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Encouragement of Discovery and Invention*

A FEW years ago the International Committee of Intellectual Co-operation, "considering that intellectual property was not then sufficiently protected and that scientific property particularly was at that time not protected at all, entrusted a subcommittee consisting of MM. Destree, Millikan, Ruffini and de Torres Quevedo with the duty of examining the means by which this protection might be assured". Many schemes for affording protection were examined, among them being one for the establishment of an international bureau; a second, for the creation of a fund contributed to by manufacturers; a third, for the donation of Government funds to the discoverer; and a fourth, for the extension of the patent system to include scientific discoveries. No definite scheme for protecting scientific discoveries was, however, adopted, and in consequence the problem of affording protection was afterwards reconsidered by a committee of the American Association for the Advancement of Science. After careful consideration of the problem the committee expressed the opinion, first, that the results of research (other than medical research) that have any possible commercial importance or industrial application should be patented; and secondly, that apart from this variation of the means at present adopted for protecting scientific discoveries, no practicable and desirable alternative had been proposed. The opinion that the results of research should be patented is apparently being widely followed in Great Britain, if it is permissible to judge from the fifty-second Report of the Comptroller-General of Patents, which has just been published.

In a statement on the trend of invention during the year 1934, the Report states, for example, that considerable advance in the field of patented chemical invention has been shown in sensitising dyes used for photographic purposes, due to a closer understanding of the relationship between absorption spectra and chemical composition of the dyes, whereby sensitising action over increasingly diverse parts of the spectrum is obtained. Further, although the discovery of the hydrogen isotope, deuterium or diplogen, is at present mainly of academic interest, applications are being received of means for obtaining 'heavy water' and for the production of organic compounds containing 'heavy hydrogen'. Attention is being

* Patents, Designs and Trade Marks: Fifty-second Report of the Comptroller-General of Patents, Designs and Trade Marks, with Appendices for the Year 1934. Pp. 24. (London: H.M. Stationery Office, 1935.) 4d. net.

increasingly directed to sexual and other hormones, and a better knowledge of their chemical constitution has brought appreciably nearer the synthesis of some of these bodies and the manufacture of compounds or derivatives which exhibit to some extent the physiological properties of the hormones.

The Report states also that in the electrical arts there have been noteworthy developments in connexion with heavy-current arc rectifiers of the non-mercury type, arc-less switching in high-power switch gear, high-frequency induction coils with compressed powder cores of low permeability, and permeability tuning units in which the magnetic properties of the cores differ according to the positions of the coil and core. There has been a continued increase in inventions in connexion with electrical discharges through high vacua or gaseous media as, for example, in X-ray tubes of hitherto unknown proportions working on voltages of the order of half a million. In electrical impedance networks for filtering and other purposes, the mathematical technique is being developed in such a manner as to enable problems of increasing generality to be solved by systematic methods. The prospect of commercial broadcast television has made cathode ray tubes the focus of much invention, and is leading to the development of amplifiers suitable for handling a wide range of frequencies and to the use of special oscillators for producing deflecting potentials of saw-tooth wave form. It will be agreed from these examples in the Report that some scientific men in Great Britain at least appear to be following the advice of the American Association committee to patent those results of research that have any possible commercial importance or industrial application.

The American Association committee also expressed the opinion that, apart from patenting the results of research, no practicable alternative to the very inefficient means at present adopted for protecting scientific discoveries has been proposed. As this opinion has been generally accepted, it appears probable that the present inefficient means will perforce continue, and therefore it is advisable that consideration should from time to time be given to the question whether the existing machinery of the rewards for discoveries and inventions can be made to work more efficiently than it has hitherto done. An important part of this machinery is the publication in proper form of discoveries and inventions, because the

encouragement of work in those fields, whether it be by honours, professional appointments, patents or otherwise, is very largely dependent ultimately on public acknowledgment of the results. The Report brings to mind the different methods of considering and publishing those scientific discoveries that are not patented, and inventions that are, and leads to two suggestions for improving these methods.

The first suggestion relates to the form in which scientific papers and specifications of inventions are published. The specifications of all patented inventions have undergone examination in the Patent Office by examiners expert in the various subjects and have been accepted by the Comptroller and published in a form that ends with "a clear and succinct statement of claim" of what constitutes the invention. Further, the inventions have been classified according to the subject-matter and the classification published, although the Report states that:

"The rise of new arts and the rapid and unpredictable developments in others during the past few years have raised serious and urgent problems in the classification of the subject-matter of specifications. Some progress has been made in the solution of these problems, and it is hoped that a revised classification of such matters as the automatic control of machines and apparatus, and the manufacture of synthetic resins and cellulose and its derivatives, will soon be ready for publication."

It might be difficult for our scientific societies to deal in a similar manner with the various papers that they publish, but it would probably simplify their procedure, and it would certainly facilitate classification and future reference, if they were to insist that each paper should contain a clear and succinct statement of what the author claims as his discovery in view of the state of scientific knowledge at the date of publication. The mass of published scientific papers that are insufficiently classified, and contain only vague description, is increasing at such a rate that it seems likely to constitute a mountainous obstacle in the path of future generations of scientific research workers.

The second suggestion relates to the conditions under which scientific papers and specifications of inventions are accepted. Scientific societies appear to be more favourably placed for considering papers submitted to them than is the Comptroller-General of Patents for dealing with specifications of inventions, in that societies can refuse any paper on the ground of subject-matter or rather lack

of it, while the Comptroller is not, in general, empowered to refuse to accept a specification on the ground of lack of subject-matter of the invention. One result of this limitation of the power of the Comptroller is that there have come into existence many 'paper' patents that are clearly invalid and

are a nuisance to the public. It would certainly be no harm to the really meritorious inventor, and would probably be greatly in the public interest, if the Comptroller were empowered to refuse to accept a specification on the ground of lack of subject-matter.

Reviews

Relativity, Thermodynamics and Cosmology

Relativity, Thermodynamics and Cosmology. By Prof. Richard C. Tolman. (International Series of Monographs on Physics.) Pp. xv+502. (Oxford: Clarendon Press; London: Oxford University Press, 1934.) 30s. net.

THE general theory of relativity has now been before the scientific world for some twenty years, and the special theory considerably longer. Fifteen or sixteen years ago, the theory may be said to have definitely superseded Newtonian mechanics in the treatment of macroscopic phenomena, and the whole of physical science, with the partial exception of atomic problems, acquired a new foundation. The superstructure, of course, was in the main unaltered, for the new mechanics faded into the old for all but the most fundamental matters, but the basic laws and equations of physics demanded re-statement, and in a few particulars their requirements were at variance with those of classical theory. In these circumstances there was clearly a need for a general statement of the new position, and for more than a decade this need has been satisfied for English-speaking readers by one book—Eddington's well-known "Mathematical Theory of Relativity". There is now a second.

Comparison is inevitable, and fortunately can be made without invidiousness. In the first place, since Eddington's latest edition differs only slightly from its original, Tolman's book presents the achievements of twelve years' work of which "The Mathematical Theory of Relativity" takes no account. Eddington's treatment of cosmology, for example, is confined to a description, without details, of the now outgrown Einstein and de Sitter universes, while Tolman devotes 150 pages to a comprehensive discussion of all the models of the universe (except that of Milne, which stands outside the applications of general relativity) that have been proposed. Much of this section represents his own original work. Again, thermodynamics—which, as an important branch of mechanics, must obviously be re-expressed in relativity terms—is given full treatment by Tolman (whose book, in fact, must now be regarded as

the only up-to-date treatment of thermodynamics in existence) but is untouched by Eddington. This work is entirely Tolman's own, except for the contributions of collaborators in some of the applications. On the other hand, in order to cover so wide a field as Tolman has chosen, some sacrifice of detail has been necessary, and for the mathematical proof of many of the fundamental relations the reader is referred to Eddington. Useful appendixes summarise notation, formulæ and constants which frequently occur.

The most important difference between the books, however, arises from the difference in outlook of the writers. Eddington presents relativity as the spectacle seen from a certain extra-physical point of view. Tolman, adhering more closely to the historical development, may be said to describe the journey towards the present position from which Eddington looks back to survey the landscape: his culmination is Eddington's origin. Thus, while to Eddington special relativity is a particular case of the general theory in which the $g_{\mu\nu}$ happen to be constant, Tolman sees it as a necessary step to general relativity and gives it independent and equal treatment. Eddington is preoccupied with the idea, Tolman with the application; Eddington with the philosophical aspect of physics, Tolman with the physical aspect of philosophy.

It is a necessary consequence that the books will appeal to minds of different types. Those who find themselves responding to and enlightened by Eddington's treatment will tend to classify Tolman's work as a textbook valuable for occasional reference and for enabling one to pass examinations. Those, however—and they are many—to whom Eddington is mystical and even unintelligible, will probably find in Tolman precisely what they have been looking for—a clear, accurate, physical account of an important branch of pure and applied science. Blessed are they who can appreciate the qualities of both, for theirs is the kingdom of relativity.

It is impossible in a brief review to indicate more than the outstanding features of such a book as this. First and foremost, the admirable 'sanity' of the treatment calls for comment. By this we

mean that consistently and evidently easily maintained attitude of stability between the Charybdis of unbridled speculation and the Scylla of blinkered restriction to the palpable and tangible, which in these days is so difficult to preserve and so rarely found. The representation of a physical system as a Riemannian manifold is clearly described and its advantages emphasised, but it is never regarded as more (or less) than a very useful device, and in the discussion of both special and general relativity the geometrical treatment is given as an independent account of the phenomena running parallel to the mechanical or analytical account. In the cosmological section, again, it is never "the universe" that is discussed, but "models of the universe", and the relations between such models and astronomical observations are clearly pointed out. One of the most valuable sections of the book, in fact, is that which treats of the wide gap separating the coefficients, $g_{\mu\nu}$, of relativity formulæ from the measurements actually made in the observatory. The connexion, for example, of what we call the "law of nebular recession" with these coefficients on one hand, and with the blackening of a photographic plate on the other, though one of the most difficult and important problems of modern science, is usually slurred over as though it did not exist. Here alone, so far as we know, is an attempt made to deal with it, and though the final treatment probably yet remains to be given, one rises from this book with a greatly clarified view of the nature of the problem.

The writing is clear and unadorned, though never repellent by its austerity. If occasionally we would like a little more elaboration, we are more often thankful that the ideas are expressed so concisely and not obscured by excessive elucidation. No attempt is made to describe the various unified theories that have been proposed with the object of including gravitational and electro-magnetic phenomena in a single scheme of mathematical expression. A wholly satisfactory theory of this type has not yet appeared, and it is probably wise to leave the whole matter outside a book which, however it may have to be modified as knowledge grows, does at least represent a consensus of opinion among those interested in these matters at the present time.

From one point of view, the most important section is that dealing with thermodynamics. This, as has been said, is Tolman's own peculiar field, and although the re-expression of thermodynamics in relativistic terms has at present no practical application outside cosmology, its effect there is sufficiently revolutionary to claim for it much greater attention than it has yet received. For some reason a physical system gains

enormously in popular prestige if it is called "the universe", and the prospect of the final running-down of the universe has caused sufficient heart-burning to make a statement of the actual probabilities very desirable. According to relativistic thermodynamics, equilibrium in a gravitational field requires not uniform temperature but a temperature gradient to prevent the flow of heat from regions of higher to those of lower gravitational potential. Reversible processes can take place at a finite rate, and irreversible processes are possible without the attainment of a maximum entropy. Consequently, to use Tolman's very cautious words, "at the very least, it would seem wisest if we no longer dogmatically assert that the principles of thermodynamics necessarily require a universe which was created at a finite time in the past and which is fated for stagnation and death in the future". Disagreement with these results would be intelligible, though they have never been challenged and are accepted by many relativists, including Einstein himself. What is incomprehensible is the neglect, excusably mistakeable for a conspiracy of silence, which has been their lot while the doctrine of the inevitable heat-death of the universe has been preached as an inevitable requirement of modern science.

Mention should be made in conclusion of the excellent printing. There are a few misprints, but we have noticed none that seriously affects the arguments.

HERBERT DINGLE.

Primitive Vital Statistics

Primitive Society and its Vital Statistics. By Prof. Ludwik Krzywicki. Pp. xiii+589. (London: Macmillan and Co., Ltd., 1934.) 20s. net.

IN order to form a picture of the state of society at any time or place, some knowledge of the density and the distribution of population is very much to be desired, and may even be said to be almost indispensable. In its absence the picture can have no clear outline. If, in addition, something can be said about marital conditions and about vital statistics (and in particular about the expectation of life), such details are very illuminating. It is a matter for comment that historians and anthropologists seem so often to be unaware of the importance of the matter. It is true that it is only for recent times and for certain peoples that the information is at all complete; but there is much information of some interest, and yet there is a failure to see its importance and to use it. If anyone doubts this, let him examine some history textbooks, and notice how seldom the heading 'population' occurs in the index. For compilers of anthropological textbooks there is the

excuse that the information has not been summarised hitherto, and therefore, such as it is, is not easily available. But this does not excuse the anthropologists, who have seldom given the matter much attention when in the field, and have never attempted to gather together the facts that are known.

It has been left to the professor of social history at the University of Warsaw to perform the latter task. Dr. Krzywicki has worked on the problem for more than thirty years, and now presents us with the results of his researches. The efforts of one man, however long pursued, cannot fully cover so enormous a field, but it may be said that, whereas there was formerly no organised knowledge of the population and vital statistics of primitive society, we now have a wealth of data subjected to critical analysis. Dr. Krzywicki is very fully aware of the defective nature of the material available. With the best will in the world it is very difficult for observers in the field to obtain correct statistical data in any quantity about primitive races. In fact, as the author points out, observers have seldom been much interested in this side of native life, and in consequence the existing numerical data "have really just got by chance into the pages of books of first-hand information".

