession to Mascart, he had been director of the Bureau Central Météorologique, which, with its observatory of Parc St. Maur, was the central establishment of France for those sciences. At the same time he was professor of physics and meteorology in the Institut Agronomique National. There is a curious similarity in the position of the geophysical sciences in England and France. M. Angot writes in the preface to the third edition of his "Traité élémentaire de météorologie": "Or en dehors de l'Institut agronomique la météorologie ne figure régulièrement en France sur les programmes d'aucun de nos établissements d'enseignement"—that want of the regular academic routine of recapitulation is responsible for much in the meteorology of Britain and France in the last fifty years.

Besides the "Traité" referred to, and a book in the International Science Series on aurora, Angot's contributions to the geophysical sciences were mainly through the "Annales du Bureau Central Météorologique," a mine of information, the results of which filter only slowly into the common stock of science.

Angot was born in Paris in 1848; on his mother's side he had English relatives, and his associations with this side of the Channel were always of a most cordial character. He joined the Bureau Central in 1879 as "météorologiste titulaire." In the "Annales" for 1880 appears an elaborate paper on psychrometric formulæ based on observations at various elevations. A study of the diurnal variation of the barometer over the globe, perhaps his best-known work, appeared in 1887, and other subjects treated in like manner are diurnal variations of magnetic declination, 1899; results of the magnetic survey of France for the epochs 1901 and 1911; migration of birds, 1898; thunderstorms in France, 1904; actinometric observations at Parc St. Maur, 1909; seismological observations, 1908–9; essays on the climate of France and of Guadaloupe, and a "Première Catalogue des Observations Météorologiques faites en France depuis l'origine jusqu'en 1850."

In 1907, when Mascart was compelled by ill-health to resign, Angot became director of the Bureau and at the same time a member of the International Meteorological Committee. His colleagues on that Committee will always keep his memory in grateful appreciation. He was an excellent organiser, especially helpful in international meetings, which are apt to lose their bearings in polyglot conversations. His period of office lay in the time which followed the meteorological enthusiasm of Le Verrier and telegraphic reporting, when the actual comprehension of the weather seemed to be possible. The daily map of the Bureau Central was the "carte internationale," the pioneer among weather charts of Europe. After the first burst, development became slow and excited comparatively little interest in France. Angot made little change except in details, but devoted his attention to the underlying meteorological strata which attract little public interest compared with the daily forecasts.

In 1920 the geophysical services of France were reorganised and Angot retired with the title of Directeur honoraire du Bureau Central Météorologique; when the

Bureau itself disappeared, an Office National and Institut Géophysique took its place.

Madame Angot survives him with a son and two daughters, whose families were the joy of the years of his retirement. NAPIER SHAW.

DR. G. STANLEY HALL.

DR. G. STANLEY HALL, emeritus president of Clark University, Worcester, Mass., died on April 24, aged seventy-eight. Prof. E. W. Scripture, of the University of Vienna, has favoured us with the following appreciation of the significance of Dr. Hall's life and work.

In the middle of the 'eighties the fame of Dr. Hall as the pioneer of experimental psychology in America was talked of in the psychological laboratory of Prof. Wundt at the University of Leipzig. The Americans studying there at the time looked upon him as an enthusiastic disciple of Wundt, and were proud of the first American laboratory of experimental psychology which he founded at Johns Hopkins University. When in 1888 he accepted the presidency of the newly founded Clark University at Worcester, Mass., he made experimental psychology one of the chief departments. With the enthusiasm of a pioneer and with the inspiration of the German university system, he tried to introduce methods of research and instruction according to German ideals. He had a special knack for collecting around him men of the highest scientific gifts. The faculty at Clark University included Prof. Michelson for physics, Prof. Nef for chemistry, Prof. Franklin Mall for biology, and Prof. Donaldson for neurology. These departments became famous rapidly, in fact so rapidly that President Harper induced them all to go to the University of Chicago when it was founded. The *American Journal of Psychology* which Hall had started at Johns Hopkins University continued its work, and the *Pedagogical Seminary* was started.

Leaving the psychological work mainly to the younger men, President Hall's activities were now turned mainly to work in education. He became the inspiration for many investigators and teachers; so much so, that he was often looked up to with semi-religious adoration, which sometimes took the form of poems in his honour.

When Clark University was founded with the announcement that it was to introduce into America higher methods of university work than had yet been known in the country, there was naturally considerable excitement, with enthusiasm on one hand and resentment on the other. The high ideal corresponded to the demands of the enterprising spirit of America, but it came into conflict with the traditional ideas of the American universities, which at that time were modelled chiefly on the English system of colleges for undergraduates. The very spark of rivalry introduced by Clark University served to set loose new forces in the older universities. Not many years afterwards it was said by a Harvard graduate that Dr. Stanley Hall had done more good for Harvard University by his stimulation than he could ever accomplish at Clark University itself. The gradual enlargement of the American universities into institutes for research received much of its impetus from Dr. Hall and his ideas. In this respect he succeeded as a great American educator, although it was impossible for him to make Clark University what he wanted it to be. This University never had the slightest chance to become a great institution like the older ones. It was situated in a town with none of the additional institutions for medicine, law, science, art, and technology which were necessary for its life. It did not have the vast funds of the old institutions and had no chance for collecting new funds.

Dr. Hall was a man of most charming personality. His addresses were marked by fluent and melodious delivery; it is said of him that every sentence was an instinctive work of art, and that he never put a word in an inharmonious place. His early work in experimental psychology was of scientific value. In his later work he showed full appreciation of and sympathy with the newer developments of psychology. He was one of the first to grasp the importance of Freud's psychoanalysis. His works in general psychology, on adolescence and senescences, have high value as monuments of American learning.

WE regret to announce the following deaths:

Dr. C. W. Andrews, F.R.S., of the British Museum (Natural History), on May 25, aged fifty-eight.

Sir Asutosh Mookerjee, formerly vice-chancellor of the University of Calcutta, founder-president of the Calcutta Mathematical Society, and twice president of the Asiatic Society of Bengal, on May 25, aged fifty-nine.

Current Topics and Events.

IN his speech while proposing the toast of "Science and the Empire" at the annual dinner of the British Science Guild on May 22, Lord Sumner must have been facetious in his selection of the gramophone, kinematograph, and motor-car as instances of scientific achievement and influence. When things of this kind are taken as typical examples of what science means to modern civilisation, it is no wonder that doubt is often expressed as to whether scientific progress has been worth while when regarded as a means of human development. Science means, however, much more than contributions to popular entertainment or mechanical movement; but its strength and its significance are commonly misunderstood in high as well as in low places. The community in general does not appreciate the difference between a scientific investigator and the "wizard" inventor, and fails to distinguish between a communication to a scientific society and an announcement in a daily newspaper. So it comes about that Dr. Abrams' "sphygmobiometer," and Mr. Grindell-Matthews' "death-ray," are accepted by the daily Press as great scientific discoveries, while actual additions to natural knowledge, represented by scores of original papers read to scientific societies every week, are unregarded. A scientific or technical society is the proper place to submit claims which are alleged to have a scientific basis; and unless this has been done,

the scientific world is justified in declining to accept them, and to be suspicious of al mystery boxes or devices which have not been examined by bodies competent to express an opinion upon their construction and effects. Science signifies accurate knowledge and truthful testimony, and its methods are as applicable to social problems as they are to inquiries in the field of Nature. Mechanical and other industrial developments have been made possible by scientific discovery, but they have rarely been the purpose of it. All this is commonplace to scientific workers, but the public Press, with a few exceptions, knows nothing of science and is prepared to give publicity to assertions which it would not entertain for a moment if they concerned law or literature or finance. For these aspects of newspaper work, the services of competent editors are considered to be essential, but we still await recognition of the like need for scientific editors to offer guidance on matters relating to science, and to expose the sensational news which now so frequently passes for scientific truth.

DR. G. T. WALKER is about to retire, under the age rule, from his post of Director-General of Observatories, India, and will be succeeded by Mr. J. H. Field. On the retirement of Sir John Eliot, in 1904, the Indian Meteorological Department was reorganised, Dr. Walker being appointed to the Director-Generalship, and his tenure of the most important meteorological appointment in tropical countries will be memorable for his introduction of statistical methods into the difficult problem of seasonal forecasts. This problem had appealed strongly to Blanford and Eliot, and the latter had issued annual forecasts, which, however, were based on a method largely theoretical and empirical. The development, just before Dr. Walker went to India, of methods of research based on "correlation coefficients" put a powerful mathematical tool into his capable hands. Applying the new method first to the local factors used by Eliot in his empirical forecasts, Dr. Walker was led on to calculate correlation coefficients between monsoon rainfall and meteorological factors in all parts of the world, the results being described in a number of papers on "Correlation in Seasonal Variation of Weather," published in the Memoirs of the Indian Meteorological Department. As the final effort of his official service to meteorology, he has collected all the threads of his work together and published a memoir entitled "A Preliminary Study of World Weather" (Memoirs of the Indian Meteorological Department, vol. xxiv., part iv.), which is a mine of statistical information, containing well over 1000 coefficients of correlation between meteorological factors and a critical discussion of the reality of the various relationships found. The correlation coefficients are not as a rule very high; but Dr. Walker finds a coefficient between the monsoon rainfall of the Indian Peninsula (roughly south of a line joining Bombay and Calcutta) and certain pre-monsoon factors which reaches the high value of 0·73. As forecasts based on these factors can be issued for the coming monsoon on June 1 each year, the importance of the relationship is obvious. Under Dr. Walker's direction valuable work has been done on solar physics by Mr. J. Evershed at Kodaikanal and on the upper air by Mr. J. H. Field at Agra.

PROF. S. KITASATO, the Nestor of bacteriology in Japan and one of the few surviving pioneers from the hey-days of bacteriological discovery in the 'eighties, has been created a Baron by the Emperor of Japan for his lifelong services to medical science. Prof. Kitasato was born in 1856, and as a young man came to Europe to study bacteriological methods under Koch when the latter became Director of the new Hygienic Institute in Berlin in 1885. During his five years' sojourn in Europe, Kitasato made numerous contributions to bacteriology, among which special mention may be made of his successful effort to isolate in pure culture, and by the use of anaerobic methods, the bacillus of tetanus—an organism previously seen and described by Nicolaier. On his return to Japan in the early 'nineties, the opportunity soon arrived to put in practice his acquired knowledge of method, in connexion with the investigation of plague. With Aoyama he was sent to Hong Kong to study the plague epidemic there in 1893–94. He and Yersin working independently had the good fortune to discover the causative organism, *B. pestis*, and further to demonstrate that plague infection was the cause of the antecedent or coincident rat mortality. In 1892 the Institute for Research in Infectious Diseases was founded in Japan with Kitasato as its Director. This Institute became a potent centre of bacteriological research in Japan and provided for that country its supplies of therapeutic sera and prophylactic vaccines. Prof. Kitasato has devoted much attention to the study of native diseases such as leprosy and tuberculosis, and by his own work and that of his many disciples has done much to foster the high reputation now enjoyed by the Japanese school of bacteriology. Prof. Kitasato was elected a foreign member of the Royal Society in 1908.