The first matter to which the author gives attention is the size of the tribe and the density of population. Here, as in regard to the other problems examined, the most extensive data come from Australia and North America. He finds that out of some 120 Australian tribes, 70 number less than 500 persons, the average for all the tribes being less than 550. In North America the average size is greater, but out of some 500 tribes more than 300 number less than 1,000 persons. In the rest of America the position is similar. The strict limitation thus placed upon social intercourse is certainly a fact of the first importance in the attempt to understand primitive society and the stagnation which it characteristically exhibits.

The author next addresses himself to the dying-out of primitive races after contact with Europeans. His explanation is in line with that of other workers on the subject. The death-rate rises owing to the introduction of new diseases; the native scheme of life is destroyed. In consequence, there is little or no object in attempting to rear children who are likely to die, and for whom, if they survive, there is no obvious place. Therefore abortion and infanticide become more prevalent just when they are less needed.

The largest part of Dr. Krzywicki's work, however, is concerned with the vital statistics of primitive races before contact with Europeans had produced marked results. We are given a

great mass of material; it is unlikely that any important additions to it will ever be made, because the search of the literature has been so thorough and the opportunities of getting new information are now so restricted. The evidence points to a low fertility and a high infant mortality everywhere among primitive races. It is unusual for a woman to bear as many as five children; the common number seems to have been between three and four. Only about fifty per cent reach maturity. Though Dr. Krzywicki finds that infanticide was in some places very prevalent, he does not regard it as a very important factor, for two reasons. The children killed were sometimes the weaker; more often they were from a family where there were already young children; therefore in any case the chance of survival was remote. Though for the most part the author is concerned with collecting and analysing the facts, he also enters into some interesting discussions as to their implication, as for example, of the importance of the small size of the tribe.

A. M. CARR-SAUNDERS.

Life-Histories of Farm Weeds

Prof. Dr. E. Korsmo's Weed Plates. Series 1. Plates 1-30, comprising 42 Species of Weeds on Cultivated Soil. 84 cm. x 64 cm. With Descriptive Booklet. Pp. 78. (Oslo: Norsk Hydroelektrisk Kvaestofaktieselskab. Leipzig: Koehler und Volkmar A.-G. und Co., 1934.) Paper, 22 gold marks; Leather paper, cloth edges and eyelets, 38 gold marks.

PROF. KORSMO has conceived and produced the most accurate and detailed exposition that has ever been attempted of many common weeds in all stages of development. With the aid of generous financial support from Norwegian producers of synthetic nitrogen, three series of thirty plates each have been prepared for use as wall diagrams, specifically for teaching purposes. The drawings have been made from living plants in natural colours, under Korsmo's personal direction and control, and their detailed accuracy is remarkable. The plates are accompanied by a separate text giving the common names of each weed in a dozen languages, and a general description of its characteristics and habits, together with explanations of the plate figures. This text is being published in various languages, as most of the weeds are cosmopolitan in distribution.

The illustrations cover a wide field, the aim being to show all the features characteristic of each weed during its life-history. To this end, the morphological sketches are frequently supplemented by anatomical drawings, as, for example,

in *Chenopodium album*, where a leaf section shows the unusual type of pubescence in this species. In *Taraxacum officinale* the regeneration from mutilated roots under various environmental conditions is demonstrated, together with sections showing the origin of secondary shoots. It is impossible to indicate the wide range of developmental stages covered in these plates, but it is

safe to say that all teachers of agriculture and students will find the plates a mine of information, and that experts are the richer by a valuable work of reference. Prof. Korsmo is to be congratulated on the outstanding merit and value of this work and, not least, upon the ability and sympathy of the artists responsible for the drawings.

W. E. B.

Short Notices

The Endless Quest : Three Thousand Years of Science.

By F. W. Westaway. Pp. xx+1080+51 plates. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1934.) 21s. net.

IT is very difficult to review such a book as this—or perhaps we should say “this book”, for there can scarcely be another such. Judged by the aim which the title suggests it is, of course, a failure : to deal adequately with 3,000 years of science in a single volume is a sheer impossibility. The impossibility is, in fact, so obvious that such a judgment would clearly be absurd. We can only take the book as an isolated phenomenon and record its effect on a mind freed from preoccupation with ideas of what it should be. When this attitude is adopted, the result is wholly pleasurable. The author talks to us out of a vast store of knowledge in a manner which, subject to a broad classification on a chronological and subject basis, is delightfully informal. Biographical notes, descriptions of scientific institutions, quotations, expositions, criticisms, reflections mix with one another in the most casual way, and it is hard to imagine a more satisfying book into which to dip at those not infrequently occurring intervals which are too brief for systematic work and too long to be wasted. Photographs and diagrams are numerous and excellent ; there are questions for the problem-minded and bibliographies for those who wish to pursue the subjects raised ; and there is a good index.

Of the two possible viewpoints—those of the present time and of the timeless observer—Mr. Westaway has chosen the former : hence recent work assumes a prominence even greater than that to be expected from its great bulk. From this cause arises what is perhaps the chief defect of the book ; it is difficult on any grounds to justify the inclusion, in an account of 3,000 years of science, of the remarks of individual speakers at a Royal Society discussion on heavy hydrogen, for example. But away with criticism : the book is a pleasure to read, and we are grateful to Mr. Westaway for it. H. D.

Annual Reports on the Progress of Chemistry for 1934.

Vol. 31. Pp. 442. (London : Chemical Society, 1935.) 10s. 6d.

MUCH fundamental work is summarised in the Chemical Society's Annual Reports for 1934. Mr. R. P. Bell gives an account of the heavy isotope of hydrogen. ‘Heavy water’, or deuterium oxide, is in

fact now an article of commerce, being separated by an electrolytic method. Dr. L. A. Woodward's section on the Raman effect gives a connected account of some of its applications ; Dr. N. V. Sidgwick discusses the theory of resonance and the co-ordination of hydrogen, and presents a short statement on heats of formation in homologous series ; Mr. E. J. Bowen contributes a review of work in chemical kinetics ; Mr. Bell is responsible for sections dealing with electrolytes, kinetic salt effects, and acids and bases ; whilst Dr. H. W. Thompson refers to the emission of electrons in chemical change, to certain spectroscopic considerations, to nuclear moments, to the structure of liquids, to optical activity, to valency and the structure of molecules, to supersonic waves, and to optical phenomena and energy transfers. Prof. R. Whytlaw-Gray gives an account of atomic weight work ; Dr. W. Wardlaw of metallic carbonyl and nitrosyl compounds, of molecular structures, and of some of the rarer metals ; Dr. E. S. Hedges discusses the corrosion of metals. The report on aliphatic organic chemistry is presented by Dr. H. D. K. Drew, Dr. R. S. Morrell, Dr. E. L. Hirst and Dr. S. Peat ; Dr. G. A. R. Kon and Dr. T. G. Pearson are responsible for that on the homocyclic division, and Dr. E. E. Turner for that on the heterocyclic division. Analytical chemistry is in the charge of Mr. B. A. Ellis, Dr. J. J. Fox, Dr. S. Glasstone and Mrs. J. W. Matthews. Dr. C. P. Stewart and Mr. A. G. Pollard present an account of advances in biochemistry, whilst Dr. N. Feather discusses radioactivity and subatomic phenomena. These reports are universally valued by chemists and others who wish to keep abreast of modern developments in the subject.

A. A. E.

Chemical Engineering Plant Design. By Prof. Frank C. Vilbrandt. (Chemical Engineering Series.) Pp. x+341. (New York and London : McGraw-Hill Book Co., Inc., 1934.) 24s. net.

ANYONE who purchases this book from its title and expects to acquire information on the design of various machines and plant used in chemical works will be disappointed, since the various chapters are devoted to such subjects as location, foundations, drainage, buildings, pumps, piping, and flow diagrams, power and power transmission, and preconstruction cost accounting. The problems considered, therefore, are those associated with the layout and construction

of a chemical works and not the design of the individual machines installed therein, although in one chapter entitled "Selection of Process Equipment" brief descriptions are given of the types of machines suitable for specific operations in chemical works.

Throughout the book there are copies of questionnaires issued by various firms to enable them to assess the purchaser's requirements before submitting a quotation. There is also a large number of tables giving data upon a wide variety of subjects which would be valuable to anyone planning or constructing a chemical works. As the theory underlying any design is not fully discussed, the utility of the book, which might well be entitled "Problems in Planning a Chemical Works", depends upon the data and hints accumulated from practical sources.

The English in places is somewhat involved and prevents the reader easily acquiring the information which the author wishes to impart.

Introduction to Early Roman Law: Comparative Sociological Studies. By C. W. Westrup. *The Patriarchal Joint Family. 2: Joint Family and Family Property.* Pp. iii+192. (Copenhagen: Levin and Munksgaard; London: Oxford University Press, 1934.) 12s. 6d. net.

In this volume—a memorial volume to Sir Henry S. Maine—the author reviews two aspects of the family as an institution in the life of early Rome in so far as it is reflected in early law. In type it conforms to the pattern of the Indo-European joint family. It is compared here with the family as it is found in the records of, or in survivals among, the Indo-European peoples, Teutons, Celts, Slavs and Indians.

The controlling factor in both family organisation and inheritance of property was first the necessity for ensuring the continuance of the family cult and secondly the desire to preserve property as a group possession. The latter in the mind of the practical Roman was the more important binding force in securing the perpetuation of the family tie, centring in the inheritance by the eldest son as the controlling power in the group, but without the right of absolute possession or disposal. The author here examines in detail the modifications of the type which were introduced in Roman practice and traces the course of development in the idea of the family and family property under the influence of various factors, of which in the main the growth of the concepts of the individual family and individual property were the most decisive.

Elementary Qualitative Analysis. By Dr. F. M. Brewer. Pp. viii+228. (Oxford: Clarendon Press; London: Oxford University Press, 1933.) 6s. net.

There is a gratifying tendency for modern general text-books on analysis to become something more than collections of tables and recipes by the extension of their scope to include other matter: thus, a text on the quantitative side will deal with the underlying physico-chemical considerations. In the present handy volume, which for the sake of brevity confines itself to the familiar arbitrary common radicles, an attempt is made to emphasise the connexion between

the analytical groups and the groups of the Periodic Table, thus combining the general behaviour of an element with its analytical reactions. As an example, it is pointed out that, with one exception, those metals which are precipitated by hydrogen sulphide from acid solution occur in Nature predominantly as sulphides; this relationship, which can be extended to other insoluble compounds utilised in qualitative work, has a perfectly simple explanation, and yet is almost universally overlooked.

Of the general descriptive matter, little need be said since almost of necessity it must follow the familiar lines; nevertheless, in view of the dual purpose of the book, the volume has a just claim for favourable consideration among the numerous members of its particular class. B. A. E.

Encyclopaedia of Veterinary Medicine, Surgery and Obstetrics. Edited by Prof. George H. Wooldridge. (Oxford Medical Publications.) Second edition. In 2 vols. Vol. 1: *Veterinary Medicine.* Pp. xvi+836+xlix+2 plates. Vol. 2: *Surgery and Obstetrics.* Pp. viii+837-1652+li+plates 3-6. (London: Oxford University Press, 1934.) 126s. net.

THIS encyclopaedia, edited by Prof. George H. Wooldridge, professor of medicine and hygiene at the Royal Veterinary College, London, is written by a panel of forty-eight veterinarians, all recognised authorities in their special subjects. Intended to be of use to general practitioners, owners of valuable animals and medical men interested in animal diseases, pathological detail is reduced to the minimum necessary for the understanding of clinical conditions. In keeping with the growing importance of the subjects, new chapters on deficiency diseases and endocrinology have been introduced in this, the second, edition. The work is comprehensive, authoritative, well illustrated, and arranged on a systematic as opposed to an alphabetical plan. A table of contents, author and subject index make reference easy. The work will be of real value to all interested in the more practical aspects of animal disease.

The Indus Civilization. By Dr. Ernest Mackay. Pp. viii+210+16 plates. (London: Lovat Dickson and Thompson, Ltd., 1935.) 6s. net.

THIS little book is the first of a series of handbooks of sectional archaeology, authoritative but not technically advanced, intended for both the general reader and the student. Dr. Mackay has covered the main outline of the results of the excavation of the prehistoric sites of northern India and the relations, chronological and cultural, of the Indus civilisation adequately and with the lucidity to be expected from his intimate and detailed knowledge. He appends a useful bibliography and an excellent series of small but very clear illustrations. If the volumes which follow maintain the standard of the first—and they should if the names of the authors who are to contribute may be taken as a guarantee—this series will be a distinct addition to the literature of 'science made popular' in the best sense.

The Differential Analyser

By PROF. D. R. HARTREE, F.R.S., Beyer Professor of Applied Mathematics, University of Manchester

PURPOSE

THE application of mathematics to problems both of pure and applied science often leads to differential equations which have no formal solution in quadratures or in terms of tabulated functions, but for which numerical values of the solutions are required. Until recently, the only available methods for evaluating the solutions of such equations were graphical methods, which are rather limited in scope and accuracy, and numerical methods, which are lengthy and require continual concentrated attention on the part of the worker, and rapidly become more laborious the more elaborate the equations. So the development of a mechanical method, rapid, accurate, and applicable to a wide range of equations, is an advance of considerable importance, with applications to a wide range of problems of scientific and technical interest.