THE centenary of the birth of Lord Kelvin occurs on June 26 of this year. On that date, the Institution of Electrical Engineers, of which Lord Kelvin was thrice president, will hold a centenary conversazione. At the University of Glasgow, the Kelvin centenary will be celebrated on June 25, which is Commemoration Day. The honorary degree of Doctor of Laws will be conferred on Mr. Ramsay MacDonald, the Prime Minister, whose wife was a grandniece of Lord Kelvin. It will also be conferred on Sir James Bell, who as Lord Provost was chairman at the Jubilee Banquet to Lord Kelvin in June 1896, and on Dr. Alexander Russell, president of the Institution of Electrical Engineers, who is to give the Kelvin Oration. The Freedom of the City of Glasgow will also be conferred on the Prime Minister and on Sir Donald MacAlister, the Principal of the University. The official celebrations, in which practically every scientific and engineering society and institution in Great Britain will participate, will be held on July 10 and 11. This late date was

decided on so as to allow the many hundreds of foreign men of science and engineers who will then be in London the opportunity of participating. We note from the provisional time-table of the World Power Conference just published that on July 10 Sir J. J. Thomson will deliver a Memorial Oration on Kelvin. On the evening of the same day, the president of the Royal Society will give an official reception. On July 11 Lord Balfour will take the chair at the Kelvin Centenary Banquet.

IT was reported in the *Times* of May 22 that President Coolidge had been treated for a cold by the inhalation of a chlorine gas mixture. Thus is put to good use a gas which was one of the first employed for its noxious effects during the War. The incident illustrates a principle which has a very general application, that substances which are poisonous in higher concentrations are useful in smaller amounts; in fact, not only the substances classed as poisons, which are used beneficially every day in medical treatment, but also others, the presence of which in the body is essential to its normal functioning, are toxic in quantities above a certain level. The use of chlorine gas for the treatment of colds was suggested by certain observations upon men employed in its manufacture during the War; it was found that these workers suffered less than others from influenza. Its mode of action is probably not a direct one upon the microbes in the nasal cavities, although this explanation has been suggested for the action of the fumes of nitrogen peroxide and sulphur dioxide in preventing influenza: these gases may make the secretions acid and so hinder bacterial growth. Chlorine, however, acts more probably as an irritant to the mucous membranes, producing an increased secretion from them, and this carries with it a host of white blood cells; both the cells and the secretion attack the micro-organisms, while the latter also washes them away mechanically. Possibly also the microbes find it difficult to penetrate through these secretions into the mucosa itself. Thus it is seen that the gas acts more by stimulating the natural defensive processes of the body than by a direct effect upon the microbes themselves, showing once again the extreme importance of the defensive mechanisms of the body itself in resisting bacterial invasion.

A LARGE audience gathered at the Imperial College on Wednesday, May 21, to hear Prof. P. Zeeman's lecture on "The Optical Effects of Motion," over which Prof. A. Fowler presided. After enumerating the various effects included under the title he had chosen, Prof. Zeeman proceeded to deal in detail with the so-called Fizeau effect, namely, that the direction of a ray of light in a refracting medium is independent of the motion of the medium with respect to the ether. This was first enunciated, perhaps on insufficient grounds, by Arago, and attributed by Fresnel to a convection of ether by the moving body. Fizeau afterwards confirmed Fresnel's calculation of the actual magnitude of the predicted effect. Fresnel, however, took no account of dispersion in the medium. A correction factor was therefore necessary, and this was supplied by Lorentz in 1895. As a consequence, the experimental result of Fizeau no longer agreed with the revised calculated value of the convection coefficient. Prof. Zeeman thereupon undertook experiments on a large scale with the view of a more accurate determination. The principle employed was that of the Michelson interferometer. Experiments were made with both liquid and solid media—water, glass, and quartz—and the results, after many difficulties had been overcome, agreed in each case almost exactly with the calculated values of Lorentz. In the water experiment, tubes 6 metres in total length and 14 mm. in internal diameter were employed, and very clear interference fringes were obtained. Ingenious devices were adopted for measuring the velocities of the moving media, both liquid and solid. By means of an arrangement of linkages, velocities of 10 metres per second were given to glass and quartz plates, and accurately measurable displacements of the interference fringes were thereby obtained. An interesting fact revealed by the experiments was that the best optical glass was more homogeneous than natural crystals of quartz. In conclusion, Prof. Zeeman referred briefly to attempts which he had made to obtain evidence of the transverse Doppler effect required by Einstein's theory of relativity. He had so far been unsuccessful, but had hopes ultimately of obtaining a positive result. The lecture, which was well illustrated by lantern slides, was much appreciated.

THE second explosion (of ten tons of melinite) took place at La Courtine on May 23 at 8 P.M. (summer time) and the third (of five tons) on May 25 at 9 A.M. (summer time). A fourth was arranged for the evening of May 26. The detonation of the second explosion was more violent than that of the first, and this, it is suggested, was due to the greater resistance of the soil. It was heard somewhat differently from that on May 15, and was again clearly audible at Bordeaux. At Moulins (79 miles from La Courtine), the second explosion was heard, but not the first. No precise results were obtained by the listening post installed on the Eiffel Tower, but the instruments, which failed to indicate a disturbance on the first occasion, showed a marked deviation 18 min. 4 sec. after the second explosion occurred. This implies an average velocity of about 1086 feet per second. In the second explosion, the experiments on animals near the source were abandoned in deference to public opinion.

THE plans of an Oxford University Expedition to North-East Land, Spitsbergen, are published in the *Times*. The expedition, which has the support of the Royal Geographical Society and the Air Ministry, has secured in the Norwegian whaler *Polarbjörn* a most serviceable vessel for the work. A small Norwegian sealing sloop has also been chartered. A seaplane designed for Arctic work will be taken. It carries three men, with five weeks' provisions, a sledge, and a collapsible boat. The main object of the expedition is to conduct explorations on the ice-capped island

known as North-East Land, the interior of which has not been visited since A. E. Nordenskjold crossed it in 1873. Attempts will also be made to penetrate the seas between Spitsbergen and the north-west of Franz Josef Land. This is generally a region of considerable ice congestion and has seldom been visited on this account, but there is no strong likelihood of any new land being discovered. If the present season proves to be as favourable an ice year as last summer the work of the expedition will be facilitated, and the use of the seaplane should result in some useful surveys. Captain Helmer Hansen, who was ice pilot of the *Fram* in Captain R. Amundsen's Antarctic expedition and one of the party which reached the South Pole, will accompany the expedition. Mr. G. Binney is the leader.

AT a special meeting of the American Philosophical Society held on Friday, May 2, the City of Philadelphia through its Board of Directors of City Trusts made the following annual presentation of the John Scott Medal awards: To Prof. F. G. Banting, professor of medical research in the University of Toronto, who in 1920 and 1921 succeeded in preparing a potent extract of the experimentally atrophied pancreas which increased materially the life of depancreatised dogs by enabling them to retain larger amounts of sugar. In these researches there were associated with Dr. Banting, Drs. Macleod, Best, and Collip. To Dr. W. W. Coblentz, physicist of the U.S. Bureau of Standards, for his skill in the design and construction of thermopiles and radiometers of the highest sensitivity, with which he has measured the radiation of the fainter stars. To Prof. E. V. McCollum, professor of biochemistry, School of Hygiene and Public Health, Johns Hopkins University, who demonstrated in 1913 a growth-promoting vitamin in butter fat, the first of a long series of researches by him and his collaborators on the presence in various foods of other similar substances, promoting growth and maintaining health. To Dr. R. Modjeski, of New York City, for his skill in bridge designing. He is now chief engineer of the Delaware River bridge.

THE annual report of the British Science Guild for 1923–4 contains evidence of much activity in regard to publicity work. Last year the free distribution of publicity leaflets was begun, and the first two are reprinted in the handbook to the exhibits in pure science at the British Empire Exhibition. An experimental "Science News Service," under the direction of Mr. G. D. Knox, has also been instituted, and weekly articles on scientific subjects by experts have been published in the daily Press. The further development of this new venture is being considered. The Guild has also arranged for the broadcasting of several talks on scientific subjects and is co-operating with the British Association in the preparation of a list of science lecturers for the use of local scientific societies and other bodies. An important event in the immediate future is the conference on Science and Labour in the Modern State, proposed by the Guild four years ago and now to be held at the British Empire Exhibition on May 30 and 31. The joint organising committee is composed of influential members of the Guild and of the National Joint Council—a body representing the Trades Union Congress, the Labour Party, and the Parliamentary Labour Party. The conference is to be opened by the Prime Minister. Other matters that have received attention include the promotion of greater facilities to enable the Board of Education to concern itself with educational values rather than money-scrutinising duties; questions arising out of the British Empire Patent Conference of 1922 and amendments in international conventions relating to industrial property; and the issue of a new and revised edition of the Guild's Catalogue of British Scientific and Technical Books, which will contain more than 8000 titles, as compared with 6000 in the first edition.

THE annual visitation of Rothamsted Experimental Station, Harpenden, will be held on Wednesday, June 18, at 11.30 A.M., when the laboratories and field plots will be inspected and an account of the work in progress will be given.

THE gold medal of the Royal Astronomical Society, which has been awarded by the Council to Prof. A. S. Eddington, will be presented at the ordinary meeting of the Society on Friday, June 13, at 5 P.M., when the president will give an address setting forth the grounds of the award.

A MEETING of the Chemical Society will be held in the theatre of the Royal Institution (by kind permission of the managers) on Thursday, June 12, at 5.30 P.M., when the Faraday Lecture entitled "Atomism in Modern Physics" will be delivered by Prof. R. A. Millikan, of the California Institute of Technology, Pasadena.

AN examination of candidates for the associateship of the Institute of Physics will be held at the latter end of September next, but applications for entry must be received by the Secretary, 10 Essex Street, Strand, W.C.2, before the end of June. Application forms and copies of the papers set in 1922 and 1923 can be obtained from the same address.

THE fourteenth annual May Lecture of the Institute of Metals will be delivered in the hall of the Institution of Mechanical Engineers on Wednesday, June 4, at 8 P.M. by Dr. F. W. Aston, who will take as his subject "Atoms and Isotopes." Tickets of invitation can be obtained by sending a stamped addressed envelope to Mr. G. Shaw Scott, secretary of the Institute of Metals, 36 Victoria Street, London, S.W.1.

A PHYSICIST is required by the Directorate of Explosives Research, the Research Department, Woolwich. Candidates must possess an honours degree in physics, have a good knowledge of chemistry, with at least two years' experience in research. Written applications for the post, with copies of testimonials and references to any published work, should be sent to the Chief Superintendent, Research Department, Woolwich, S.E.18.

IN NATURE of February 9, p. 204, we quoted a newspaper correspondent's account of the discoveries of Fathers Licent and Teilhard in the Pleistocene

deposits of China. Father Teilhard now writes to correct some misapprehensions in this account, remarking especially that no remains of human skeletons of Pleistocene age have so far been found. Several Palæolithic floors, however, rich in worked quartzite and the fossil remains of Pleistocene mammals, have been explored. The small horse referred to is apparently a hemionus or wild ass, closely similar to that still living in Tibet.

AT the meeting on July 3 of the Council of the Royal Society, applications will be considered for assistance from the fund recently donated by Messrs. Brunner Mond and Co. in aid of the expenses of scientific publications, as well as applications for aid from the Government Publication Fund. The donation of Messrs. Brunner Mond and Co. is limited to aiding publications in physics, chemistry, mathematics, and astronomy. Applications from recognised scientific societies will be received by the secretaries of the Royal Society; other applications should be put forward through a member of the Council. All applications should be received not later than June 26.

ACCORDING to *Science* the medals of the National Academy of Sciences have been presented as follows: The Agassiz Medal to O. S. Pettersson, of Sweden; the Henry Draper Medal to Prof. A. S. Eddington, Plumian professor of astronomy and experimental philosophy in the University of Cambridge; the Watson Medal to Prof. C. V. L. Charlier, director of the Royal Observatory and professor of astronomy in the University of Lund, Sweden; the Daniel Giraud Elliot Medal, for 1921, to Prof. Bashford Dean, professor of vertebrate zoology in Columbia University, New York; for 1922, to Prof. W. M. Wheeler, professor of economic entomology in Harvard University, and for 1923, to Ferdinand Canu, of Versailles, France.

THE following committee has been appointed to formulate a detailed scheme for individual tests of agricultural machinery for the consideration of the Ministry of Agriculture and Fisheries: Prof. W. E. Dalby (chairman), Mr. Thompson Close, Mr. F. S. Courtney, Mr. Henry Deck, Mr. Harry German, Mr. W. Harrison, Mr. B. J. Owen, Dr. T. E. Stanton. Mr. P. Barker, of the Ministry of Agriculture and Fisheries, has been appointed secretary of the committee. The committee is empowered to co-opt, for the purpose of inquiry into any particular class or classes of machine or implement, or into any particular form of test, such person or persons whose knowledge may be of assistance.

THE Council of the Royal Society of Arts has unanimously resolved to confer the Albert Medal for 1924 on the Prince of Wales, in recognition of services rendered to arts, manufactures, and commerce as president of the British Empire Exhibition and by his visits to the Dominions and India. The president of the Society, the Duke of Connaught, has approved the award. The Medal, which was founded in 1863 to commemorate the Prince Consort's presidency of the Society from 1843 to 1861, is awarded annually for "distinguished merit in promoting Arts, Manufactures, and Commerce.'

ONE of the sessions of the Empire Textile Conference which will be held at the British Empire Exhibition, Wembley, during Whitsun week, will be devoted to a general discussion on "Physical and Physico-chemical Problems relating to Textile Fibres." This has been arranged jointly by the Faraday Society and the Textile Institute, and it will be held on Wednesday, June 11, from 2.30 to 6.30 P.M., in Conference Hall No. 4. The introductory address will be given by Dr. W. Lawrence Balls, and the programme of 12 papers includes contributions from all the leading laboratories in Great Britain and Ireland engaged in textile research. Full particulars may be obtained from the Secretary of the Faraday Society, 10 Essex Street, London, W.C.2, or from the Secretary of the Textile Institute, St. Mary's Parsonage, Manchester.

AT the annual general meeting of the Institution of Civil Engineers, held on Tuesday, May 13, the following officers were elected for the year beginning in November next: *President*, Mr. Basil Mott; *Vice-Presidents*, Sir William Ellis, Mr. F. Palmer, Sir Archibald Denny, Mr. E. F. C. Trench; *Other Members of Council*, Mr. H. N. Allott, Mr. A. A. Biggs, Sir John Cadman, Sir Dugald Clerk, Col. R. E. B. Crompton, Mr. H. A. Cutler, Mr. W. W. Grierson, Sir Robert Hadfield, Sir Brodie H. Henderson, Mr. E. P. Hill, Mr. G. W. Humphreys, Sir Cyril R. S. Kirkpatrick, Sir Murdoch Macdonald, Mr. J. MacGlashan, Mr. J. P. Maxwell, Sir Henry Maybury, Sir John Monash, Mr. G. T. Nicholson, Dr. J. B. Porter, Sir Richard Redmayne, Sir Hugh Reid, Capt. M. H. P. Riall Sankey, Sir John Snell, Mr. W. A. P. Tait, Mr. J. D. Watson, Sir Alfred Yarrow.

A SHORT but useful catalogue (N.S. No. 13) of works on astronomy, physics, zoology, botany, and geology has reached us from Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2. Some 260 books and serials are listed.

MESSRS. A. J. and A. G. Campbell, writing from Melbourne, raise some controversial questions of interpretation of rules of zoological nomenclature. We regret to be unable to find space for a discussion of the points to which they refer, and we suggest that their best course would be to lay any specific complaints before the International Commission on Zoological Nomenclature. We are unable to communicate directly with Messrs. Campbell, as they give no address in their letter.

MESSRS. AITCHISON AND CO., LTD., consulting ophthalmic opticians, have sent us an interesting and useful little pamphlet entitled "Sights of London." A simply written account of the optics of the eye appears on alternate pages, the remainder of the booklet constituting a guide to noteworthy places in London, to which is added folding maps showing the principal thoroughfares, underground railways, etc. The chief branch of the firm is at 428 Strand, W.C.2, from which copies of the pamphlet can be obtained free of charge.

AN English translation of the third German edition of H. von Helmholtz's "Treatise on Physiological Optics," edited by Prof. James P. C. Southall, professor of physics in Columbia University, and published by the Optical Society of America, is to be issued in three volumes, approximately in the same style as the original German edition, with the same illustrations, plates, etc. It is hoped that the first volume will be ready for distribution by June and the other volumes will follow. The edition is limited to one thousand copies. Orders can be sent to F. K. Richtmyer, Rockefeller Hall, Ithaca, N.Y.

AMONG the forthcoming books of the Cambridge University Press are volume 2 of the Life of Sir Francis Galton, by Prof. Karl Pearson, which will deal with the contributions of Sir Francis in middle life to geography, anthropology, psychology, and photography, and his earlier statistical researches. It will also contain his correspondence with Alphonse de Candolle, Charles Darwin, and Florence Nightingale; "The Earth: Its Origin, History and Physical Constitution," by Dr. Harold Jeffreys, in which will be described the present position of knowledge concerning the physical constitution of the earth, the causes of mountain formation, and the nature of isostasy; and "Matter and Change," by W. C. D. Whetham, being an introduction to physical and chemical science.

MESSRS. OLIVER AND BOYD, Edinburgh, have in course of preparation a series of monographs on experimental biology, under the editorship of Dr. F. A. E. Crew, Animal Breeding Research Department, The University, Edinburgh, and Mr. D. Ward Cutler, Rothamsted Experimental Station. The purpose of the series is to provide authoritative accounts of the most recent investigations in the field of biological research, both pure and applied. The first volume of the series by Dr. Lancelot T. Hogben on "The Pigmentary Effector System" is now ready, and will be followed immediately by Dr. E. Ponder's on "The Erythrocyte and the Action of Simple Hæmolysins." Other volumes in actual preparation are by F. A. E. Crew, D. Ward Cutler, J. S. Huxley, J. Hammond, J. Brontë Gatenby, R. A. Fisher, G. C. Robson, and others.

Our Astronomical Column.

SPOTS ON VENUS.—The present very favourable evening apparition of Venus has been noted for an unusual number of observations of markings on the disc. One was seen in February by Dr. W. H. Steavenson: some others are noted in *Astr. Nachr.* 5286 by A. Nissen and A. Foch. On February 10 and on February 24 there were several distinct spots, some bright, some dark. There was a bright spot near the south pole, and another in the northern hemisphere crossed by a dark band which the authors regarded as a shadow of an upper cloud on a lower one. Conclusions as to rotation time are discordant. A. Nissen concluded that it was in the neighbourhood of $23^h\ 56^m$, but W. H. Steavenson saw no motion while he watched the spot, and favoured a longer period. The question is of such interest and importance that observers should utilise to the utmost any opportunities that may present themselves. The planet will again be well placed as a morning star after the inferior conjunction on July 1.

SOLAR ACTIVITY AND ITS EFFECTS.—While it is not yet possible to account in a satisfactory way for the influence of the sun on terrestrial magnetic and electrical phenomena, progress continues to be made in correlating events in the two regions. In the April issue of the Journal of the Meteorological Society, Dr. Chree compares sun-spot frequency with rainfall, temperature, sunshine, electrical potential gradient, and deviation of the compass for the years 1856–1922, and shows that while the connexion is undoubtably close in the case of sun-spots and terrestrial magnetism, the evidence for any connexion in the other cases is very inadequate. In the March issue of *Terrestrial Magnetism and Atmospheric Electricity*, Dr. Bauer shows that while over the period 1901–1923 the electrical potential gradient increased with the sun-spot number, there are two periods about 1855 and 1889 for which the opposite is true. Mr. J. P. Ault shows that, during the eclipse of the sun on September 10, 1923, the usual daily variations in the earth's magnetic field were decreased as if night-hours had been interposed among the day-hours. Mr. H. F. Johnson found that the potential gradient fell 15 per cent. and the electrical conductivity of the air rose 10 per cent. owing to the eclipse. These eclipse observations were made at various points of the path of totality from California to Guatemala by arrangement of the Department of Terrestrial Magnetism of the Carnegie Institution, Washington.

THE VELOCITY OF SOLAR PROMINENCES.—Dr. W. Anderson, in the *Zeitschrift für Physik*, March 28, suggests that the cause of solar prominences may be the hydrodynamical phenomenon which causes the action of the hydraulic ram. When a pipe in which a fluid is flowing is suddenly closed a high pressure is produced, so that if a small hole is left open the fluid will pass through it with a greatly increased velocity. Dr. Anderson considers that something like a head-on collision between two currents of gas in the lower layers of the sun may have a similar effect, producing an enormous pressure and driving a stream of gas up to and beyond the surface with very great velocity. The gas will be strongly compressed by the shock and will thus be heated and will radiate more than before the shock takes place. Fényi has observed the appearance of bright points in the chromosphere, and immediately afterwards a flame or small prominence appeared; this has been seen by other observers. Hydrogen prominences have been observed to last for days, and even for weeks; this may be due to the fact that the density of the gas forming them is only a little greater than that of the corona gas; the latter, Dr. Anderson considers, is probably almost pure "electron gas," and that of the prominences may be electron gas with more hydrogen, calcium, and other gases than are found in corona gas. Other causes may be concerned in giving the high observed initial velocities to the prominences, for example, the sudden development of inter-atomic energy. The source of energy of the prominences may be of the same nature as that which supplies the solar heat, but Dr. Anderson considers that his shock theory gives a sufficient explanation.

Research Items.

MANDAN MUSIC.—Bulletin 80 of the Bureau of American Ethnology is a study of Mandan and Hidatsa music by Frances Densmore, who has already published careful accounts of the music of the Chippewa, Sioux, and Ute. One hundred and ten songs of these two tribes of North Dakota Indians are recorded, of which the greater number are connected with the ritual of societies. Although the life of the Mandan and the Hidatsa, both of Siouan stock, has been blended for many years, each tribe has, to a great extent, preserved its own songs. The Mandan, however, frequently use the Hidatsa language to their own tunes because it is easier to sing. The instruments used are drums, rattles, and whistles of various types with specific uses. The several groups of songs, whether connected with ceremonies, legends, or tribal warriors, differ in melodic and rhythmic peculiarities. The Indian asserts that "he can tell the kind of song when he hears it." Most of the songs are said to have been received from supernatural beings or animals, and are believed to have "supernatural power." The oldest songs belong to the societies which were organised by "Good Fur Robe," the first corn priest, a culture hero, who established certain organisations and customs for the good of the tribe.