Such an advance has been made by Dr. V. Bush, of the Massachusetts Institute of Technology, by the development of a machine known as the differential analyser, of which the first was designed and built there¹. The general idea of such a machine in the abstract is due to Lord Kelvin², but the practical design of a machine which could be made, and would work accurately when made, is due essentially to Dr. Bush.

A similar machine, with which the writer has been closely concerned, has been built at the University of Manchester; a short notice of the formal opening of this machine appeared in NATURE recently³. Another such machine has quite recently been built at the University of Pennsylvania.

CONSTRUCTION

The machine consists of a number of units which can be connected to shafts which drive them or are driven by them. These shafts can be connected together by gearing in various ways, so that the relations between the rotations of the different shafts satisfy various differential equations. The adaptability of the machine as a whole, which is one of its most important features, depends essentially on the wide range of possibilities of such interconnexions.

The essential units are those called integrators, since they carry out mechanically the operation of integration. Each of these is a continuously variable gear, consisting of a friction drive from a horizontal disc, which can rotate about a vertical axis, to a vertical wheel resting on it; the distance from the centre of the disc to the point of contact

of the wheel with it can be varied by displacing the disc, the axle of which is carried in bearings in a carriage which can move along a pair of guide bars. This displacement of the disc represents the integrand, the rotation of the disc represents the variable of integration, and the rotation of the wheel represents the result of the integration (Fig. 1).

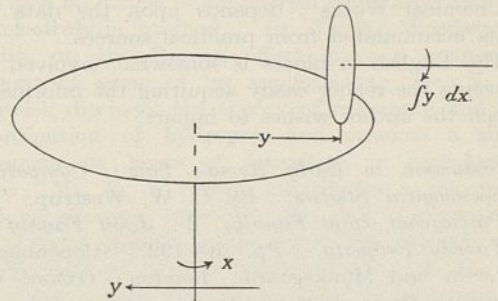


FIG. 1. Principle of the integrator.

It is essential for accurate operation of the machine that, in the rotational motion of the disc, there should be no slip between disc and wheel at the point of contact. On the other hand, it is often necessary to make such connexions that a considerable amount of mechanism is to be driven by the rotation of the wheel, and the friction at the point of contact between disc and wheel is quite insufficient to provide the necessary torque on the shaft. To avoid this difficulty, an ingenious mechanical servo-mechanism, called a torque-amplifier, has been developed by Dr. Bush for this purpose. Its operation is similar in principle to a power-operated capstan. A band passes round a drum which is driven by an independent source of power and is continually running; one end of the band is fixed to an arm on the shaft carrying the integrating wheel, and the other to an arm on another shaft (output shaft) coaxial with it. The rotation of the integrating wheel tightens the band and therefore increases the friction between it and the drum, and this additional frictional force on the band pulls round the arm attached to the output shaft, so that in effect the rotation of the integrating wheel simply operates as a control of the supply of power to the output shaft. As developed by Dr. Bush, this control is very delicate, the torque required to operate it being about one ten-thousandth of the torque required to drive the output shaft, and this small torque can be provided by friction between disc and integrating wheel without any danger of slip.

Other units are input tables, used for supplying

to the machine information in the form of a functional relation between variables occurring in the equation. A graph representing this relation is fixed to a board spanned by a movable bridge carrying a pointer which can be moved along it. The position of this pointer along the bridge is controlled by rotation of a handle, which also drives the shaft to which the information expressed by the curve is to be transmitted. The bridge is moved across the table by the operation of the machine, and an operator stationed at the table

In addition, there are differential gears which serve to add or subtract the rotations of two shafts, and 'front-lash units', the object of which is to compensate any backlash in the various drives. This is achieved by a gear train arranged to give a small and adjustable angular advance of a driven shaft relative to a driving shaft, at each occasion on which the direction of rotation of the latter changes.

The machine is driven by electric motors. One motor drives the shaft the rotation of which

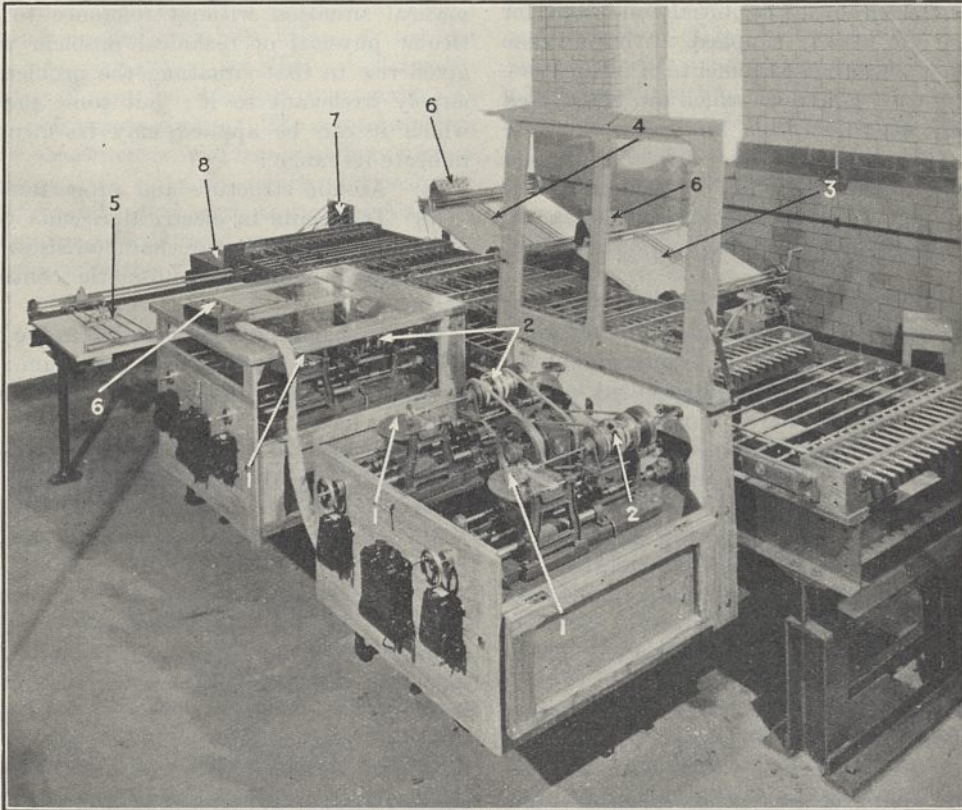


FIG. 2. General view of the differential analyser at the University of Manchester. 1, Integrators; 2, torque amplifiers; 3, input table; 4, special input table; 5, output table; 6, control switches; 7, revolution counters; 8, base for camera (camera not shown). Photograph by Metropolitan-Vickers Electrical Co., Ltd.

turns the handle to keep the pointer on the curve as the bridge moves.

There is also an output table, similar in construction to an input table, on which the machine delivers the result in the form of a graph of the solution of the equation. For a general survey of the behaviour of the solution, this is the most convenient form of record, but it is not suitable if quantitative results are required, on account of the distortion of paper with changes of temperature, etc., and also on account of the time required to measure up the curves. An alternative recorder is a camera which takes photographs, at selected intervals, of a set of revolution counters which can be connected to the appropriate shafts.

represents the independent variable, and each pair of integrators has a motor driving their two torque amplifiers, one for each integrator. The running of the machine is controlled by a set of switches placed conveniently for an operator who may be following a curve on an input table. These switches operate contactors which control the supply of current to the various motors.

A general view of the machine at the University of Manchester is shown in Fig. 2, in which the main component units are indicated.

OPERATION

The operation of the machine involves two processes: first that of setting up the inter-

connexions between the units in such a way that the relations between certain shafts satisfy the equation in question; and secondly the carrying out of an actual solution of the equation.

The setting-up is first carried out in diagrammatic form, on paper, and the scales on which the rotations of shafts represent variables in the equation are decided. At this stage, experience counts for a lot, in discovering how to put an equation on the machine, and in deciding between various alternative ways which may be possible. The interconnexions on the machine are then set up from the diagram. The initial conditions for the solution are usually supplied to the machine in the form of initial displacements of integrators.

There are many equations which can be handled without any attention from an operator in the course of the running of the machine, beyond pressing the control switches. Other equations require the use of one or more input tables, for each of which an operator is required as explained above.

The process of setting up the machine may take from half a day to a day, but once it is set up, a solution may be obtained in ten to fifteen minutes, this time being practically independent of the complexity of the equation so long as it is within range of the machine, whereas the process of solution of a comparatively simple equation by purely numerical means would probably take an experienced worker four hours to a day of work which needs continuous careful attention, as, although it is of a routine nature, it is not altogether simple and straightforward; a more elaborate equation, or a less experienced worker, would require much longer.

Use of the machine may thus not lead to a great saving of time when only a single solution of an equation is required, though even then there is considerable saving of mental labour of a routine kind. But when a number of solutions of one equation, for example, solutions with different initial conditions, or different values of numerical coefficients occurring in it, are required, the time occupied in setting up the machine for the equation is a small proportion of the whole period concerned with work on that equation, and the total time required to obtain a specified set of solutions may then be reduced by a factor of 10 or 20. This very large saving of time, and the corresponding saving of mental effort, is important not only in dealing with problems which would in time be dealt with in any case, but even more in making it practicable to undertake extended investigations which without such mechanical assistance would be altogether too laborious and time-consuming.

Further, since the time and labour of mechanical solution does not increase appreciably with the

complexity of the equations, whereas the time and labour of numerical solution does increase very considerably, the value of the machine increases rapidly with the complexity and range of equations within its capacity, and this increases rapidly with the number of units of which it is constituted. A machine with eight integrators, for example, is very much more than twice as valuable as one with four integrators.

APPLICATIONS

Since the differential analyser handles a mathematical situation without reference to the particular physical or technical problem which has given rise to that situation, the problem itself is largely irrelevant to it; but some problems to which it can be applied may be mentioned to indicate its range:

- (a) Atomic structure and properties.
- (b) Transients in electrical circuits containing elements with non-linear characteristics.
- (c) Performance of automatic control mechanism.
- (d) Propagation of radio waves in the Heaviside layer, regarded as a stratified medium.
- (e) Vibrations of systems with non-linear restoring forces.
- (f) Paths of electrified particles in the field of a magnet (for example, in connexion with the theory of the aurora and of cosmic radiation).
- (g) Equilibrium and stability of stellar structures.

By the nature of the case, the differential analyser provides a numerical (or graphical) solution of an equation with definite numerical values of coefficients in the equation, and of initial conditions, and cannot provide a general analytical solution; indeed, one of its virtues is that it can be applied to equations for which no such solution exists. Thus it does not seem likely to be of any great interest or value in purely mathematical fields, in which the interest, if any, in the solution of any equation lies in the general form of the solution, or in its formal analytical expression. On the other hand, in physical and technical investigations, it is often the special solutions, and actual numerical values, which are required; and it may happen that even if there is a formal analytical solution, it is unsuitable for numerical evaluation. So that it is mainly in connexion with such applications that the differential analyser is likely to be used.

THE DIFFERENTIAL ANALYSER AT THE UNIVERSITY OF MANCHESTER

In general design and in many details, the differential analyser at the University of Manchester, which has been constructed by the

Metropolitan-Vickers Electrical Co., Ltd., follows closely Dr. Bush's original machine at the Massachusetts Institute of Technology, but several modifications in detail have been made.

The machine is being built in two sections, one of which is now complete. This completed section comprises four integrators and two input tables, the output table, and a special camera designed and built by Messrs. Newman and Guardia, Ltd., for the photographic recorder. One of the input tables is of special construction, for handling equations describing the behaviour of a system in which the rate of change of a quantity at time t may depend explicitly on its value, or on the values of other quantities, at time $t - T$ (where the time-lag T may be constant or variable) as well as on their values at time t . The second section, now under construction, will comprise four further integrators, making eight altogether, and probably four further input tables, and, as explained above, the greater range will very greatly increase the value of the machine.

The construction of this differential analyser has been made possible, first through the great generosity of Mr. Robert McDougall, deputy treasurer of the University, who first gave to the University a donation to cover the estimated cost of the first section, now completed, and has recently supplemented this by a further donation to cover the completion of the machine in accordance with the original estimates; secondly, by the friendly and generous co-operation of Dr. Bush himself, who freely gave his drawings, and several suggestions for improvement, and helped greatly by his advice based on experience of construction and operation of his own machine; and thirdly, through the co-operation of Mr. A. P. M. Fleming, of Metropolitan-Vickers Electrical Co., Ltd., who undertook the construction of the machine, and of those members of the firm who have been concerned in its design, construction and erection.

¹ V. Bush, *J. Franklin Inst.*, Oct. 1931, and "Proc. Internat. Congress on Applied Mechanics", Cambridge, 1934.

² Sir W. Thomson, *Proc. Roy. Soc.*, 24, 269; 1876. *NATURE*, 135, 535, April 6, 1935.

Royal Society Discussion on Supraconductivity

IN opening the Royal Society discussion on supraconductivity, Prof. J. C. McLennan referred first to new methods of helium liquefaction which have recently been developed. In Prof. F. Simon's method, high pressure helium gas is cooled to liquid hydrogen temperatures and then allowed to expand through a valve, a small quantity of liquid helium being produced which is quite adequate for many types of experiments. A second method, developed by Prof. P. Kapitza at Cambridge, applies to helium the method first used by Claude for the liquefaction of air, part of the gas doing external work in an expansion engine and so cooling the remainder below the inversion temperature of the Joule-Thomson effect, whence it can be liquefied by expansion.

Prof. McLennan then discussed the rapid progress in the attainment of temperatures near the absolute zero made possible by the adiabatic demagnetisation method, the latest experiments of de Haas with potassium chromium alum having reached a temperature of 0.0044° on the scale obtained by measuring the magnetisation and using an extrapolated Curie Law to obtain the temperature. Progress is at the same time being made in the establishment of the thermodynamic scale in this temperature region. Prof. W. H. Keesom reported that the thermodynamic scale has been established down to 0.9° K. using the helium thermometer. Prof. Simon reported the results of an ingenious method developed at

Oxford in which the heat, dQ , required to warm up the salt from its lowest temperatures to its initial temperature is determined by using γ -rays to warm up the salt. Since the entropy change, dS , on magnetisation can be calculated and the cooling is adiabatic, the temperature on the absolute scale is obtained from dQ/dS . The results show that the thermodynamic scale and the magnetic scale using iron ammonium sulphate do not differ by more than 10 per cent down to 0.08° K., but that below this temperature the thermodynamic temperature is greater than the magnetic temperature. For these lower temperatures the shape of the specimen has a large effect on the magnetic temperature owing to the increasing importance of the demagnetising coefficient.

Prof. McLennan referred also to the prediction that at these low temperatures the effect of nuclear magnetic moments should become important, owing to the thermal energy becoming comparable with the energy of magnetisation due to nuclear moments. Prof. Simon considers that it may be possible to use a two-stage demagnetisation process for the attainment of the lowest temperatures, the nuclear moments becoming effective in the second stage. Dr. Heitler's prediction in the discussion that it would take a year for equilibrium to be set up owing to the smallness of the nuclear interaction failed to shake Prof. Simon's determination to try the experiment.

The production of these low temperatures has

extended the list of supraconducting metals, and Prof. McLennan gave a list of fifteen such metals with transition temperatures ranging from 0.40°K . to 9.2°K . As Mr. J. D. Bernal pointed out in the discussion, these metals lie in Groups IVa, Va, VIa and IIb, IIIb, IVb of the Periodic Table, and in no others. A number of supraconducting alloys, on the other hand, have been discovered, such as the gold-bismuth series, the components of which lie on either side of these groups and are not themselves supraconducting. Mr. Bernal considers that supraconductivity has little to do with the crystal lattice, since superconductors of many crystal types are found. Prof. Keesom pointed out, however, that one of the varieties of tin is supraconducting whilst the other is not.

Prof. McLennan referred next to the remarkable phenomenon of the 'Meissner effect'. When a metal sphere placed in a weak magnetic field is cooled down to the temperature at which it becomes supraconducting, the lines of magnetic induction move out of the sphere at the transition temperature, and the field outside takes precisely the form which would be expected if $B=0$ in the interior of the sphere, supraconductivity being thus characterised by the conditions $B=0$, $E=0$. When the tangential component of the magnetic field reaches the critical value for supraconductivity, the lines of force re-enter and supraconductivity disappears.

Dr. Meissner described a number of further experiments on this phenomenon. Measurements have been made of the magnetic field in the space round a supraconducting cylinder placed with its axis perpendicular to the field. The lines of force in the hollow of the cylinder do not move out, but on the contrary are increased in density when the cylinder becomes supraconducting, and on removal of the external field these lines of induction remain almost unchanged, thus imparting a magnetic moment to the cylinder. As the external field is increased, the normal component of the field outside the cylinder increases, showing increasing penetration of the lines of force.

Dr. K. Mendelssohn described experiments on this phenomenon which show that only in the ideal case of a perfectly pure metal and a perfect lattice do all the lines of induction disappear from the supraconducting sphere. When the metal is impure, some of the lines of induction appear to be 'frozen in', a rod of moderately pure lead retaining about ten per cent of the flux. The results can be explained, he considers, by the formation of annular supraconducting regions in which the flux is 'locked', the formation of such regions being aided by the effect of impurities in increasing the local transition temperature for supraconductivity.

Since a state of zero magnetic induction is equivalent to a diamagnetic susceptibility of $-\frac{1}{4}\pi$, experiments on the force exerted by an inhomogeneous magnetic field on a lead sphere should show an enormous increase in the pull when supraconductivity sets in. An experiment of this type carried out at Cambridge was described by Mr. Shoenberg, the force for weak fields corresponding precisely to that expected. As the field is increased, the susceptibility remains constant until the field at the equator reaches that critical for supraconductivity. At this point, the lines of force begin to penetrate the sphere, and the susceptibility decreases to zero as the main part of the external field reaches the critical value.

Considerable discussion took place on the evidence provided by low temperature phenomena on the behaviour of electrons in metals. Thus, for supraconducting metals of high purity, the thermal conductivity is increased when the supraconductivity is destroyed by a magnetic field, in agreement with the hypothesis that the supraconducting electrons are an appreciable fraction of the ordinary conduction electrons and that they become available for heat transfer when supraconductivity is destroyed. On the other hand, the thermal resistance should tend to zero near absolute zero, whereas the actual resistivity shows a minimum and begins to rise again at the lowest temperatures, one striking case being reported by Prof. Simon in which the thermal resistivity of a copper rod became equal to that of glass at room temperature.

Prof. Keesom described experiments on the specific heats of metals which show the presence of an additional heat capacity due to the electrons, increasing linearly with temperature in the case of tin up to 9°K . Prof. N. F. Mott considers that additional evidence for the heat capacity due to electrons is provided by the specific heat of metals such as nickel at temperatures of 1000°K ., where C_v is greater than the Debye value of $3R$ by at least $1R$, the maximum contribution for electrons being $3/2R$.

Further experiments on the effect of electrons in metals were demanded by Prof. R. de L. Kronig, who suggested that the reflecting power of metals should show measurable changes on transition from the supraconducting to the conducting state. Changes should also occur in the fine structure of X-ray absorption edges and in the transmission of wireless waves by thin metal films.

Prof. L. Brillouin and Dr. F. London discussed the state of the theories of supraconductivity. The former emphasised the facts which a theory has to explain, and referred to a proof by Bloch that no classical theory can explain a stable state of persistent currents. Dr. London opened a new

attack on the problem by refusing to consider supraconductivity as the limiting case of ordinary conductivity and by considering it as a more elementary state in which the whole metal behaves like a large diamagnetic atom. A new equation, $\lambda C \text{ curl } J = -H$, relating current density and

magnetic field, is postulated, this assumption replacing Ohm's Law in a superconductor and leading directly to a solution in which stable persistent currents are possible, these currents being confined to a depth of 10^{-5} cm. below the surface of the conductor.

Obituary

PROF. H. M. MACDONALD, O.B.E., F.R.S.

HECTOR MUNRO MACDONALD was born in 1865 at Fearn, Ross-shire, and educated at Tain Academy, Aberdeen Grammar School and the University of Aberdeen, proceeding in 1886 to Clare College, Cambridge, and taking the Mathematical Tripos in 1889. The list of Wranglers was one of considerable distinction: Sir Gilbert Walker was senior, Sir Frank Dyson second, Macdonald fourth and A. S. Ramsey (president of Magdalene) sixth. He was soon elected to a fellowship at Clare, and in 1891 was Smith's Prizeman.

During Macdonald's formative period, the professorial chairs at Cambridge were occupied by Stokes, Adams (the discoverer of Neptune), Cayley, J. J. Thomson and G. Darwin; while of the other teachers, he seems to have owed most to Routh, Hobson, Glazebrook and Larmor. But perhaps his greatest debt was to Verdet's "Leçons d'optique physique", Maxwell's "Electricity and Magnetism" and the works of Horace Lamb and the third Lord Rayleigh.

Macdonald's first published papers were on hydrodynamics and the mathematical theory of electricity—waves in canals, electrical distributions on conductors of various shapes, and self-induction. In 1897, however, he began to write on pure mathematics—the relation between convergent series and asymptotic expansions, the zeros and the addition theorem of Bessel functions, various Bessel integrals, spherical harmonics and Fourier series. In the paper on the zeros of the Bessel functions (*Proc. Lond. Math. Soc.*, 29; 1898), he gave the result since known as Macdonald's theorem, that the number of zeros of a function $f(z)$ in the region bounded by a contour at each point of which $|f(z)| = a$ constant, exceeds the number of zeros of the derived function $f'(z)$ in the same region by unity, the function $f(z)$ being supposed analytic in the region.

Macdonald's reputation as a discoverer was, however, chiefly due to a third group of researches, which began with his Adams Prize essay of 1902 on electric waves, and was continued in a paper of 1903 on the bending of electric waves round a conducting obstacle, two memoirs on the diffraction of electric waves round obstacles (*Phil. Trans. Roy. Soc.*, 1911–12), several papers on the diffraction of light by opaque prisms, straight edges, etc. (*Proc. Lond. Math. Soc.*, 1913–15), and a series of papers (*Proc. Roy. Soc.*, A) from 1914 onwards on the transmission of electric waves round the earth's surface.

In 1905 Macdonald left Cambridge on being appointed to the chair of mathematics in his old

University of Aberdeen. The value of his work was recognised by the fellowship of the Royal Society in 1901, an honorary fellowship of Clare in 1914, a Royal Medal of the Royal Society in 1916, the presidency of the London Mathematical Society in 1916–18, and the Honorary LL.D. of Glasgow in 1934. During the last thirty years of his life, he took an active part in the administrative work of the University of Aberdeen and of educational institutions in the north-east of Scotland, and was almost invariably one of the delegates appointed to any conference of representatives of the four Scottish Universities. In recognition of his scientific eminence and public services, a subscription portrait was presented to the University of Aberdeen in 1933.

Macdonald never married. He died after a short illness on May 16, 1935. E. T. WHITTAKER.

PROF. W. R. HODGKINSON, C.B.E.

ON April 8, at Blackheath, died, at eighty-three years of age, Prof. William Richard Hodgkinson, one of the older school of chemists, whose interests in chemistry covered a wide field. Born at Sheffield in 1851, and educated at the Royal Grammar School there, he early came under the influence of Sorby, the father of metallography, and to this is to be traced his later work on metals and their treatment.

Having gained a scholarship to the Royal School of Chemistry and of Mines in London, Hodgkinson studied geology, and under Sir Edward Frankland organic chemistry, before proceeding to the University of Würzburg, where his natural feeling for research was stimulated by Prof. Wislicenus, whose textbook on "Organic Chemistry" he translated. On returning to England his investigations at the Royal College of Science were mostly in organic chemistry, and in this branch of chemistry he published papers on such subjects as the action of the alkali metals on organic bodies, with W. H. Perkin, junr., and on organic bases and on naphthalene derivatives, with Dr. W. Limpach, whose sister he married nearly fifty years ago.

After a short period at the Royal Military Academy, Hodgkinson became lecturer in chemistry and metallurgy at the Ordnance College, and later professor of chemistry there, retiring in 1921 after thirty-one years of service in the College (now the Military College of Science). Most of Hodgkinson's work was thus carried out at Woolwich, and much of it was directed to Service problems and to training many generations of gunner officers, who look back to this

period of their career with much affection for their teacher, but the feature which impressed itself on all who knew him was the exuberance of his mind in suggesting new investigations. Of such as have been published may be mentioned his researches on the reducing properties of hydrazine and on hydrazine nitrate as an explosive, and on the carburisation of metals by acetylene. He edited and enlarged a textbook of chemistry known throughout many editions to generations of students—Valentin-Hodgkinson's "Qualitative Chemical Analysis".

It will thus be seen that as distinct from modern specialisation, Hodgkinson had an equal interest in and was fruitful in suggestion in organic, inorganic and metallurgical chemistry and became an authority on the chemistry of explosives, writing the Service treatise on that subject. For his work during the War in advising on and directing certain manufactures, he was made a C.B.E. in 1918.

Hodgkinson's personality endeared him to all, and his interests were not confined to his main subject. Thus he was chairman of the Blackheath School of Art and took a live interest in its work; for he himself was a wood-carver of great ability. He took part in the local government and in the educational affairs of the neighbourhood of Blackheath, and was founder of the Radium and of the Imperial College Lodges of Freemasonry.

Prof. Hodgkinson leaves a widow, a son (Capt. C. R. Hodgkinson, R.A.) and two daughters, one married to Mr. T. Morson. A much loved son was killed in the War.

R. ROBERTSON.

PROF. WILHELM KOLLE

BY the death of Prof. Wilhelm Kolle at sixty-six years of age, on May 10, Germany loses one of her foremost bacteriologists, whose reputation was world-wide. Qualifying in medicine in 1892, Kolle entered the Institute of Infectious Diseases in Berlin in 1893 and became assistant to Robert Koch. By virtue of his position and work in that Institute, he was invited in 1897 by the Cape Government to conduct a scientific expedition in South Africa for the study of leprosy and rinderpest, and in 1900 was sent on a similar mission by the Egyptian Government to the Sudan, where he founded a laboratory at Khartoum. He was afterwards for a time professor of hygiene and bacteriology in the University of Berne, and in 1915 succeeded Paul Ehrlich as director of the Institute for Experimental Therapy in Frankfurt-on-Main, where he remained for the rest of his life.

On plague, cholera, leprosy and rinderpest, Kolle made important contributions. He was the first to prepare an effective antiserum for an ultra-microscopic virus, that of rinderpest or cattle plague, and the simultaneous method of protection against this disease with virus and immune serum was due to him and to the late Sir George Turner, formerly Medical Officer of Health for the Transvaal. In association with R. Otto, he devised a method of immunisation against plague with attenuated culture of the plague bacillus, and with R. Pfeiffer evolved

a method of protection against cholera by means of dead culture. At Frankfurt, where he was also director of the Georg Speyer-Haus research institutes, Kolle carried out investigations upon syphilis and spirochaetes, and was the first to produce the drug 'neosalvarsan', and also another drug, 'spirocid', the forerunner of stovarsol, which was discarded on account of toxicity.