FAUNA OF NUYTS ARCHIPELAGO.—A series of papers on the fauna and flora of Nuyts Archipelago and of other islands lying off the coast of South Australia to the west of Eyre's Peninsula, has appeared in the Transactions of the Royal Society of South Australia (vol. 46, 1922; vol. 47, 1923). The material described was obtained during expeditions led to these islands by Dr. F. Wood Jones, professor of anatomy in the University of Adelaide, who visited them in the hope of finding remnants of the mainland fauna and flora which had been isolated during the Pleistocene submergence. A new species of nesting rat was discovered on the western of the two Franklin Islands, which Mr. Oldfield Thomas has named *Leporillus jonesi*. "The possibilities of the dispersal of rats is well known," writes Prof. Wood Jones, "and *Leporillus jonesi* might by some be regarded as being an immigrant to the Franklin Islands. But with the wallabies the case is very different. There can hardly be an alternative to the supposition that they are part of the original mainland fauna." Unfortunately these expeditions were already too late, for "several species have become extinct within the memory of the present generation and not even a skin or a skull is preserved in any collection." Nevertheless, the expedition was rewarded by the discovery of a new and peculiar form of wallaby on Pearson Island (*Petrogale pearsoni*) and a new bandicoot (*Isoodon nauticus*) on the Franklin Islands. The wallaby on Pearson Island has developed a strange gait and certain structural modifications, adaptations to a life among great boulders and sea cliffs. The leader of the expedition was fortunate in obtaining the co-operation of experts in Australia, New Zealand, and at home in describing the collections brought back; their reports make up the series of papers now published. The contributions by Prof. Wood Jones are illustrated by exact and instructive drawings made by himself and give full and interesting descriptions of the life-habits of all the animals studied on these unfrequented islands.

DISTRIBUTION OF MARINE ALGÆ.—Svedelius (*Arkiv f. Botanik*, Bd. 19, No. 3, p. 1, 1924) discusses the discontinuous geographical distribution of tropical and sub-tropical marine algæ and presents a good deal of new evidence on this subject. He points out that there are two good cases of seas possessing marine vegetation which must have been derived by routes which were previously sea, but are now closed by continents. Many species and genera of algæ occurring in the Caribbean Sea must have originated in the Pacific. The Mediterranean has received both phanerogams and algæ from the Indian Ocean. In both cases previous sea must have existed. It is concluded that the majority of older genera of algæ have their main distribution in the Indian-Pacific region, whence they have migrated into the Atlantic. The algæ flora of the Atlantic thus appears to be of more recent origin than that of the Indian-Pacific Ocean. This agrees with the demands of Wegener's theory of continental drift, according to which the Atlantic is of much more recent date.

PINK BOLL-WORM IN EGYPT.—A paper prepared by Mr. C. B. Williams, Senior Entomologist, on behalf of the Cotton Research Board of the Ministry of Agriculture, Egypt, for presentation at the International Cotton Conference at Rio de Janeiro in 1922, and now published in the Third Annual Report of the Board for 1922, issued in 1924, throws a vivid light upon the contributory cause of the prevailing shortage of cotton. The paper records that the pink boll-worm was first found in Egypt by Mr. Willcocks in the autumn of 1910, and since then the total loss to Egyptian cultivators from this pest up to 1922 is estimated at 50,000,000 *l.*, whilst it is further considered that without the control measures introduced the loss would have been twice as great. There are two types of life-cycle in this moth—the short-cycle larvæ pupate immediately they are full grown and emerge at once as moths; the long-cycle larvæ make a cocoon of silk, usually between two cotton seeds, and remain thus in the larval stage for months before they pupate. With the regulation now in force in Egypt preventing the growth of cotton or other host plants after November 30, the moths that infest the new crop of cotton, planted in March and April and flowering from May onwards, practically all come from the long-cycle larvæ, hibernating in dropped, scattered, and partly buried bolls, and amongst the sticks stored as fuel on the roofs of the houses, or in the picked cotton. Now every ginnery has to heat cotton seed to 57° C.-60° C. for a time sufficient to kill all worms, but the dropped bolls and stored fuel remain difficult legislative problems, as appears from the letter on this subject in NATURE, May 24, p. 745. Modified agricultural processes in the winter to destroy the bolls in the soil, compulsory burning of all stored fuel after a certain date in spring, and the plant breeder working to find a variety of cotton that speeds up boll production, may work together to lessen the length of time during which the host plant is at the disposal of the pest.

THE FIGURE OF THE EARTH.—Two interesting papers on the figure of the earth were read at the Royal Geographical Society's afternoon meeting of May 12. In the first, Captain G. T. McCaw reviewed our existing knowledge of the subject and analysed broadly the published data. In the second, Mr. A. R. Hinks pointed out the desirability of using direct, rather than indirect determinations, and expressed a preference for Clarke's 1880 figure, if an existing figure were to be adopted for continental areas. We may take it that, at present, the best value for the semi-axis major is 6,378,300 metres, with a probable error of 50 metres; and the reciprocal of the compression may be taken as $296 \pm 1{\cdot}5$. The old

figures of Airy, Everest, and Bessel, in which the semi-axis major is considerably too small, may now be left out of account. It is well known that the United States, Canada, and Mexico have adopted, for the continent of North America, Clarke's 1866 figure, in which the semi-axis major is 6,378,206 m. and the reciprocal of the compression is just under 295. The International Geodetic and Geophysical Union will this year meet at Madrid, and will discuss, amongst other matters, the question of recommending a figure for continental areas. This is chiefly a matter of cartographical convenience, and no doubt the geographers will have something to say to it. On the continent of Europe at the present time the multiplicity of figures and differences of origin cause some slight difficulties along the frontiers. We might reasonably consider, in the case of Africa, whether we might not avoid some of these difficulties in the future by adopting an arbitrary standard figure *now*. There remains the scientific problem of the best general figure; and it may be hoped that no attempt will be made to decide this until we have digested the mass of geodetic data accumulated during the last forty years, but still unused for this purpose, in Europe, India, Canada, South America, Africa, and Spitsbergen. This laborious task might well be undertaken by the Geodetic Section of the International Union.

THE PROPAGATION OF SOUND.—The *Meteorological Magazine* for April contains an article on the propagation of sound in the atmosphere by Mr. F. J. W. Whipple of the Meteorological Office. It was suggested after the War, by Prof. de Quervain, of Zurich, that the destruction of surplus explosives might serve a good purpose scientifically by causing explosions and listening for them; arrangements were made with the International Commission on the Exploration of the Upper Atmosphere. An experimental explosion was produced at Oldebroek in Holland in October 1922, and was heard or registered instrumentally in south-east England, south Belgium, northern France, and also in Austria. The "normal" zone of audibility reached only to a distance of 12 miles to the north-east and 40 miles to the south-west of the site of the explosion. Beyond the wide "zone of silence" the explosion was heard at a distance of 450 miles to north-west, 400 miles to west-south-west, and 350 to the south. The distance from La Courtine, where the recent experimental explosions have taken place, to the south coast of England is nearly 400 miles, and the author is of opinion that autographic records should have been obtained. There are many conditions in the atmosphere to complicate calculations, and the discussion of the observations will involve a heavy task.

THE INFLUENCE OF GASES ON THE PHOTOELECTRIC EFFECT.—It has been found that, when either hydrogen or oxygen is generated by electrolysis on the dark side of a thin iron plate, the photoelectric sensitiveness, P, of the other side is greatly increased, and that P falls off quickly when the generation of gas ceases. Messrs. R. Dümpelmann and W. Hein, in the *Zeitschrift für Physik*, April 4, describe experiments in which the illuminated surface of the iron could be scraped in vacuo by means of a magnetically operated scraper. The effect of electrolysis was observed immediately after scraping, showing that the action is not simply a renewal of the clean surface by the gas which diffuses through the metal. It was proved experimentally that the changes of P caused by starting and stopping the electrolysis are not due to changes of temperature produced by the electrolysing current, and also that the changes in P observed when a current is sent through the iron plate are caused by changes of temperature, and not to any other effect of the current. When hydrogen is generated over the dark side of the plate by the chemical action of dilute sulphuric acid, the same increase in P takes place as is observed when it is generated electrolytically. Using a copper plate, which only absorbs a small quantity of gas, the increase in P due to electrolytic gas generation is very small or zero. With iron, P diminishes under illumination, and recovers in the dark. So far as the experiments go, the recovery is more rapid with iron containing much absorbed gas than with that containing a small quantity.

DISTORTION IN RADIO TELEPHONY.—Mr. L. C. Pocock read an important paper on distortion in radio telephony at the Institution of Electrical Engineers on May 7. The extending use of broadcasting has directed great attention to the improvement of the design and construction of telephone apparatus. So far as land line and cable telephony is concerned, the problem has been solved sufficiently well for practical requirements. But to receive and transmit music so that a critical ear will be satisfied is immensely more difficult. Mr. Pocock pointed out that frequency distortion is much the most difficult problem in high quality sound reproduction by a loud-speaking receiver. If cost were no consideration, a near approach to perfection could be attained. The troubles arising from amplitude distortion of particular components can be overcome if amplifiers of sufficient capacity are used. Where crystal sets or amplifiers of low power having good characteristics are used with head receivers, it is generally agreed that the quality of reproduction is excellent. The naturalness also is probably good, but the conditions of listening make the judgment of naturalness difficult. The differences produced by various head receivers can, however, easily be detected. These differences are due to differences in the natural frequency of the mechanism, and more particularly to differences in the degree of damping. Kennelly's methods of impedance analysis and modern research have placed receiver design on a sound scientific basis. This is proved by the fact that the first receiver designed by the new methods had an acoustic power $2\frac{1}{2}$ times greater than previous receivers for the same power input, although it was actually smaller and lighter. Recent improvements in design have considerably reduced both the frequency distortion and the amplitude distortion.

FOSTER OPTICAL PYROMETRY.—Messrs. The Foster Instrument Co., Letchworth, have issued a descriptive pamphlet of the Foster optical pyrometer. This is of the disappearing filament type, in which the intensity of the visible radiation from the hot object is matched against the brilliance of the filament of a small incandescent lamp. In the usual form of this instrument, an ammeter is inserted in the lamp circuit and the current required for heating the filament to the desired intensity is a function of the temperature. The disadvantage of this is that only a portion of the ammeter scale is employed, as the scale range up to the value of the current which heats the filament to redness is not utilised. In the present instrument, openness of scale over the working range is secured by arranging the lamp as one arm of a Wheatstone bridge and inserting a milliammeter in the usual position occupied by the galvanometer. The scale of the milliammeter is engraved to read temperatures directly. A detailed account of the instrument is given in the *Journal of Scientific Instruments* for April.

The Spectra of Silicon at Successive Stages of Ionisation.[1]

By Prof. A. FOWLER, F.R.S.

THE present lecture may be regarded as a continuation of the Bakerian Lecture of 1914, in which it was established that series in spark spectra, though otherwise similar to arc series, are characterised by a fourfold value of the series constant N. This result was in complete agreement with Bohr's theory, according to which arc series originate in neutral atoms, and spark series in ionised atoms. The theory further suggested that atoms which had lost two electrons, or had become doubly ionised, would give series having 9N for the constant; atoms which had lost three electrons would yield series with 16N for constant, and so on.

In a search for spectra of the higher orders, one of the most promising elements appeared to be silicon, which Sir Norman Lockyer had already shown to be represented by different groups of lines in stars of successively higher temperatures. The spectra obtainable from this element under the action of discharges of increasing intensity have accordingly been investigated over the long range of spectrum necessary for the investigation of series relationships. The results of the inquiry are in accordance with theoretical prediction so far as the fourth spectrum.