Kolle's literary activity was prodigious, and he was the author in collaboration with Wassermann of the classical handbook of pathogenic micro-organisms, the last edition of which runs to ten volumes, as well as of a handbook on salvarsan treatment, a textbook of clinical methods of investigation, and one on experimental bacteriology.

R. T. HEWLETT.

PROF. V. POSEJPAL

WITHIN a few weeks of the death of Prof. B. Brauner, Czechoslovak science sustained a second heavy loss. Prof. Václav Posejpal, professor of experimental physics at the Charles University of Prague, died suddenly on April 8. He was born at Chlumec in Moravia on December 20, 1874, and studied at Hradec Kralové before going to Prague and taking his degree in natural sciences in 1900. He selected for his dissertation a thesis on Fourier series. After a period in Paris, studying certain Volta effects on magnetic fields, he returned to Prague, becoming *Privatdocent* at the University in 1910. In 1919 he was installed as professor of physics, and was Dean of the Faculty of Sciences in 1929-30.

Prof. Posejpal was one of the leading Central European research workers in experimental physics, and carried out noteworthy investigations on such subjects as the refractivity of gases at low pressures, fluorescence phenomena, X-ray spectroscopy and resonance. He also contributed to our knowledge of the ether and the neutron. Most of his work appeared in Czech scientific journals, but he also published papers from time to time in the *Comptes rendus* of the Paris Academy of Sciences and in German publications.

Prof. Posejpal was a Chevalier of the Legion of Honour and honorary member of many physical societies. He was general secretary of the Czechoslovak National Research Council and a vice-president of the International Union of Pure and Applied Physics. His colleagues and students held him in high esteem and he will be greatly missed in scientific circles in Czechoslovakia. He was known to a wider public through his popular broadcasts on scientific matters.

Prof. Posejpal was keenly interested in winter sports and frequently conducted parties of friends and students on ski-ing expeditions to the High Tatras and to the Austrian Alps.

J. G. F. D.

MR. R. E. RICHARDSON

THE Middle West of the United States lost an outstanding ichthyologist and aquatic biologist by the death on April 14 of R. E. Richardson, best

known for his work on the monumental volume, "The Fishes of Illinois", written in collaboration with S. A. Forbes, and for his researches and publications on the use of organisms as indexes of the degree of pollution of natural waters.

Robert Earl Richardson was born at Brighton, Illinois, on November 28, 1877. He was the son of Robert and Emily Dickerson Richardson, members of pioneer families of Macoupin county. After preparatory work at De Pauw University, he graduated from the University of Illinois in 1901. He was

elected a fellow in zoology there and received the M.A. degree in 1903. He was co-author with David Starr Jordan in a series of papers on the fishes of Formosa, Japan and the Philippines. From 1909 until 1922 he had charge of the floating laboratory of the Natural History Survey on the Illinois River. His interests in science were wide and he read widely in other fields—literature, biography, history and finance. Owing to delicate and uncertain health, he lived a quiet and secluded life.

DAVID H. THOMPSON.

News and Views

King's Birthday Honours

THE following names of men of science and others associated with scientific work appear in the list of honours conferred by the King "on the occasion of his Majesty's Birthday, and in commemoration of the completion of the twenty-fifth year of his Majesty's reign":—*O.M.*: Sir Frederick Gowland Hopkins, in recognition of his eminent services to biochemistry, especially in connexion with the discovery of vitamins. *Viscount*: Lord Bledisloe, lately Governor-General of New Zealand. *G.C.M.G.*: Sir Henry Birchenough, president of the British South Africa Company and chairman of the Beit Trustees. *G.B.E.*: Sir George Newman, lately chief medical officer, Ministry of Health and Board of Education. *K.C.B.*: Dr. G. C. Simpson, director of the Meteorological Office. *K.B.E.*: Prof. J. C. McLennan, professor emeritus and visiting professor of physics, University of Toronto, Dominion of Canada, for fundamental discoveries in physics and scientific services. *D.B.E.*: Mrs. M. M. Ogilvie Gordon, vice-president of the International Council of Women and former president of the National Council of Women. *Knights*: Mr. N. Ashbridge, chief engineer of the British Broadcasting Corporation; Prof. J. Barcroft, professor of physiology, University of Cambridge; Prof. A. J. Hall, emeritus professor of medicine, University of Sheffield, for distinguished service to medicine and medical science, with special reference to problems of the health of industrial workers; Mr. J. H. M. Home, vice-chairman, Advisory Council to Department of Agriculture for Scotland; Dr. L. L. Fermor, director of the Geological Survey of India; Mr. H. H. Humphries, city engineer of Birmingham, president of the Town Planning Institute; Mr. P. P. Laidlaw, pathologist to the Medical Research Council, for distinguished service to medical science; Dr. S. L. Pearce, engineer-in-chief of the London Power Company, Ltd.; Dr. C. L. Woolley, for services to archaeology.

C.B.: Dr. W. T. Calman, keeper of zoology, British Museum (Natural History), president of the Linnean Society of London; Dr. F. S. Sinnatt, director of fuel research, Department of Scientific and Industrial Research; Mr. H. E. Wimperis, director of scientific research, Air Ministry. *C.M.G.*:

Dr. G. S. H. Barton, Deputy Minister of Agriculture, Dominion of Canada; Mr. E. Harrison, director of agriculture, Tanganyika Territory; Mr. E. J. Wortley, director of agriculture, Trinidad. *C.I.E.*: Lieut.-Colonel B. Higham, chemical analyser to the Government of Bombay; Lieut.-Colonel R. Knowles, professor of protozoology and secretary of the Calcutta School of Tropical Medicine. *C.B.E.*: Dr. W. F. Bewley, director of the Experimental and Research Station of the Ministry of Agriculture and Fisheries at Cheshunt; Colonel W. MacC. Burden, chief superintendent of the Research Department, Royal Arsenal, Woolwich; Dr. C. E. Cook, chief protector of aborigines, Northern Territory, Commonwealth of Australia; Dr. G. W. M. Findlay, member of the scientific staff of the Wellcome Research Institution, London, for services in connexion with the study of prevention of yellow fever; Prof. A. Fowler, emeritus professor of astrophysics, Imperial College, South Kensington, for services to science; Mr. E. Marsden, secretary, Department of Scientific and Industrial Research, Dominion of New Zealand; Dr. W. L. Miller, president of the Royal Society of Canada; Mr. F. T. Shutt, lately Dominion Chemist, Dominion of Canada; Dr. N. V. Sidgwick, reader in chemistry at the University of Oxford, for services to science. *I.S.O.*: Mr. W. Dallimore, keeper of museums, Royal Botanic Gardens, Kew. *O.B.E.*: Mr. C. E. Blaker, principal, Government School of Engineering, Rasul, Punjab; Prof. G. B. Bryan, professor of physics, Royal Naval College, Greenwich; Mr. G. R. King, lately principal of the Gordon Institute of Technology, Geelong, State of Victoria; Mr. H. S. Hensman, superintendent, Government Mental Hospital, and lecturer in mental diseases, Medical College, Madras; Dr. W. A. Richardson, principal of the Technical College, Derby; Mr. A. Walter, director, Meteorological Service, East Africa; Mr. H. Wolfe, deputy director of agriculture, Kenya. *M.B.E.*: Mrs. N. L. L. Alcock, plant pathologist, Department of Agriculture for Scotland; Mr. W. Barnicot, secretary of Rothamsted Experimental Station for Agricultural Research; Mr. E. O. Sampson, deputy conservator of forests, in charge Dangs Forests and *ex officio* Deputy Political Agent for the Dangs, Bombay; Mr. G. Walton, assistant agriculturist, Northern Rhodesia.

New Foreign Members of the Linnean Society

THE four recently elected foreign members of the Linnean Society are all botanists. Dr. A. F. Blakeslee, assistant director in the Department of Genetics at the Carnegie Institution of Washington, is not only an outstanding geneticist but was also the discoverer of the phenomenon of heterothallism in the Mucorineæ, which has had a most profound influence both on the study of fungi and on theories of sex. Prof. P. A. Dangeard, until lately professor of botany at the Sorbonne, is known chiefly as a mycologist and cytologist though he has covered a very wide field in botanical research: he has been responsible for *Le Botaniste* since 1889, contributing the whole of many of the volumes. Prof. G. Senn, director of the Botanical Institute at Basle, is a botanist of many-sided activities. At first mainly interested in algal flagellates, he turned his attention to the physiology of the plant cell, studying particularly the chromatophore. More recently he has written a valuable treatise on the botany of Theophrastus. He has also worked on alpine plants. Prof. C. Raunkiaer, formerly professor of botany at Copenhagen, has considerably influenced ecological thought by his work on growth forms. He has been chiefly interested in phytogeography, morphology, taxonomy and statistical methods. His papers have recently been translated into English under the title "The Life Forms of Plants and Statistical Plant Geography".

Dr. Herbert Smith

THE Principal Trustees of the British Museum have appointed Dr. George Frederick Herbert Smith to be keeper of mineralogy in the British Museum (Natural History), in succession to Dr. L. J. Spencer, who retires on July 7 next. Dr. Herbert Smith was born in 1872. He was educated at Winchester, and at New College, Oxford, where he held a Winchester scholarship. He took a first in Mathematical Moderations (1892), Final School of Mathematics (1895) and Natural Science School, Physics (1896). He entered the Museum as an assistant in the Department of Mineralogy in 1897, and soon became recognised as an authority on mineralogy and crystallography, and wrote numerous papers on these subjects. His book on gem-stones has for many years been used as the standard textbook in the jewellery trade. He invented the three-circle goniometer, and a hand-refractometer for the determination of gem-stones. Dr. Herbert Smith's interest in general civil service problems led to his appointment in 1921 to the post of secretary of the Museum, which he has since held. He is honorary secretary of the Society for the Promotion of Nature Reserves, and chairman of the Wild Plant Conservation Board.

Franklin Institute Medals Awards

SCIENCE SERVICE of Washington, D.C., states that the Franklin Institute, Philadelphia, has recently awarded Franklin Medals to Prof. Albert Einstein for his researches on relativity and the photo-electric effect, and to Sir Ambrose Fleming for his work on

the thermionic valve. A certificate of merit has been awarded to G. S. Kelley, of New York, for reducing rock dust hazard. The following medal awards have also been made for the work indicated: Edward Longstreth Medals to Edmund Bruce of the Bell Telephone Laboratories (short wave radio antennæ); Howard D. Colman and B. A. Petersen of Rockford (an automatic spooler); P. Davey of New York (a portable balancing device); and K. B. McEachron of the General Electric Co., Pittsfield (for developing the material thyrityte): John Price Wetherill Medals to Dr. F. F. Lucas of the Bell Telephone Laboratories (photomicroscopy); R. E. Naumburg of New York (an unusual mechanical apparatus); W. H. Shortt and F. Hope-Jones (precision clocks); Dr. J. E. Shrader of Drexel Institute, Philadelphia (a vibration-measuring instrument); Dr. L. B. Tuckerman of the National Bureau of Standards (an optical strain gauge); H. E. Warren of Ashland, Mass. (the telechron used in electric clocks): Walton Clark Gas Medal to F. J. West of Manchester (work in the gas industry): Louis Edward Levy Medal to Dr. H. L. Hazen of the Massachusetts Institute of Technology (mechanical robots or servo-mechanisms).

The Quetta Earthquake of May 31

WITHIN little more than sixteen months, the Indian Empire has been visited by another great destructive earthquake. On May 31, at about 2.45 a.m. (probably about 9.15 p.m. on May 30, G.M.T.), the cities of Quetta, Mastung and Kalat were almost entirely razed to the ground. In Quetta alone, the loss of life is estimated at more than 20,000. The region is one that has frequently been disturbed by destructive earthquakes. The valuable report by Mr. W. D. West on those of August 25 and 27, 1931, has recently been noticed in *NATURE* (April 27, p. 661). The earlier shock had its centre near Sharigh, which lies 39 miles east of Quetta; the later and stronger near Mach, 26 miles south-east of the same city. In the recent earthquake, the epicentral area—if we may take it as lying along the Quetta-Mastung-Kalat line—is roughly parallel to the zone joining Sharigh to the main part of the Mach area, and about 50 miles to the west. It is also parallel to the main structural lines of the country, and especially to the great boundary fault, 45 miles to the west, that runs along the west side of the Khojak Range for a distance of at least 120 miles. It was to a nearly horizontal shift of about 2½ ft. along this fault that the severe earthquake of December 20, 1892, was due.

Revision of Ordnance Survey Maps

WE are glad to note that the Minister of Agriculture has appointed a committee, under the chairmanship of Mr. J. C. C. Davidson, Chancellor of the Duchy of Lancaster, to consider the measures necessary to accelerate the revision of the Ordnance Survey maps. The maps in question are the large-scale plans, that is, the 25-in., the 6-in. and, in some cases, even those on larger scales, but chiefly those

mentioned. The small-scale maps, namely, those on the 1-in. and smaller scales, present no problem. The large-scale plans, which are numbered by tens of thousands, have been gradually getting very much out of date. This is mainly due to two causes: the action of the Geddes Committee of 1922 in recommending further reductions in an already reduced department, and the great alteration in the countryside caused by the expansion of the built-up area and the spread of 'ribbon development'. There is also the further difficulty that, simultaneously with the enforced slowing up of revision, there has been an increased demand for the large-scale plans for town planning and for land registration. It is clearly high time that the whole matter was examined. Many interests are involved, as is indicated by the fact that no fewer than six public departments are represented on the Committee. The question is somewhat urgent, and it is to be hoped that the Committee may be able to report speedily, for every month the arrears become more serious. There is one curious item in the terms of reference; the Committee is to "review the scales and styles of Ordnance Survey maps placed on sale". It is not to be desired that we should enter again upon the 'battle of the scales' which was happily decided more than two generations ago. Nothing has happened since then to throw doubt upon the wisdom of the choice of the 25-in. scale as that of our principal large-scale plans. That old 'battle of the scales' lasted from 1840 until 1863, and since the latter date the country has enjoyed, in this matter, the great advantage of an uninterrupted, continuous policy.

Civil Aircraft in the Royal Air Force

THE Air Ministry has acquired a De Havilland *Dragon Rapide* and an Avro *Ava*, two well-known commercial types of aircraft, for R.A.F. use. Such purchases indicate two possible lines of attack on the problem of rapid expansion recently announced. The degree of military usefulness of such machines, and the amount of modification necessary, can be studied in actual experiment by the R.A.F. personnel concerned. Also the more immediate problem of obtaining a sufficient supply of machines for training and flying practice, for the increased establishment under the new R.A.F. expansion scheme, will be helped, if civil machines are found suitable, and can be built immediately in factories already in production of them. It is understood that the first two of the five new training schools are to be opened this month, each school having the equivalent of three squadrons. Thus the problem of equipment is not only to supply these, but also a progressively increasing number of machines for the use of these pupils as they pass out into the service. It has to be discovered whether it is best to allow constructing firms to accelerate the production of their own aircraft, modified to R.A.F. requirements, or to change them over to contracts to build other machines specifically designed for R.A.F. work. Large contracts have also been placed for the construction of aeroplane hangars in various places.

German Commercial Airship Plans

THE new Zeppelin, Airship *L.Z. 129*, is now reported to be complete in skeleton, and work on covering has commenced. It is hoped to launch it at the end of July. When completed it will be the largest airship in the world. It is 813 ft. in length, 135 ft. maximum diameter, and has gas capacity of 6,720,000 cubic feet. Dr. Eckener says that he intends to build three further ships for routes across the North Atlantic, South Atlantic, and to India and Batavia, that will operate under American, German and Dutch control respectively. The German operating base will be changed from Friedrichshafen to Frankfort, which is not only more convenient for commercial traffic but is also at a lower altitude. The loss of available lift due to starting from the higher altitude of Friedrichshafen is estimated to be about three tons for the *L.Z. 129*. Arrangements have also been completed for the construction of a mooring mast and gas plant at Seville, in conjunction with the Atlantic routes. A new operating company, in which the German Government is said to be interested, is being formed with a capital of about £835,000.

The Admiralty Magnetic Survey Ship

AT the sixteenth annual meeting of the American Geophysical Union, held at Washington on April 26, the following resolution was adopted: "WHEREAS, The magnetic survey of the oceanic areas, carried on for 25 years by the Carnegie Institution of Washington, was brought to a sudden end by the destruction of the *Carnegie* at Apia, Western Samoa, November 29, 1929, in the course of a cruise designed to determine the secular change of the Earth's magnetism in all oceans, and WHEREAS, It is of very great importance, not only for the practical needs of the navigator but also for the effective study of the Earth's magnetism, that these observations be resumed at an early day, and WHEREAS, It has been announced that the British Admiralty has decided to build a non-magnetic vessel, designed primarily for securing magnetic data at sea, therefore be it RESOLVED, That the American Geophysical Union is highly gratified at this action of the British Government, assuring, as it does, the continuance of the ocean magnetic work, and expresses the hope that the construction and equipment of the vessel may be pushed to a speedy conclusion, and be it further RESOLVED, That a copy of this resolution be sent to the British Admiralty, to the Astronomer Royal, and to the Chairman of the British National Committee for Geodesy and Geophysics." In transmitting this resolution, Dr. Isaiah Bowman, chairman of the National Research Council, writes, "All geophysicists must extend grateful thanks to the British Admiralty in making possible the further accumulation of data so essential to the needs of navigators and of scientific enquiry".

Noise Abatement Exhibition at the Science Museum

ON May 31, the Prime Minister opened the Noise Abatement Exhibition which has been organised by

the Anti-Noise League and is being held at the Science Museum, South Kensington, during this month. The opening ceremony was held in the lecture theatre, and was attended by some two hundred guests. The chair was taken by Lord Horder, chairman of the Council of the Anti-Noise League. Mr. MacDonald in his speech opening the exhibition said that formerly a person who confessed that he was troubled by noise was put down as an irreparable crank; but now it is rightly regarded that noise is something that ought not to be tolerated by any decent man or woman. He suggested that their campaign against nerve jarring should be regarded as a great movement in æstheticism. It is the duty of all to co-ordinate in the protection of life from jars of the eye and the nerves—jars of the complete human personality. Sir Henry Richards, chairman of the Executive Committee of the Anti-Noise League, in moving a vote of thanks to the Prime Minister, said that the League is an educational body and the exhibition is intended to show to the public the means of escape from noise. The Prime Minister made a short tour of the exhibition and inspected among other things a silenced pneumatic road-drill, a silenced motor-cycle engine, a ripple tank illustrating the behaviour of sound-waves from a speaker in the House of Commons and several models demonstrating the scientific principles of the reduction of noise from machinery and in buildings.

The Health of Sunderland and County Durham

DR. G. F. WALKER, of Sunderland, in a letter to *The Times* last December, made an appeal that the deterioration of health of a section of the population in Sunderland and adjacent districts in County Durham, where unemployment has been severe and prolonged, was serious, and deserved more national consideration. In consequence of statements made in Dr. Walker's letter, the Ministry of Health instituted an inquiry by Dr. Pearce, Ministry of Health, Dr. Glover, Board of Education, and Mr. Grant, Ministry of Health, whose report has now been issued ("Report of an Inquiry into the Effects of Existing Economic Circumstances on the Health of the Community in the County Borough of Sunderland and certain districts of County Durham. London: H.M. Stationery Office, 1935. 9d. net). The matter of this report is too lengthy to quote in detail, but is summarised in the concluding paragraph. While admitting that there may be some slight deterioration of health and small increase in the incidence of certain diseases, the investigators state that "We are unable to accept Dr. Walker's statement that there has been in this area a 'substantial and progressive deterioration in public health'".

Technological Advances of the Past Twenty-five Years

SIR FRANK SMITH, secretary of the Department of Scientific and Industrial Research, spoke on June 3 at a special Jubilee luncheon, held under the auspices of the Society of Engineers, on "Some Significant Technological Achievements of the King's Reign". Sir Frank dealt with four outstanding types of achievement of the period. The first was the advances

in medicine which have prolonged our lives; the second was the more complete harnessing of the electron, an achievement which has given birth to industries unknown in 1910; the third was the fixation of nitrogen, an achievement which has overthrown the menace to our food supplies resulting from diminishing quantities of Chile nitrate; and finally, the production of new steel cutting tools, which has largely affected mechanisation, the price of manufactured goods and the leisure of man. Speaking of the industrial applications arising from the discovery of the electron, and the researches of Sir J. J. Thomson and Lord Rutherford and others on the structure of the atom and on matter in general, Sir Frank said: "When the King came to the throne there was not one listener in the world, for there was no broadcasting station. To-day in this country alone there are over 7 million people with licensed receivers. There are millions of thermionic valves in use, and on his Jubilee day the King spoke via millions of thermionic valves to hundreds of millions of his subjects. The radio engineer was in charge, and by the simple operation of switches, millions and millions of electrons played the parts arranged for them beforehand." The turnover in the radio broadcasting industry, which did not exist twenty-five years ago, was more than 20 millions sterling last year. The harnessing of the electron has been, in Sir Frank's opinion, one of the greatest achievements of the King's reign. It enables one person to speak to and be heard by the whole of the civilised world; it has increased entertainment and amusement through the 'talkies', and it has enabled our homes, our roads and our public buildings to be illuminated in a manner which many would have thought impossible twenty-five years ago.

British Standards Institution

THE annual meeting of the British Standards Institution was held on May 28, with Dr. E. F. Armstrong in the chair, who, in presenting the report, said the year's work showed marked progress in every section. He laid stress on the fact that more than 150,000 copies of the British Standard Specifications have been sold and distributed during the year, an increase over last year of 23,000, and that there are now 700 committees holding more than 1,000 meetings a year, the total membership exceeding 5,000. The machinery of the B.S.I. is such that no section of industry need fear that its considered views will not receive the fullest consideration, or that a British Standard Specification would be issued in the face of soundly based objection. Moreover, it has been definitely stated that the Institution does not contemplate setting itself up as a testing authority. Mr. W. Reavell, a past-president of the Institution of Mechanical Engineers, has been elected chairman for the ensuing year. He was one of the first to recognise the necessity for the co-ordination of the work of mechanical standardisation, in which the Institution of Mechanical Engineers is taking a leading part. Perhaps one of the most important results of the year's work is the increasing success of the inter-Imperial co-operation which is now so firmly

established. Australia has a standards organisation with 500 committees manned by more than 4,500 individuals, and during the past year 75 industrial standards have been issued and 20 more are out for public criticism. British Standard Specifications are good propaganda for British trade, and it is to be noted that more than 12,000 copies have been sent to diplomatic and trade commissioners in all parts of the world, so that they may maintain complete sets which may be consulted by those desiring information regarding British products, as represented by British Standard Specifications. The Government continues its whole-hearted support of the B.S.I. as the national standardising body in Great Britain.

Cider Tasting Day at Long Ashton

THE Open Field Day at the Research Station, Long Ashton, near Bristol, was held on May 2. A large and distinguished company of growers, brewers, men of science and administrators met to exchange views, inspect the laboratories and outdoor plots, and to exercise a discretionary taste upon the samples of cider prepared under controlled conditions by the National Fruit and Cider Institute. Representatives from Canada, South Africa, India, and the United States were present. The function has retained its atmosphere of informality and free intercourse throughout its thirty years, in spite of the fact that visitors have increased in number about a hundred-fold since the first meeting of twenty-five members. The desire to take full advantage of the educational opportunities of the day has also grown. The ciders of 1934 were definitely above the average in quality, but were slightly inferior to the superlative product of the previous year—one cannot expect equal quality from two heavy crops in succession. An exhibit of centrifuging as a method of controlling fermentation attracted much interest, whilst experiments and outdoor demonstrations on pomology, plant nutrition, fruit breeding, economic mycology and entomology, willow culture and fruit and vegetable preservation, were also shown. The Agricultural Advisory Centre, Berkeley Square, Bristol, and the National Mark organisation provided additional exhibits.

Soil Research in Scotland

AT a Scottish joint meeting of the Chemical Society, Institute of Chemistry and Society of Chemical Industry held in Aberdeen on May 17–18, at which Prof. Alexander Findlay presided, the work being carried out at the Macaulay Institute for Soil Research provided the subject for discussion. Dr. Ian M. Robertson read a paper entitled "The Agricultural Utilisation of Peat Land", in which the geology of peat formation, the physical and biological properties of peat and their relation to land reclamation were described. Members of the three Societies had an opportunity to visit the Macaulay Institute for Soil Research on May 18, when the Director, Dr. W. G. Ogg, and his staff, described the particular branches of soil research carried out in Scotland. These included geological work on soils, soil survey work, the investigation of soil fertility, and advisory work among farmers.

South Africa: Progress of Twenty-five Years

THE special South Africa supplement of *The Times*, presented with the issue of May 31, deserves mention for its wealth of interest and its authoritative articles. Published to commemorate the silver jubilee of the Union of South Africa, the supplement reviews the progress of the Dominion during the last twenty-five years. Articles on agriculture, mining, migration, education, wild-life and native affairs are particularly noteworthy; but other sides of South African life, such as finance, architecture, sport, communications and holiday resorts are not omitted. Altogether, the supplement, which runs to thirty pages and is illustrated with maps and photographs, may be regarded as an important 'volume' on all aspects of South Africa, and one of permanent value.

Malaria in Ceylon

THE seriousness of the epidemic of malaria that has been raging in Ceylon may be realised from the fact that 74,000 deaths are attributed to this disease during the six months, November–April. Up to the end of April, nearly two million rupees were expended in relief, exclusive of sums for medical treatment. The situation has afforded an opportunity to test on a large scale the value of quinine and of synthetic antimalarial drugs, and the report thereon when published should prove of great value.

British Standard Density Hydrometers

THE Hydrometer Sub-Committee of the British Standards Institution has prepared a draft specification for British standard density hydrometers and tables for use with the hydrometers. The draft specification and tables are now being circulated to interested bodies by the Institution for criticism prior to their final publication. The Institution would welcome comments on the proposals from as wide a circle as possible, and a copy of the draft specification and tables will be forwarded to anyone interested on application to the Director, British Standards Institution, 28 Victoria Street, London, S.W.1.

Nutrition Advisory Committee

THE Minister of Health and the Secretary of State for Scotland have appointed a Nutrition Advisory Committee to "inquire into the facts, quantitative and qualitative, in relation to the diet of the people, and to report as to any changes therein which appear desirable in the light of modern advances in the knowledge of nutrition". The members of the Committee are: Lord Luke (chairman), Mrs. Eleanor Barton, Mr. J. N. Beckett, Dr. G. F. Buchan, Prof. E. P. Cathcart, Mr. R. R. Enfield, Dr. J. Alison Glover, Dr. J. M. Hamill, Dr. A. Bradford Hill, Sir F. Gowland Hopkins, Dr. Donald Hunter, Prof. E. Mellanby, Sir John Boyd Orr, Mr. E. C. Ramsbottom, Mr. J. M. Vallance, Mrs. Chalmers Watson, Mr. J. R. Willis, Mr. E. H. T. Wiltshire. The secretaries of the Committee are: Mr. W. J. Peete, of the Ministry of Health, London, S.W.1, to whom all communications on the subject should be addressed; Mr. N. F. McNicoll, of the Department of Health for Scotland;

and Dr. H. E. Magee, of the Ministry of Health (Medical Secretary).