Theoretical expectations in regard to the relations between these spectra and those of elements which immediately precede silicon in the periodic table have also been realised, the necessary additional data for a full comparison being provided by Paschen's recent work on the second and third spectra of aluminium. The relations between the various spectra may conveniently be indicated as follows:

	Doublets.	Triplets.	Doublets.	Triplets.
$n=1$	Na I	Mg I	Al I	Si I
C=N	11+, 10 −	12+, 11 −	13+, 12 −	14+, 13 −
$n=2$	Mg II	Al II	Si II	
C=4N	12+, 10 −	13+, 11 −	14+, 12 −	
$n=3$	Al III	Si III		
C=9N	13+, 10 −	14+, 11 −		
$n=4$	Si IV			
C=16N	14+, 10 −			

Series constant $=C=\frac{2\pi^2e^2m}{ch_3}\cdot\frac{M}{M+m}\cdot(ne)^2$.

Under each symbol the number preceding the + sign represents the nuclear charge, and that preceding the − sign the number of external electrons in addition to the one which generates the spectrum, so that in the first row the atoms as a whole are neutral. All spectra in the same vertical column have been found to be similar, but as n increases, corresponding lines are of higher frequencies, and the doublet or triplet separations are increased.

The principal numerical data, some of which are of immediate importance in connexion with work on the temperatures of the hotter stars, are included in the following brief references to the four spectra of silicon.

[1] Substance of Bakerian Lecture of the Royal Society delivered on Thursday, May 15.

Si I.—Theory suggests that new features will be presented by this spectrum, inasmuch as the effective electron probably traverses a 3_2 orbit; a p or P term may therefore be expected for the highest limit, and not an S term as in Mg I. The triplets are very feebly developed, there being but one representative of each of the s and d series. From analogy with other triplet spectra, however, the limit $3p_2$ may be expected to be in the neighbourhood of 85000. Six singlets which are reversed in the arc can be arranged in two series of subordinate type converging near to 60000, which may be taken as the value of 3P. If the resonance line $3p_2 - 3P$ be λ3905 (ν25598), as is not improbable, the term $3p_2$ will be 85600, in close accordance with the first estimate. Further work on this spectrum is necessary, but the resonance and first ionisation potentials may provisionally be taken as 3·2 and 10·6 volts respectively. Some of the strongest lines of the arc spectrum form two multiplets of the pp' type.

Si II.—The spectrum forms a doublet system analogous with that of Al I, and the various constituent series are well represented. Lines at λλ1533·55, 1526·83 ($\nu\nu$65208, 65495) form the leading pair of the sharp series, the limits of which are $3\pi_1 = 131531$, $3\pi_2 = 131818$. The resonance potential is therefore 8·09 volts and the second ionisation potential 16·27 volts. Besides the usual sets of terms, there is a double term of d type, $x_1 = 76498$, $x_2 = 76514$, which yields a strong series of fundamental type in the far ultra-violet; no corresponding terms have been noted in aluminium.

Si III.—The spectrum is of the same type as that of Al II and Mg I, consisting of triplets and singlets. The first line of the first d triplet is at λ1113·76, and that of the first s at λ997·7. The limits of the triplet series are $3p_1 = 216879$, $3p_2 = 217142$, $3p_3 = 217273$. The singlet series have not been certainly identified, but there is evidence that the resonance line $3S - 3p_2 = \nu$39330, and the first principal line $3S - 3P = \nu$82857. If so, the resonance potential will be 4·85 volts, and the third ionisation potential 31·66 volts (3S = 256472).

Si IV.—Additional lines of the doublet system of Si IV have been photographed by Millikan in the extreme ultra-violet, but the series limits previously published are not materially modified. The resonance lines are λλ1393·9, 1402·9 ($\nu\nu$71740, 71280), indicating a resonance potential of 8·86 volts. The fourth ionisation potential is 44·95 volts.

The ionisation potentials, and the doublet or triplet separations of elements in the same column of the foregoing table, are more simply related than those of elements in corresponding columns of the periodic table.

International Congress on Applied Mechanics.

THE International Congress on Applied Mechanics, held at Delft during the last week of April, was an extremely successful gathering of about two hundred scientific men drawn from all parts of Europe and America for the discussion of papers covering a wide range of subjects, which may be roughly classified as dealing with the theory of elasticity and recent researches in plasticity, hydrodynamics, and aerodynamics. It was mainly due to the energy and organising ability of the chairman, Prof. Biezeno, and secretary, Prof. Burgers, that the meeting was such a pronounced success.

Delft is an admirable centre for a congress on applied science, as it is the focus of most of Dutch activity in this field, with an extensive range of buildings and laboratories in which teaching and research work go on side by side.

The Dutch contributions to the fifty or more papers presented were naturally a prominent feature and included a very interesting theoretical paper, by Prof. Biezeno, on graphical and numerical stress determinations in beams and plates, a paper on the motion of a fluid in the boundary layer along a plane surface, by Dr. Burgers, forming an extension of

the well-known work of Osborne Reynolds, Prandtl and Lorenz, and also an extremely interesting account of measurements of the gravitation constant made in seas between Java and Holland from a submarine, by Dr. Vening Meinesz (v. NATURE, May 3, p. 641).

An important part of the proceedings dealt with stress distribution of materials in the plastic state, to which Dr. Hencky, of Delft, contributed a theoretical discussion, while Prof. Prandtl gave a valuable summary of the work in this field associated with his name and the Göttingen school. The English contributions in this branch were also of importance, as Mr. Southwell gave an account of his recent work on the stability of plates under shear stress, Mr. Griffiths described his well-known theory of rupture by the aid of some interesting experiments on quartz fibres, while Prof. Haigh also contributed an interesting account of his theory of rupture by fatigue.

Closely related to this group there were papers by Dr. Masing on season cracking and volume changes due to internal stress, Dr. Nadai on slip bands in plastic material, Dr. Schmid on recent researches on single metallic crystals, and the theory of deformation structure by Dr. Weissenberg.

In the elastic field, Dr. Wyse contributed a valuable survey of the stress distribution in hook-shaped bodies based on strain measurements of a most exhaustive kind and giving results which, if necessary, could be readily confirmed by photo-elastic measurements, in which latter subject Prof. Coker contributed a paper on his recent researches of the stress distribution in foundations of masonry structures, incompletely braced frames, and the effects of planing, milling, and lathe tools on various materials. In this section there was also a discussion of the solution of boundary problems by the valuable method of Ritz.

The section on hydrodynamics and aerodynamics was very naturally largely taken up with aeroplane problems, to which Prof. Bjerknes contributed a notable paper relating to the forces which lift aeroplanes, while Prof. Witoszynski discussed the theory of circulation around them by some interesting applications of the complex variable.

A most interesting experimental lecture, by Prof. G. I. Taylor, on the hydrodynamics of rotating fluids, was especially remarkable for the effective experimental demonstration of the instability of motion produced between rotating cylinders, resulting in the formation of vortices separated by equidistant planes perpendicular to the common axis of the cylinders. Another paper, by Sir Napier Shaw, of interest in this field, related to the physical structure of the atmosphere treated from the dynamical point of view.

A visit to the Government Aeronautical Institution at Amsterdam was made by members of the Congress.

A very complete volume of abstracts of the papers, about seventy in number, was available, and it is proposed later to issue a volume giving a more extended account of the proceedings, while it is also hoped to arrange a further congress in 1926 either at Zurich or Rome. E. G. C.

Water Power Resources of Canada.

By Dr. BRYSSON CUNNINGHAM.

THERE has recently been issued by the Water Power Branch of the Canadian Department of the Interior a report, dated February 1 last, which reviews the present position of water power development in the Dominion. During the year 1923 there was an increase of more than a quarter of a million horse-power, and the total hydraulic power installation of the country now aggregates the imposing total of 3,227,414 h.p. The known available water power from all sources is computed at 18,255,000 h.p. for conditions of ordinary minimum flow, and at 32,076,000 h.p. under a flow estimated for maximum development, *i.e.* a flow which can be depended upon for, at least, six months of the year. These estimates are of a conservative character; from observations of existing plant it is found that the average machine installation is 30 per cent. greater than the six-months' flow maximum power. Accordingly, it may be safely inferred that the present turbine installation of 3,227,414 h.p. represents only 8 per cent. of the recorded available water power resources.

An analysis of the foregoing figures shows them to be distributed as shown in the accompanying table.

Subdivided according to method of utilisation, it is of interest to note that the existing installations comprise:

2,411,701 h.p. in central stations for general distribution for all purposes. The average installation is of about 8550 h.p.

497,620 h.p. in pulp and paper mills. This is exclusive of 228,755 h.p. purchased by pulp and paper companies from central stations.

318,093 h.p. in industries other than central stations and pulp and paper mills.

The total installation for the Dominion averages 353 h.p. per thousand of population, Canada thus ranking, among the countries of the world, third to Norway and Switzerland in the *per capita* utilisation of water power.

The report expresses the view that there is every reason to expect a continued and rapid development of water power. At the present time there are actually in process of construction, or in active prospect, hydro-electric plants aggregating 900,000 h.p.

Province.	Available 24-hour Power at 80 % Efficiency.		Turbine Installation.
	At Ordinary Min. Flow.	At Ordinary 6-months Flow.	
British Columbia .	1,931,142	5,103,460	355,517
Alberta . . .	475,281	1,137,505	33,067
Saskatchewan .	513,481	1,087,756	...
Manitoba . .	3,270,491	5,769,444	162,025
Ontario . . .	4,950,300	6,808,190	1,445,480
Quebec . . .	6,915,244	11,640,052	1,116,398
New Brunswick .	50,406	120,807	44,539
Nova Scotia . .	20,751	128,264	54,950
Prince Edward Is.	3,000	5,270	2,239
Yukon and N.W. Territories . .	125,220	275,250	13,199
	18,255,316	32,075,998	3,227,414

On a moderate estimate, the effective working increase will be at the rate of one million h.p. every 5 years, so that by the year 1940 no less than 7 million h.p. should be developed. The cost of the existing installations represents a capital outlay of more than 687,000,000 dollars, which, in fifteen years' time on the same basis of increase, will reach 1,500,000,000 dollars. Hence the outstanding importance of an intelligent administrative policy to govern the exploitation of the valuable water power resources of the country.

University and Educational Intelligence.

BELFAST.—Applications are invited for Musgrave Research Studentships, five in number and each of the value of 200*l.*, at the Queen's University. The studentships are restricted to British subjects who are graduates of at least one year's standing in a university in the British Empire and are conducting or show marked capacity for original research in pathology, biology, chemistry, physics, or physiology. Applications, on a prescribed form, must reach the secretary of the University by, at latest, July 1.

CAMBRIDGE.—It is proposed to confer honorary degrees upon His Grace the Duke of Rutland, the Right Honourable the Earl of Crawford and Balcarres, Sir Charles Holmes, Director of the National Gallery, and Dr. D. G. Hogarth, Keeper of the Ashmolean Museum, Oxford.

The Council of the Royal Institute of British Architects has, on the recommendation of the Board of Architectural Education, offered to the University an annual scholarship of 70*l.* for the advancement of the study of architecture within the University.

Mr. H. F. Gadow, King's College, has been reappointed as a manager of the Balfour Fund, and Mr. H. M. Fox, fellow of Gonville and Caius College, has been elected Balfour Student. Dr. C. Shearer, Clare College, has been nominated to use the University Table at the Zoological Station at Naples for two months. Mr. J. Gray, fellow of King's College, has been appointed demonstrator of comparative anatomy. Mr. W. J. Harrison, fellow of Clare College, has been reappointed University lecturer in mathematics.

LEEDS.—Mr. J. B. Speakman has been appointed lecturer in textile chemistry in succession to Mr. E. A. Fisher. Mr. Speakman has been engaged since 1920 in full-time chemical research, the results of which have been embodied in several papers in the technical and scientific journals.