National Baby Week

THE National Baby Week Council, 117 Piccadilly, London, W.1, has issued its report for 1934. The propaganda subject for the year was "The Making of an A 1 Nation", and special propaganda dealt with "The Diet of the Expectant Mother" and "Food and Feeding". National Baby Week is to be held this year on July 1-7, and the special subjects suggested for consideration are "The Welfare of the Pre-School Child" and "Good Nutrition of Mothers and Children". A poster competition is arranged for boys and girls of 'senior schools', and prizes are offered to parents for the best essays on one of two subjects: "What should be done were there an Outbreak of Diphtheria", and "On the Effect of Overcrowding on the Welfare of Mothers and Little Children". The Council will gladly advise and give help on propaganda work, the choice of subjects for lectures, etc., and on other matters relating to infant welfare.

South-Eastern Union of Scientific Societies

THE fortieth Annual Congress of the South-Eastern Union of Scientific Societies will be held at Bournemouth on June 26-29, under the presidency of Prof. A. C. Seward. On June 26, Prof. Seward will deliver his presidential address entitled "The Herbarium of the Rocks". Prof. J. Cameron will deliver a public lecture on June 27 at 8, entitled "Egyptology"; and Lieut.-Colonel C. D. Drew will deliver a public lecture on June 28, at 8, entitled "Recent Excavations at Maiden Castle". The following sectional presidential addresses are announced: Archaeological Section (Mr. T. D. Kendrick), "Early Christian Art in the British Isles"; Botanical Section (Prof. H. J. Tabor), "Effects of Certain Physical Factors on the Determination of Plant Habitat"; Zoological Section (Rev. F. C. R. Jourdain), "Zoological Progress during the last Half-Century, with special reference to Ornithology"; Geological Section (Dr. H. D. Thomas), "Some Aspects of Evolution"; Regional Survey Section (Dr. Vaughan Cornish), "Scenic Amenities in Town and Country". Further information can be obtained from the Honorary General Secretary, Mr. Edward A. Martin, 14 High View Close, Norwood, London, S.E.19.

Announcements

AT a meeting on April 27, the Leeuwenhoek Gold Medal of the Royal Academy of Sciences, Amsterdam, was awarded to Prof. S. N. Winogradsky, foreign associate of the Academy and also a foreign member of the Royal Society, who is director of the Division of Agricultural Microbiology of the Institut Pasteur, Brie-Comte-Robert, France, for his outstanding contributions to the development of soil microbiology. The medal is awarded decennially to commemorate the discovery of micro-organisms by Antony van Leeuwenhoek. Previous recipients of the medal have been: C. G. Ehrenberg, Ferd. Cohn, L. Pasteur, M. W. Beijerinck, Sir David Bruce and F. d'Hérelle.

DR. WESLEY BOURNE, of Montreal, has been awarded the first Hickman Medal of the Royal Society of Medicine. Dr. Bourne is anæsthetist to the Royal Victoria Hospital, Montreal, and also lecturer in pharmacology in McGill University. He is well known to many anæsthetists in Great Britain, both personally and for his researches into the physiology and pharmacology of anæsthesia.

SIR FREDERICK HOBDAY will deliver the Stephen Paget Memorial Lecture on the occasion of the annual general meeting of the Research Defence Society on June 12 at 3, in the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, taking as his subject "The Relief of Animal Suffering".

THE Walter Rathbone Bacon Travelling Scholarship of the Smithsonian Institution has been awarded to Dr. Richard E. Blackwelder, now engaged in entomological work at the U.S. National Museum, for an intensive study of the staphylinid beetles of the West Indies. Dr. Blackwelder will collect these curious little beetles, which are distinguished from other families of beetles by their short wing covers, although nearly all have normally large wings and most of them are good flyers, on twenty-five West Indian Islands, including Cuba, Hispaniola, Puerto Rico and Jamaica. After completing his collections in the West Indies, Dr. Blackwelder will study the large collections in the British Museum.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Three University lecturers and one demonstrator in the University of Cambridge—Mr. H. Thirkill, Clare College, Cambridge (June 10). A lecturer in mechanical engineering in the West Hartlepool Technical College—The Secretary for Education, Education Offices, West Hartlepool (June 14). A head of the Science Department, Central Polytechnic, Croydon—The Education Officer, Education Office, Katherine Street, Croydon (June 15). A lecturer in physiology in the University of Bristol—The Registrar (June 19). A lecturer in physics and mathematics in the Northampton Polytechnic, St. John Street, London, E.C.1—The Principal (June 21). Geologists on the Geological Survey of Great Britain and the Museum of Practical Geology, Exhibition Road, South Kensington, S.W.7—Director (June 21). A lecturer in physics in the Constantine Technical College—The Director of Education, Education Offices, Middlesborough (June 22). A head of the Chemistry Department in the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne, 2 (June 22). An assistant lecturer in agricultural botany in the South-Eastern Agricultural College, Wye, Kent—The Secretary (June 22). A temporary lecturer in geography in Armstrong College, Newcastle-upon-Tyne—The Registrar (June 25). Two research workers at the research laboratory of the Freshwater Biological Association of the British Empire, Wray Castle, Ambleside, Westmorland—The Naturalist-in-Charge (July 1).

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 962.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Echo Sounding in Fishery Research

THE vessel used for the annual oceanographical investigations in the Lofoten area (the *Johan Hjort*) had a Hughes echo sounding gear (magnetostriction system, frequency 16,000 cycles per second) installed

the conclusion of this investigation on April 5. Concurrently, the temperature in the 'fish' water-layer had decreased from 6.5°-6.0° to about 3.0° C. In some instances a perceptibly lower oxygen and hydrogen ion concentration was observed in this water-layer than in the layers immediately above and below.

Although two zigzag trips were made across the entire bank area of the West Fjord, strong marks such as those shown in the records reproduced were only obtained at the locality referred to above; in other places only small and widely separated dots. Still a certain amount of fishing, if not very successful, was going on everywhere. A true estimate of the quantity of fish represented by marks of different types can, however, be gained only by further study in connexion with the use of suitable fishing implements.

OSCAR SUNDB.

Johan Hjort,
Kabelvåg, Lofoten.
April 6.

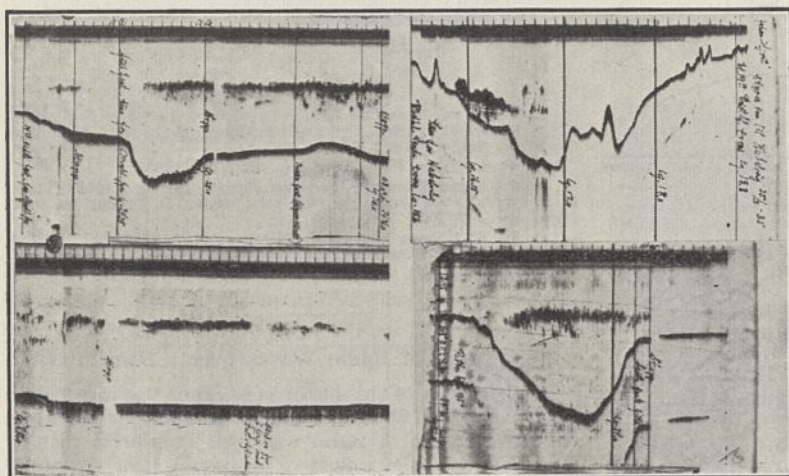


FIG. 1. Four 'echo'-records showing spawning cod in midwater at Lofoten. The left-hand diagrams partly with ship stopped. The bottom right-hand record is somewhat disfigured by oscillations set up by excessive shaking of ship's motor; but it shows also a second echo from the bottom, reflected from the surface. Marks on top of each diagram are produced every minute and are 6-7 mm. apart.

before leaving Bergen last February. The gear worked smoothly all along the coast and besides furnishing a great number of interesting sections, revealed many features hitherto unsuspected; among others, that the clay flooring of deep fjords is invariably about 10 m. thick and generally very flat.

Marks referable to fish were seen on the record only after the arrival at that portion of the Lofoten fishing area where the most prolific fishing has been going on during recent years—at Høla—a bight of the West Fjord of very restricted dimensions, say, 10 miles by 4 miles. At this place fish were indicated continuously along straight courses of 2 nautical miles and more. The nature of the indications may be seen from Fig. 1, which is a photographic reproduction of four separate records, partly obtained while the ship was stationary among the hand-line boats, which got the fish exactly at the depth indicated.

It is interesting to note that this spawning concentration of cod has apparently no relation to the bottom. This was well known before, but no one could have imagined the fish to be limited to such a sharply defined layer of only 10-12 metres in thickness, extending widely above deep water and shallow, always at the same distance from the water surface. This distance was 72 metres at the first encounter with the spawning shoals (March 11) and 50 metres at

Absorbing Layer of the Ionosphere at Low Height

THE ionosphere is now generally regarded as divided into two main regions of intense ionisation. The upper (*F* or Appleton) region commences at a height of about 250 km., while the lower (*E* or Kennelly-Heaviside) region begins at a height of about 90 km. Besides these two main regions, the existence of a so-called *D* or absorbing layer has been suggested from time to time¹. The presence of such a layer has not, however, until now been experimentally demonstrated, and it has rather been the tendency in recent years to discredit its existence. Recently we have, however, in the course of our ionospheric studies at Calcutta been able to detect echoes of radio waves returned from a virtual height of about 55 km. by the well-known pulse method. The echoes from the *E* layer were at the same time observed to be returned from a virtual height of 119 km. The present communication gives a preliminary account of the observations we have made in connexion with the existence of a low-lying absorbing layer.

The appearance of echoes from the *D* layer is closely connected with the weakening of echoes from the *E* layer which is observed with the progress of the day². This absorption may be due either to a decrease in the gradient and lowering of the height of the lower boundary of the *E* layer, or to the formation of a distinct absorbing layer at a much lower

level. Against the first hypothesis, both observations and calculations show that the lower boundary of the *E* layer must be extremely sharp³. From such a boundary all frequencies below the critical penetration frequency will be copiously reflected, while all those above will penetrate the boundary. Observations made by us, however, show that during daytime there is a frequency band above and below the limits of which no reflection is obtained from the *E* layer. The limits of the frequency band vary with the hour of the day. Fig. 1 depicts typical limits on a summer day at Calcutta.

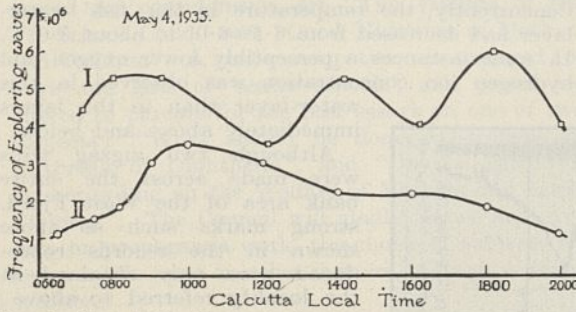


FIG. 1. Curve I gives the penetration frequencies of the *E* layer for various hours of the day. Curve II gives the frequencies for which echoes from the *E* layer first appear from the side of long waves. The vertical distance between the two curves for any hour of the day gives the range of frequency for which echoes are obtained from the *E* layer only.

The hypothesis of a diffuse *D* layer at low height, where collision frequency is very great, offers an easy explanation of these phenomena. This layer will absorb long waves strongly, preventing their reflection due to the diffuse boundary, and will only allow waves of lengths below a certain limit to penetrate it. These latter waves will either be reflected from or will penetrate the *E* layer. In short, the *E* layer with its sharp boundary will reflect all frequencies below a certain limit and the *D* layer with its diffuse boundary absorb all frequencies below another lower limit. The sharp boundary of the *E* layer cannot cause the disappearance of frequencies lower than the critical penetration frequency as shown in Fig. 1. The hypothesis of a diffuse *E* layer boundary causing absorption is untenable because the virtual height of the *E* layer as measured by us for a number of frequencies in the frequency band of Fig. 1 has been found to be practically constant.

On very rare occasions when the lower boundary of the *D* layer becomes extremely sharp, it is able to reflect waves. Such were the occasions on April 2, 3 and 5 between the hours 15.00 and 17.00, when we were able to detect the echoes as reported in the beginning of the note.

There are other arguments in favour of the existence of the *D* region. Without the intervention of such a region, the virtual height of the *E* layer ought to rise gradually with the setting of the sun. Observations show, however, that the height has a tendency to decrease with the close of the day. This is easily explained as due to the disappearance of the *D* layer, which by its presence during the day increases the virtual path of the wave. Again, Fig. 1 shows that Curve I, which is a graph of the penetration frequencies of the *E* layer, has pronounced hourly variations. This feature of the curve is present almost every day during this part of the year. Curve II, which is a graph of the frequencies for

which echoes begin to appear from the *E* layer, has no such pronounced hourly variations, but gradually rises and falls with the progress of the day. There being scarcely any correlation between the two curves, it follows that the agency responsible for Curve I must be different from that for Curve II. This other agency, according to our hypothesis, is the absorbing layer at a virtual height of 55 km.

It is noteworthy that the region where the absorbing layer has been detected by us, is also, according to many authorities, the region of the ozonosphere⁴. It is not unlikely that the ionisation in this region is connected with the formation of ozone, as suggested by Chapman⁵.