The West Yorkshire Coal Owners' Association has given 800*l.* towards the funds of the Mining Department.

LONDON.—A course of three public lectures on "Atoms and Ethereal Radiations" will be delivered at University College, at 5.30 o'clock, on June 16, 17, and 19, by Prof. R. A. Millikan, of the California Institute of Technology. No tickets will be required.

Mr. P. J. Baker has been appointed as from August 1 to the Sir Ernest Cassel chair of international relations tenable at the London School of Economics. In 1918 Mr. Baker joined the League of Nations Section of the Foreign Office and in 1919 was principal assistant to Lord Robert Cecil at the Peace Conference in Paris, also acting as British Secretary to the League of Nations Commission. From 1920 to 1922 he was a member of the Secretariat of the League of Nations.

Mr. F. R. M. de Paula has been appointed as from August 1, 1923, to the newly-instituted University readership in accounting and business organisation tenable at the London School of Economics. Since 1919 Mr. de Paula has been lecturer on accounting at the London School of Economics.

The following doctorates have been conferred:—D.Sc. (*Chemistry*): Mr. S. Sugden (Birkbeck College), for a thesis entitled "The Measurement of Surface Tension and its Relation to Chemical Composition"; D.Sc. (*Geology*): Mr. H. H. Read (Imperial College, Royal College of Science), for a thesis entitled "Researches on the Metamorphic and Igneous Geology of North-east Scotland"; D.Sc. (*Mathematics*): Mr. H. T. Flint, for a thesis entitled "A General Vector Analysis in Four Dimensions, with an Application to General Electrodynamical Theory," and other papers.

A grant of 60*l.* from the Publication Fund has been made to Miss M. M. McFarlane in aid of the publication of her Ph.D. thesis entitled "A Study in Practical Ability."

The report of the Principal Officer on the work of the University during the year 1923–24 gives statistics which show but little variation from the corresponding figures of the preceding year but a large increase when compared with those of ten years ago. The total number of admissions, 7731, was more than double, and the total number of candidates for matriculation and registration more than treble the corresponding number in 1913. The percentage of successful candidates in all examinations other than final examinations for degrees and diplomas, which was in 1922 noticeably lower than in 1913, was in 1923 lower still. The tale of benefactions for specific purposes includes grants and gifts for students' welfare (hostels, athletic grounds, etc.), libraries (1000*l.*), school of librarianship, engineering laboratories (5000*l.*), otology (10,000*l.*), municipal engineering and hygiene, chemical engineering, buildings and research funds for the London School of Economics (115,000 dollars from the Laura Spelman Rockefeller Memorial Fund), Dutch studies (1000*l.*), Scandinavian studies (500*l.*), chair of international relations, and university extension work. It is noteworthy that all the non-recurring Treasury grants were for hostels and other provision for students' welfare, and that the Chancellor gave 5000*l.* towards a university athletic ground. The urgent need of funds for capital expenditure on such objects was emphasised at the Universities Conference of May 10.

OXFORD.—Prof. A. D. Lindsay, professor of moral philosophy in the University of Glasgow, has been elected Master of Balliol College in succession to the late Dr. A. L. Smith, who died on April 12.

THE Society for the Advancement of the Training of Mechanics, Leyden, Holland, has arranged for the holding of vacation courses for mechanics and glass-blowers, in August, in the Physical (Cryogenic) Laboratory of the University of Leyden. Information concerning the courses may be had from Dr. C. A. Crommelin at the address named.

BRITISH women graduates wishing to spend the coming academic year working in Paris will be interested to know that the American University Women's Club, 4 Rue de Chevreuse, is again offering three residential scholarships for graduates of British Universities who wish to study at the Sorbonne or other institution of higher education. The value of each scholarship is 350 francs a month for nine months from October 1924. The rates charged by the club are such that each scholar would need to pay an additional 500 francs per month. The club is conveniently placed in a quiet street near the Luxembourg Gardens, and is most comfortably furnished and equipped. Each resident has a good study-bedroom and the use of several excellent public rooms, including a good restaurant. Applicants for these scholarships should send a statement of their age, qualifications, and proposed course of study, with recommendations from two persons well acquainted with their career, to the Secretary, British Federation of University Women, 92 Victoria Street, London, S.W.1, not later than June 10.

Early Science at the Royal Society.

May 26, 1670. Dr. Croune acquainted the Society that Sir Nicholas Millet had mentioned to him, and Mr. Hooke, that he had a manuscript of his own writing, which contained the observations of the variations of the needle made for seventeen or eighteen years in the same place. They were desired to procure a sight and perusal of that manuscript.

May 27, 1663. Upon the reading of a letter sent out of Ireland to the Secretary, concerning the expectation, which the committee, that had heretofore given the society an account of Sir William Petty's new ship, entertained of hearing the sense of the society thereupon; it was ordered, That the committee should be put in mind by the secretary, that the matter of navigation being a state concern was not proper to be managed by the society: and that Sir William Petty, for his private satisfaction, may, when he pleases, have the sense (if he hath it not already) of particular members of the society, concerning his new invention.

1685. Mr. Hooke observed [in discussion] that the scarlet-red windowglass was brought from Germany; but that there had been none brought over for eighty years past.

May 28, 1668. The president produced an Italian letter written to himself as president, by the Prince and Cardinal Leopold de Medicis, in answer to the letter written to him acknowledging the favour of his eminence's present of the Florentine experiments. The cardinal's letter was read and ordered to be entered, and the favour and respect to the society expressed in it to be acknowledged on a proper occasion.

1673. Mr. Hoskyns produced a piece of silver ore, lent him by Captain Bertue, who had brought it out of Sweden, where, he said, in the Swedish Silverberg, they throw in coal over night into the rocky mine, and having let it burn and calcine all night, slake it the next day; whereupon the stony part being washed out of the ore by the water, the metal appears, as in this piece, in long, thick, silvery streaks.

May 29, 1679. The Society then went to take a view of the new weather-clock, which was set up in Mr. Hunt's lodgings, made to keep an account of the quantity and time of all the changes, that happen in the air, as to its heat and cold, its dryness and moisture, its gravity and levity; as also of the time and quantity of the rain, snow, and hail that fall: all of which it sets down in a paper, so as to be very legible and certain.

1665. Mr. Howard having presented the society with several curious exotic plants and flowers, had their thanks, and was desired to continue these presents from time to time, that they might be put upon the table at the meeting of the society.

May 30, 1667. The duchess of Newcastle coming in, the experiments appointed for her entertainment were made.

1678. Sir Jonas Moore gave an account, that Mr. Edmund Halley, who went to the island of Saint Helena, in order to observe the true places of the stars near the south pole, was newly returned to England; and that he had completed his design by having taken the true places of above four hundred considerable stars: that the place of his observation was above a thousand yards higher than the surface of the sea: that by reason of that great hight there were there almost continual clouds and mists, which passed very swiftly: that this mistiness and moisture of the air dissolved the glue of the tubes.

Societies and Academies.

LONDON.

Royal Society, May 22.—J. W. **Gregory** and C. J. **Gregory**: The geology and physical geography of Chinese Tibet, and its relations to the mountain system of South-Eastern Asia. The continuation of the Himalayan System eastward from India has been suggested on two lines—one N.E. into Northern China and the other S. through Western Burma to the Eastern Archipelago. In a journey across this region in 1922 the authors found that in addition to the N. and S. strike, due to movements of Hercynian age in the later Palæozoic, there was clear evidence of transverse Kainozoic disturbances, such as should accompany an extension of the Himalayan axis into S.W. China. Marine rocks were found belonging to the Devonian, with a reef of Stromatoporoids, and to the Carboniferous, Permian, and Triassic Periods. The Triassic limestones and the Permo-Triassic sandstones show evidence of widespread dislocation by over-thrusts and over-folds, which are certainly post-Hercynian, and are regarded as Himalayan. These movements have brought up blocks of older pre-Palæozoic rocks along E. to W. belts. The country is therefore regarded as having been folded by Himalayan movements, and afterwards fractured in the Pliocene along lines which trend predominantly N. and S., and have produced a series of tectonic basins. The authors do not accept the great uplift of S.E. Asia in the Pleistocene. The succession of earth-movements and volcanic eruptions in comparison with that of East Africa indicates that both areas were profoundly affected by the subsidence of the Indian Ocean.—Madge **Kaye** and Dorothy Jordan **Lloyd**: A histological and chemical investigation of the swelling of a fibrous tissue. The behaviour of a heterogeneous system, such as skin in water, acids and alkalies, differs in several important respects from that of a homogeneous system, such as gelatin. The fibres of skins are grouped into regular bundles and are divided longitudinally into fine threadlike fibrils. These are embedded in a colourless semi-fluid matrix, the "inter-fibrillary substance," which has the characteristics of an albumen. The fibres and fibrils of fresh skin are in a state of internal strain, due to (*a*) the inherent structure of the fibril, and (*b*) their arrangement in the tissue. These strains are released when the fibres are swollen, but new temporary strains are produced by encircling threadlike elements binding the fibres together, which only become visible when the bundles are in a swollen condition. Drying introduces additional strains, but destroys the constricting bands. In swollen skins, water is present in at least two conditions—(*a*) imbibed between the fibres or fibrils, (*b*) combined with the internal substance of the fibrils. In fresh skins the inter-fibrillary albumen does not prevent absorption of water in either way, but the coagulated albumen of skin dried under the influence of heat or ultra-violet light offers considerable resistance to both. Skins dried under conditions which do not coagulate albumen are brought nearer to fresh skins; solutions which disperse coagulated albumen increase the power of water-absorption of dried skins, but some irreversible changes seem to occur in drying.—C. H. **Browning**, J. B. **Cohen**, S. **Ellingworth**, and R. **Gulbransen**: The antiseptic action of compounds of the apocyanine, carbocyanine, and isocyanine series. In general, these substances are very powerfully antiseptic towards *Staphylococcus aureus*, but are much less active towards *B. coli*. In the presence of serum their antiseptic action is practically as well

marked as in watery medium. Unlike the acridine series, the introduction of amino-groups did not enhance the action of the cyanine compounds. In the isocyanine series the introduction of side-chains into the quinoline fraction of the molecule, as compared with their presence in the quinaldine fraction, had a depressing effect on antiseptic potency. Otherwise significant alterations in antiseptic power were not observed as a result of variations in chemical structure within the groups.—H. J. **Watt**: Dimensions of the labyrinth correlated. The dimensions of the semicircular canals of mammals (and birds), like those of the cochlea, are highly correlated with one another and with the length of the head and body, so that they may be said to maintain a typical form, varying in scale with the length of the head and body. They show no noteworthy signs of variation from type, except that the dimensions of the canals in the porpoise and the Cape sea-lion are relatively unusually low, while the dimensions of the body and head of the whale, the sea-cow, and the horse are relatively unusually high.

Linnean Society, May 1.—Dr. A. B. Rendle, president, in the chair.—E. **Clement**: Seedlings of Odontoglossum, Dendrobium, Cattleya, and Cymbidium germinated without fungal aid. Bernard and Knudson succeeded in inducing germination by chemical means, but all previous success was gained with seeds which are easily germinated. The present cultures showed that, with suitable media, about 90 per cent. of Odontoglossum seeds will germinate, and normal growth continues after transfer from the medium to potting materials.—J. **Gray**: Some problems in experimental cytology. Analysis of the ciliated cells in the gills of Mytilus indicates that although most of the main constituents of sea-water are intimately connected with the normal conditions, the only factors which vary in such a way as to cause a variation in ciliary activities are the temperature of the sea, and the accumulation of carbon dioxide when the animals are stranded at low tide. The effect of carbon dioxide is such as to cause an effective guard against the destructive effect of a lack of oxygen. Certain problems peculiar to dividing cells can also be attacked by experimental methods. The view that the astral rays are comparable to muscle fibrils, cleaving the cell by a process of contractions, is completely at variance with the fact that the process of cytoplasmic cleavage is unaccompanied by any change in the oxygen consumption of the cells. There is a steady increase in the rate of oxygen consumption as growth proceeds, but it is not to be associated with any particular phase of nuclear activity. Experiments can also be made on the effect of a cell on the structure or activity of neighbouring cells. In some cases intercellular processes exist, but in the case of *Spirochæta balbani* there occurs a synchronisation of movement of individuals which are only in contact by their anterior end.

Zoological Society, May 6.—Prof. E. W. MacBride, vice-president, in the chair.—R. **Broom**: On some points in the structure of the Pareiasaurian skull.—D. M. S. **Watson**: The Elasmosaurid shoulder-girdle and fore-limb.

Geological Society, May 7.—Dr. J. W. Evans, president, in the chair.—Mrs. Ethel Gertrude **Woods** and Miss Margaret Chorley **Crosfield**: The Silurian rocks of the Clwydian Range, from Moel Arthur to Gyrn. The Clwydian Range forms part of a complex anticlinal fold of Silurian rocks, folded and faulted into position between the New Red Sandstone of the Vale of Clwyd on the west, and the Carboniferous Limestone of the North Wales Coalfield on the east. The part of the range mapped consists, in detail, of a number of synclines and anticlines of Lower Ludlow age, running nearly due east and west in the north, and more north-west to south-east in the south. The nature of the deposits shows contrasting conditions of deposition, from a still-water, landlocked area, subject to rhythmic changes, to an open-sea, near-shore area with abundance of clastic material, followed by a partial return to earlier conditions. The beds form part of the pre-Carboniferous floor of North Wales. Subjected as they have been to the strong Caledonian forces, they show many signs, not only of yielding to and resistance to pressure, but also of having moved with a certain amount of individual freedom. The chief valleys all run in a Caledonian or sub-Caledonian direction. The contrasting pitch of the beds in the north and south, and the change in direction of folds and faults, shows that the Moel Fammau block (consisting of Moel Fammau itself and the region east of it) has acted as a pivotal line, about which the regions north and south have swung, the torsional movement being greater in the south than in the north.

Optical Society, May 8.—E. A. H. **French**: The preparation of coppered glass mirrors. An earlier research on this subject was conducted by Chattaway in 1907, using phenylhydrazine as a reducing agent, but on his findings it was not possible to obtain a coherent copper film on plate glass surfaces. This was probably due to the formation of tarry by-products, which appear inevitably to result when such a reducing agent is used. Experiments were conducted at the War Department Searchlight Experimental Establishment with the object of eliminating this drawback, as well as temperature difficulties insuperable from the use of phenylhydrazine. It was found that a satisfactory coherent and lasting film can be deposited on plate glass surfaces at a comparatively low temperature by the use of hydrazine sulphate. The cleaning of the glass surface is peculiarly important.—H. W. **Lee**: The Taylor-Hobson F/2 anastigmat. The lens has proved useful in theatrical photography, since by its use the actual performance on the stage can be photographed with the ordinary stage lighting. It also permits of kinema photographs being taken with less intensely actinic light than is at present used in kinematograph studios. In astronomy the new lens should prove useful. Its large angular field, combined with its large linear aperture, makes it possible to plot star fields very rapidly. It should also be possible to photograph meteors. The illumination in the meteor image depends on the aperture ratio and the quality of definition of the lens, and the large field is a necessity.—T. **Smith**: A reference system for primary aberrations. It is proposed to employ as a complete reference system for primary aberrations, the state of correction of spherical aberration along the whole axis. Such a system is advantageous, since it involves no arbitrary choice of object and stop positions.

Royal Statistical Society, May 20.—M. **Greenwood**: The mortality statistics of Sweden and of England and Wales: an essay in international comparison. Seventy or eighty years ago male mortality from childhood to the age of 35 was greater in England and Wales than in Sweden, and less at ages over 40; the mortalities of females in the two countries bore a similar relation one to the other, but absolutely the English rate was higher at all ages. In the decennium 1901–10 the relative positions were completely reversed. During this period English young and

adolescent rates had improved extraordinarily, mortality at ages 40-50 relatively little; Swedish adolescent mortality, on the contrary, showed little change, while at later ages the rate had improved almost 50 per cent. In the seventy years which preceded 1910 the prosperity of the United Kingdom increased far more than that of Sweden, but the mortality in the less prosperous country at the ages of maximal productivity, 30 to 60, became increasingly better. Looking upon a birth as an investment of life capital, and years lived between 20 and 60 as national interest on the investment, in which country does the investment pay better? In Sweden every 1000 male live-births yield 28,378 years of life between 20 and 60, in England and Wales 26,317; in females the yields are 29,205 and 27,921 respectively; *i.e.* male life capital earns 7 per cent. more interest and female 4·5 per cent more than in England. The higher adolescent mortality of Sweden has not neutralised the advantage of the lesser infantile mortality which her figures continue to show.

PARIS.

Academy of Sciences, May 5.—M. Guillaume Bigourdan in the chair.—Charles **Moureu**, Charles **Dufraisse**, and Jacques **Panier des Touches**: Auto-oxidation and anti-oxygen action. The catalytic properties of the iodo-phenols. It has been shown in earlier communications that both phenols and iodine and its compounds possess marked catalytic properties in the phenomena of auto-oxidation. It is now found that iodo-phenols have practically the same catalytic effect on the oxidation of acrolein as the corresponding non-substituted phenols.—P. **Bazy**: Urinary suppuration, without micro-organisms being present and non-tuberculous.—W. **Kilian** and Antonin **Lanquine**: The tectonic of the outermost Alps between Chabrières and Moustiers-Sainte-Marie (Basse-Alpes) and on the facies of the strata which constitute them.—Edmond Beecher Wilson was elected correspondant for the section of anatomy and zoology in succession to the late M. Loeb.—A. **Angelesco**: Poisson's integral in the complex domain.—Maurice **Fréchet**: The notion of dimension in functional fields.—Charles **Rabut**: The conditions of security of massive barrages.—L. **Escande** and M. **Ricaud**: The similitude of hydraulic movements.—A. **Buhl**: The ametric tensorial calculus.—E. **Brylinski**: Some equations of electromagnetic dimensions.—J. **Granier**: The conductivity of electrolytes at very high frequencies. The range of wave-length used was from 43,500 metres to 3·8 metres. Preliminary experiments appeared to show a change in the resistance with the wave-length, but after the systematic study of various causes of error, the author concludes that there is no appreciable change in the conductivity of the electrolytes examined with the wave-length.—A. **Dauvillier**: Preliminary measurements of intensity in the high-frequency spectra of the elements.—F. **Baldet**: The spectra of the thermionic discharge in carbon monoxide. A new band spectrum.—Max **Morand**: The spectrum of the light emitted by the stoppage of the positive rays of lithium.—Jean **Lecomte**: Qualitative studies on the infra-red absorption spectra of organic bodies.—H. **Chipart**: General properties of optically active media.—Pierre **Auger**: The secondary β-rays produced in a gas by the X-rays.—G. **Bruhat** and M. **Pauthenier**: The destruction of carbon bisulphide by the ultra-violet rays. A mercury arc lamp focussed on a glass cell containing carbon bisulphide gives a deposit of sulphur in a few seconds. If the quartz plate forming the side of the cell is lightly half-silvered, silver sulphide is formed by the action of the rays, and a sort of photograph of the ultra-violet spectrum is obtained.—Germaine **Cauquil**: The esterification of some homologues of cyclohexanol.—Paul **Pascal**: The plurality of the insoluble alkaline metaphosphates.—Pierre **Jolibois** and L. **Chassevent**: Solutions of calcium sulphate.—E. **Darmois**: The melting-points of mixtures of camphene and pinene. Remarks on a recent note by M. Austerweil.—V. **Auger** and Mlle. I. **Robin**: A basic zinc acetate analogous to the acetate of beryllium. Anhydrous zinc acetate, heated to 250° in a good vacuum, gives a crystalline sublimate of a basic zinc acetate $Zn_4O(C_2H_3O_2)_6$. The basic beryllium acetate of Urbain and Lacombe $[Be_4O(C_2H_3O_2)_6]$ resembles the zinc compound in its composition, volatility, and crystalline form (octahedra).—M. **Picon**: The effect of heat on hydrated sodium thiosulphate and sodium sulphite in a vacuum.—A. **Kling** and M. and Mme. A. **Lassieur**: Study of the separation of aluminium and iron from zinc, manganese, and nickel by the basic acetate method.—Marcel **Oswald** and Robert **Pinta**: The treatment of coals with liquid naphthalene. Working in an atmosphere of nitrogen, liquid naphthalene at the temperature of its boiling-point dissolved from 12 to 18 per cent. of the coals examined.—P. **Brenans** and C. **Prost**: A new *p*-iodoxybenzoic acid. The starting-point for the preparation of this acid was nitroanthranilic acid: the acid $[1.4.2].C_6H_3(CO_2H).(OH)I$ was obtained.—M. **Bourguel**: A partial dehydration of aldehyde and ketones leading to the production of acetylenic hydrocarbons.—Georges **Dupont**: An hypothesis on the related origins of the terpenes and the crystallised acids constituting the resins of conifers. Accepting the view of Köhler that the substance secreted by the resin-producing cells is an aldehyde of the composition $C_{10}H_{16}O$, the author's hypothesis is that the terpene and resin acid are produced by diastatic action according to the equation

$$3C_{10}H_{16}O = C_{10}H_{16} + C_{20}H_{30}O_2 + H_2O.$$

This requires that the terpene and acid must exist in definite proportions in the crude turpentine, and this has been verified by the author for some turpentines.—H. **Gault**, Frédéric A. **Hessel**, and Yervante **Altchidjian**: The pyrogenic dissociation of the acyclic hydrocarbons.—M. **Lespieau**: The preparation of true doubly acetylenic hydrocarbons. A description of the preparation of $CH{:}C(CH_2)_7.C{\equiv}CH$ and $CH{:}C(CH_2)_{12}.C{:}CH$.—Albert **Baldit**: Magnetic measurements in the south of France. The magnetic elements (reduced to January 1, 1922) are given for 47 stations, of which 14 are new points.—A. **Hée**: The intensity of respiration in plants and the law of size.—André **Broca** and **Turchini**: The movements of the eyes.—Alphonse **Labbé**: The curious sensitive organs of the male allomorphs of *Eurytemora velox*.

Official Publications Received.

Journal and Proceedings of the Royal Society of Western Australia. Vol. 9, Part 2, 1923. Pp. 121. (Perth.) 5*s*.

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1923. No. 72. Pp. 115. (Marlborough.)

Papers and Proceedings of the Royal Society of Tasmania for the Year 1923. Pp. v+188+13 plates. (Hobart: Tasmanian Museum.) 10*s*.

The Indian Forest Records. Vol. 10, Part 6: General Volume Tables for *Sal* (*Shorea robusta*) Classified by Diameter and Height. By S. H. Howard. Pp. iii+58+7 plates. (Delhi: Government Central Press.) 1.7 rupees.

Survey of India. General Report for 1922-23: from 1st October 1922 to 30th September 1923. Prepared under the Direction of Col. C. H. D. Rider. Pp. vii+61+7 maps. (Calcutta: Survey of India). 2 rupees; 4*s*.

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 254: Emissive Tests of Paints for decreasing or increasing Heat Radiation from Surfaces. By W. W. Coblentz and C. W. Hughes. Pp. 171-187. (Washington: Government Printing Office.) 5 cents.

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1923. Pp. ii+14. (Cape Town.)

Botanical Survey of South Africa. Memoir No. 6: A Preliminary Check List of Plant Diseases occurring in South Africa. Compiled by Dr. E. M. Doidge. Pp. 56. (Pretoria: Agricultural Department.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1364: Important Pecan Insects and their Control. By John B. Gill. Pp. 49. (Washington: Government Printing Office.) 10 cents.

The Carnegie United Kingdom Trust. Tenth Annual Report (for the Year ending 31st December 1923) submitted by the Executive Committee to the Trustees on Friday, 14th March 1923. Second impression. Pp. ii+90. (Dunfermline.)

Scripta Universitatis atque Bibliothecae Hierosolymitanarum. Vol. 1, VII: Beweis der Nichtexistenz eines überall regulären zentrisch symmetrischen Feldes nach der Feld-Theorie von Th. Kaluza. Von Albert Einstein und Jakob Grommer. Pp. 5+4. Vol. 1, XII: Fluid Motion past Circular Barriers. By S. Brodetzky. Pp. 14+14. Der Vibrationssinn. Von David Katz. Pp. 14+10. (Hierosolymis [Jerusalem]; The Hague: Martinus Nijhoff.)

Observatoire de Zi-ka-wei. Notes de Sismologie, No. 5: Étude sur les microséismes. Principaux sismogrammes, juillet-décembre 1923. Par le Rév. P. E. Gherzi. Pp. 19+8 planches. (Zi-ka-wei, Chang-hai.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 5, 1923. 1: Månadsöversikt över väderlek och vattentillgång. Pp. 124. (Stockholm.) 2·50 kr.

City of Norwich. The Report of the Castle Museum Committee to the Town Council, 1923. Pp. 25. (Norwich.)

The British Science Guild. Annual Report, 1923–1924. Pp. 16. (London: 6 John Street, Adelphi.)

The University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor for the Session 1922–1923. Pp. 11. (Leeds.)

The Institute of Physics. Report of the Board for the Year 1923. Pp. 13. (London: 10 Essex Street, Strand.)

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 2, No. 23: The Geology of Prince Charles Foreland, Spitsbergen. By Dr. G. W. Tyrrell. Pp. 443-478+2 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 5s.

Diary of Societies.

SATURDAY, MAY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Nabokoff: Shakespeare in Russia.

MONDAY, JUNE 2.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 5.—Sir Frederick Lugard: The Mandate System and the British Mandates.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. G. Dawes Hicks: Force and Energy in Nature.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—R. A. Frazer and E. F. Relf: Central Spitsbergen and Northeast Land.

TUESDAY, JUNE 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Major W. S. Tucker: Acoustical Problems (II.). Outdoor Problems.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—H. S. Pearson: (1) The Skull of the Dicynodont Reptile *Kannemeyeri*; (2) A Dicynodont Reptile reconstructed.—R. I. Pocock: The External Characters of the Pangolins (Manidæ).—Prof. J. P. Hill and Dr. E. A. Fraser: Some Observations on the Female Urogenital Organs of the Didelphyidæ.—Mary L. Hett: A New Land-Nemertean from New South Wales.—Hem Singh Pruthi: (1) The Post-Embryonic Development and Homology of the Male Genital Organs of *Tenebrio molitor* (Coleoptera); (2) The Development of the Ovipositor and the Efferent Genital Ducts in *Tenebrio molitor* (Coleoptera), with Remarks on the Comparison of the latter Organs in the two Sexes.—Dr. C. F. Sonntag: (1) The Comparative Anatomy of the Tongues of the Mammalia. X. Rodentia; (2) The Comparative Anatomy of the Tongues of the Mammalia. XI. Marsupialia and Monotremata.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—The Analysis of Motion by Kinematography.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Annual General Meeting.

WEDNESDAY, JUNE 4.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. H. H. Swinnerton: A New Catopterid Fish from the Keuper of Nottingham.—Dr. C. E. Tilley: A Preliminary Survey of Metamorphic Zones in the Southern Highlands of Scotland.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.—Dr. C. Da Fano: A Parasitic Form of Encephalitis of the Domestic Rabbit in its relation to the Experimental Transmission of Epidemic Encephalitis.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Dr. F. W. Aston: Atoms and Isotopes (May Lecture).

THURSDAY, JUNE 5.

ROYAL SOCIETY, at 4.30.—J. E. Littlewood and A. Walfisz: The Lattice-Points of a Circle.—P. L. Kapitza: A Method of producing Strong Magnetic Fields.—Dr. V. Henri and H. de Làszlò: The Analysis of the Absorption Spectrum of Naphthalene Vapour: The Structure and Activation of the Molecule of Naphthalene.—W. Jevons: The Band Spectra of Silicon Oxide and Chloride, and Chlorides of Carbon, Boron, and Aluminium.—R. C. Johnson: Ultra-violet Emission Bands associated with Oxygen.—Sir Richard Paget, Bart.: The Nature and Artificial Production of Consonant Sounds.—Prof. H. S. Allen: The Band Spectrum of Hydrogen.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. C. G. Seligman: The Veddas of Ceylon.

CHEMICAL SOCIETY, at 8.—Prof. T. M. Lowry and H. S. French: The Absorption Spectra of Camphor and of Camphorquinone.—H. Burgess and Prof. T. M. Lowry: Studies of Dynamic Isomerism. Part XVI. Mutarotation of Beryllium Benzoylcamphor. Formation of an Addition-compound with Chloroform. The Optical Activity of Beryllium.

FRIDAY, JUNE 6.

PHILOLOGICAL SOCIETY (at University College), at 5.30.—W. Worrall: Dictionary Evening.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Lord Rayleigh: The Glow of Phosphorus.

SATURDAY, JUNE 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. Nabokoff: The Historical Trilogy of Count Alexis Tolstoi.

PUBLIC LECTURES.

SATURDAY, MAY 31.

BRITISH EMPIRE EXHIBITION (Conference on Science and Labour), at 11.—Sir Arthur Newsholme, Dr. C. S. Myers, Dr. Cyril Burt, Miss May Smith, and others: Science and the Human Factor. Chairman: Miss Margaret Bondfield.—At 3.—R. H. Tawney, Sir Thomas Holland, Dr. R. P. Scott, and others: Science in Educational Organisation. Chairman: Rt. Hon. Arthur Greenwood.

TUESDAY, JUNE 3.

BRITISH EMPIRE EXHIBITION (Empire Mining and Metallurgical Congress), at 11 A.M.—Viscount Long of Wraxall: Mineral Resources, and their relation to the Prosperity and Development of the Empire.

WEDNESDAY, JUNE 4.

BRITISH EMPIRE EXHIBITION (Empire Mining and Metallurgical Congress), at 10.30, 2, and 4.30.—The following Papers will be introduced and discussed on this and the following day:—Section A—Mining: E. Williams: Economics of the Coal Mining Industry.—Prof. H. Louis and H. F. Marriott: Economics of the Metalliferous Mining Industry.—Researches on Safety Problems in Mining: (*a*) Introduction by Sir Edward Troup, with Sections dealing with: (*b*) Coal-mining Explosives, Sir Frederic Nathan; (*c*) Spontaneous Combustion of Coal, Dr. J. S. Haldane; (*d*) Fire-damp Explosions, Prof. H. B. Dixon; (*e*) Coal-dust Explosions, W. Mason; (*f*) Electricity in Coal Mines, R. Nelson; (*g*) Miners' Safety Lamps, Dr. R. V. Wheeler.—Dr. J. S. Haldane: Physiological Problems in Mining.—Dr. T. L. Llewellyn: Miners' Nystagmus—Its Prevention and Cure.—Prof. D. Hay and R. Clive: Ventilation in Mines.—E. L. Hann: Provision of Compressed Air in Mines.—S. Mavor: Mechanical Problems in Coal-getting.—F. S. Sinnatt and H. E. Mitton: Preparation of Coal for the Market.—S. G. Blaylock and others: The Mining and Treatment of Zinc-Lead-Silver Ores at the Sullivan Mines, British Columbia.—R. H. Kendall and A. F. Hosking: Treatment of the Gold-bearing Quartz of the Kolar Goldfield.—L. G. Attenborough: Tin-mining in the Federated Malay States.—Section B—Petroleum: Sir Robert Waley-Cohen: Economics of the Oil Industry.—T. Dewhurst: Petroleum Geology.—A. Beeby Thompson: Petroleum Engineering and Drilling.—C. Dalley: Petroleum Engineering.—Dr. A. E. Dunstan and J. Kewley: Crude Oils of the Empire.—E. M. Bailey: Refining of Oil-Shale.—H. Barringer: Oil Transport: Tankers and Pipe Lines.—Sir Frederick W. Black: Bulk Distribution of Oil: Depots and Bunkering.—Section C—Metallurgy of Iron and Steel: Sir William J. Larke and M. S. Birkett: Economics of the Iron and Steel Industry.—C. S. Cameron: Development of the Iron and Steel Industry in Canada.—H. M. S. Tuckwell: The Iron and Steel Industry in India: Its Rise, Present Position, and Future Prospects of Development.—F. W. Harbord and E. F. Law: British Iron and Steel Industry.—F. Clements: Modern British Blast-Furnace Practice.—Sir Robert A. Hadfield, Bart.: Fuel Economy in Iron and Steel Works.—G. Hebden: A Comparative Survey of Coke-Oven Practice in various Countries.—W. H. Hatfield: Modern Developments in the Metallurgy of Special Steels.—E. H. Saniter: Railway Steels.—J. G. Pearce: The British Cast Iron Research Association: Its Present Work and Future Development.—Section D—Non-Ferrous Metallurgy: Dr. W. Rosenhain: Aluminium and Light Alloys.—Dr. J. L. Haughton: Metallurgical Research in Government Laboratories.—Dr. R. S. Hutton: The Work of the British Non-Ferrous Research Association.—Prof. H. C. H. Carpenter: Metallurgical Education of University Rank in Great Britain.

CHELSEA PHYSIC GARDEN (Chelsea Embankment), at 5.15.—Sir David Prain: The Economic and Hygienic Relationships of Cinchona Bark and its Alkaloids (Chadwick Lecture).

LONDON SCHOOL OF ECONOMICS, at 5.30.—Rt. Hon. L. C. Amery: The Defences of the Empire.

THURSDAY, JUNE 5.

BRITISH EMPIRE EXHIBITION (Empire Mining and Metallurgical Congress), at 10.30, 2, and 4.30.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. W. Trotter: The Sensibility of the Skin in relation to Neurological Theory.

FRIDAY, JUNE 6.

BRITISH EMPIRE EXHIBITION (Conference of Engineering Societies), at 10.30.—E. Benedict and E. J. Flight: The Channel Tunnel.—R. Freeman-Matthews: Sanitation and Water and Gas Supply at the British Empire Exhibition.—A. Honeysett: Pumping in relation to Irrigation.—G. V. Mathieson: Surveying and Pioneer Roadwork in W. Africa.

BRITISH EMPIRE EXHIBITION (Empire Mining and Metallurgical Congress), at 11.30.