S. K. MITRA.
P. SYAM.

Wireless Laboratory,
University College of Science,
92 Upper Circular Road,
Calcutta.
May 6.

¹ Appleton and Ratcliffe, *Proc. Roy. Soc., A*, **128**, 155; 1930. M. A. Bontch-Bruewitch, *Proc. I.R.E.*, **22**, 1135; 1934. S. Sillitoe, *Canad. J. Res.*, **11**, 163; 1934.
² F. W. G. White, *Proc. Phys. Soc.*, **46**, 101; 1934.
³ Appleton and Naismith, *Proc. Roy. Soc., A*, **137**, 39; 1932 (Fig. 1). Mary Taylor, *Proc. Phys. Soc.*, **46**, 415; 1934. D. F. Martyn, *Proc. Phys. Soc.*, **47**, 335, 338; 1935.
⁴ G. M. B. Dobson and D. N. Harrison, *Proc. Roy. Soc., A*, **114**, 537, 540; 1927. Chapman, *Proc. Roy. Soc., A*, **132**, 356; 1931.
⁵ Chapman, *Quart. J. Roy. Met. Soc.*, **52**, 231; 1926.

Propagation of Radio Waves over a Plane Earth

THE purpose of this letter is to point out an error in sign in Prof. A. Sommerfeld's original paper (1909) on the attenuation of radio waves¹. This error in sign has recently been reflected in Bruno Rolf's graphs² of the Sommerfeld formula, predicting dips to zero in the field intensity at finite distances from a radio transmitter and other anomalous phenomena. This error in sign has been corrected in Prof. Sommerfeld's 1926 papers³ and also does not occur in the derivation by B. van der Pol and K. F. Niessen⁴. In this latter paper an exact expression is given for the potential of a vertical infinitesimal dipole (equation 21). After expanding this expression, I found that most of the terms are negligibly small at moderately low frequencies for distances from the source greater than a wave-length, giving for the potential function of a vertical dipole over a plane earth:

$$\Pi(r, 0) = \frac{e^{ik_1 r}}{r} \left[1 - 2\sqrt{p} e^{-p} \int_{i\infty}^{\sqrt{p}} e^{w^2} dw \right]$$

where $p = ik_1 r \left[1 - \left(1 + \left(\frac{k_1}{k_2} \right)^2 \right)^{-1/2} \right] \equiv p_0 e^{i\theta}$ (1)

and $k_1 = \frac{2\pi}{\lambda}$, and $k_2^2 = k_1^2 (\epsilon + i2c\lambda\sigma)$,

where ϵ is the dielectric constant of the ground referred to air as unity, σ is the conductivity of the ground in electromagnetic units, c is the velocity of light in cm. per sec., λ is the wave-length in cm. and r is the distance in cm.

In the above equation, p is the 'numerical distance' as defined by van der Pol and Niessen and is slightly different for high frequencies from the 'numerical distance' used by Sommerfeld; this difference makes the above formula accurate for large values of the

parameter b and free from the errors which Rolf⁵ made by using the Sommerfeld 'numerical distance'.

Rolf used equation (1) with the lower sign reversed on the integral for computing the field intensity from a distant radio transmitter. Correcting this error in sign, I have found that the following empirical formula for the field intensity may be determined from equation (1):

$$F = \frac{c}{r} \sqrt{P} \left[f(p_0) - \sin b \sqrt{\frac{p_0}{2}} e^{-\frac{5}{8} p_0} \right] \dots \dots (2)$$

This formula gives the field intensity, F , in microvolts per metre when the radiated power from the transmitter is P kilowatts and is applicable for $b < 30^\circ$, that is, for frequencies less than about 10,000 kc./s. for transmission over ground of average conductivity about 10^{-13} E.M.U. The quantity in the square brackets is the 'attenuation factor' and reduces to $f(p_0)$ in the case $|k_2^2| \gg k_1^2$. This was the case discussed by Sommerfeld, and values for $f(p_0)$ are given by Rolf in his first paper—van der Pol⁶ also gives the following empirical formula for $f(p_0)$:

$$f(p_0) = \frac{2 + 0.3p_0}{2 + p_0 + 0.6p_0^2} \dots \dots \dots (3)$$

Formula (2) is limited in this application to a plane earth, the actual ground wave field intensity being influenced by the curvature of the earth at the greater distances, this effect being the predominating influence at sufficiently low frequencies.

K. A. NORTON.

Federal Communications Commission,
Washington, D.C.
March 8.

¹ *Ann. Phys.*, **28**, 665; 1909.

² *Ingenjors Vetenskaps Akademiens, Handlingar* No. 96; 1929. *Proc. I.R.E.*, **18**, 391; 1930.

³ *Ann. Phys.*, **81**, 1135; 1926.

⁴ *Ann. Phys.*, **6**, 273; 1930.

⁵ See criticism by W. H. Wise, *Proc. I.R.E.*, **18**, 1971; 1930.

⁶ "Jahrbuch der Drahtlosen Tel. und Tel.", **37**, 152; 1931.

Band Spectroscopic Observations of the Isotopes of Zinc and Cadmium

ACCORDING to earlier mass-spectroscopic investigations by Aston¹, cadmium has the following isotopes arranged in order of their abundances: 114, 112, 110, 111, 113, 116. Later, two additional isotopes, 108 and 118, were observed by one of us², as a result of an investigation of the band spectrum of cadmium hydride.

Recently, Aston³ has reported the discovery of three new cadmium isotopes, 106, 108, 115, but no evidence of the existence of Cd¹¹⁸ was obtained. As Cd¹⁰⁶ appeared to be more intense than Cd¹⁰⁸, and the former isotope had not been mentioned by Svensson, Aston concludes that these results are not reliable; in particular, that the existence of Cd¹¹⁸ must be considered as rather dubious.

Our spectrograms, on which the above mentioned observations were based, did really give indications of lines corresponding to Cd¹⁰⁶, but were not published because of their spurious appearance as compared to the lines of Cd^{108,118} which were present in some thousands of groups in the spectrum. As may be seen from Fig. 1 (a) representing the group

at λ 4728 Å. and corresponding to R_2 ($18\frac{1}{2}$) in ($v'=0$; $v''=3$) of the ${}^2\Sigma \rightarrow {}^2\Sigma$ transition, Cd¹⁰⁶ is present, although having decidedly less intensity than Cd^{108,118}. This intensity relation seems to hold throughout the observed spectrum. The existence of odd isotopes in cadmium could not be verified⁴ on account of insufficient separation of the even components in a group.

The isotopes of zinc have also been the subject of several investigations, contradictory results having been obtained. Thus according to Aston⁴, the following isotopes are present: 64, 65, 66, 67, 68, 69, 70. Bainbridge⁵, however, was unable to observe Zn^{65,69}. From an unpublished investigation on the band spectrum of zinc hydride, one of us (G.S.) observed the following isotopes: 64, 66, 68, 67, 65, 63, 70, their abundances being in the order in which the numbers are given. Thus agreement is found with the results of Aston regarding Zn⁶⁵ (not observed by Bainbridge) and vice versa regarding Zn⁶⁹. Our new isotope Zn⁶³ is clearly visible in Fig. 1 (b),

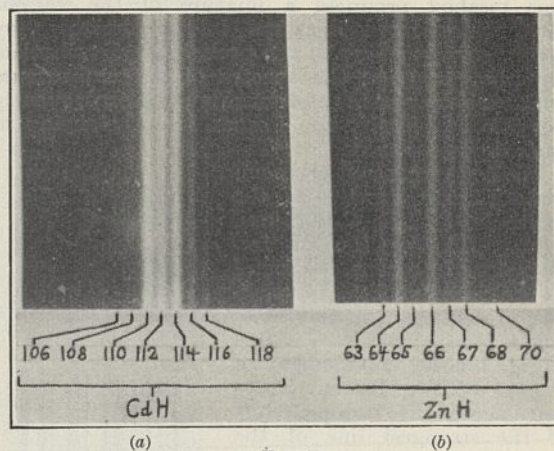


FIG. 1.

representing the group at λ 4035.0 Å. and corresponding to R_1 ($33\frac{1}{2}$) in ($v'=0$; $v''=0$) of the ${}^2\Pi_{3/2} \rightarrow {}^2\Sigma$ transition. The line corresponding to Zn⁶³ is far more intense than that of Zn⁷⁰, which is too faint to appear on the reproduction, although clearly visible on the original plates.

Our statements regarding the isotopes of zinc and cadmium are based on observations of extensive regions in the spectra of their hydrides. Some thousands of line groups have been measured in each spectrum, the isotope separations being in perfect agreement with the theory of isotope effects in band spectra. We would suggest, therefore, that the disagreement between band spectroscopic and mass-spectroscopic observations regarding the existence of isotopes does not indicate the unreliability of the former method but must be explained in some other way.

GÖSTA STENVINKEL.
ERIK SVENSSON.

Laboratory of Physics,
University, Stockholm.
March 20.

¹ F. W. Aston, "Mass-spectra and Isotopes", 1933, p. 120.

² Erik Svensson, *NATURE*, **131**, 28; 1933.

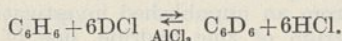
³ F. W. Aston, *NATURE*, **134**, 178; 1934.

⁴ F. W. Aston, "Mass-spectra and Isotopes", 1933, p. 118.

⁵ K. T. Bainbridge, *Phys. Rev.*, **39**, 487; 1932.

Raman Spectrum of Deuterobenzene

WE have photographed the Raman spectra of the various deuterobenzenes. In order to obtain the isotopic shifts of the Raman frequencies with a fair accuracy, the spectra were investigated with high dispersion, which necessitates a rather large volume of the substance; the Raman tube employed contained 18 c.c. For the preparation of deuterobenzene we have investigated various possible exchange reactions and have finally chosen the Friedel-Craft reaction:



This process has the advantage of high reaction velocity, and further, our experiments indicate an appreciable shift of the equilibrium towards the deuterobenzene. Details concerning this reaction as well as the common physical properties of the deuterobenzene will appear elsewhere. Of course this method produces a mixture of the various deuterostituted benzenes in proportions very nearly corresponding to the probability distribution. By photographing the spectra of deuterobenzenes with various contents of deuterium, it is consequently possible to identify the Raman lines belonging to each deuterobenzene.

We have measured the complete Raman spectra of the molecules $\text{C}_6\text{H}_5\text{D}$, $\text{C}_6\text{D}_5\text{H}$ and C_6D_6 . All the Raman frequencies of benzene are found to be lowered by introduction of deuterium in the molecule.

Fig. 1 is an enlargement of a part of two Raman plates and shows the isotopic shift of the strongest line of the spectrum, namely, the frequency corresponding to the symmetrical ring vibration. The plates show distinctly greater isotopic shift between C_6H_6 and $\text{C}_6\text{H}_5\text{D}$ than between $\text{C}_6\text{D}_5\text{H}$ and C_6D_6 , owing to the comparatively greater alteration in mass in the first case. The Raman frequencies are respectively: 992.6, 981.5, 952.4 and 946.6 cm^{-1} .

The Raman frequencies of C_6D_6 , together with those of C_6H_6 , are as follows:

Raman Frequencies (cm^{-1})

C_6H_6	606.4, 849.7, 992.6, 1175.6, 1585.9, 1604.2, 3048.3, 3061.5.
C_6D_6	581.6, 844.7, 946.6, 869.8, 1555.4, 1569.0, 2266.8, 2292.0.

It is interesting to note the great shift of the 1175.6 line in benzene (to 869.8 cm^{-1} in C_6D_6), which shows that this frequency, as well as the 3048.3 and the 3061.5 frequencies, belongs to a pronounced hydrogen vibration.

The spectra of $\text{C}_6\text{H}_5\text{D}$ and $\text{C}_6\text{D}_5\text{H}$ are much more complicated owing to the split up of the degeneracy of certain vibrations in the symmetrical molecules

C_6H_6 and C_6D_6 , and are of great interest for the identification of these. A detailed report of the investigation and a discussion of the results will appear shortly elsewhere.

A. KLIT.

A. LANGSETH.

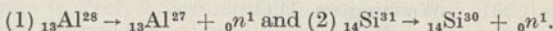
Universitetets kemiske Laboratorium,
København.
May 3.

Spontaneous Emission of Neutrons by Radio-elements

I. CURIE, Joliot and Preiswerk¹ have shown that by bombarding silicon and phosphorus by neutrons there are produced radio-elements which spontaneously emit neutrons, in addition to electrons (Fermi effect), positrons and γ -rays. Thus an entirely new type of radioactivity has been discovered by them.

The mechanism of the spontaneous ejection of neutrons is not fully understood. At any rate, it may be supposed that this process is a secondary one, as the experiments on the Fermi effect have shown clearly enough that the potential energy of the neutron in the nuclear field is negative (the barrier is absent), and hence the neutron, having received somehow or other some positive energy, must leave the nucleus immediately or pass into a state of negative energy, exciting another particle or emitting γ -quanta.

In their communication, I. Curie, Joliot and Preiswerk explain the emission of the neutrons by the following processes:



Such an interpretation (primary process) cannot be admitted according to the considerations mentioned above; moreover, it would seem impossible energetically, although we cannot assert this definitely because the accurate values of the masses of all the components of reactions 1 and 2 are not known.

I have attempted to find the energy distribution of the spontaneously ejected neutrons or at least to estimate its upper limit. For the detection of the neutrons I used a photographic plate with a thick layer of emulsion (50 μ) specially prepared for the registration of H-particles. At a distance of 0.2-0.4 mm. of the plate, there was placed a paraffin film

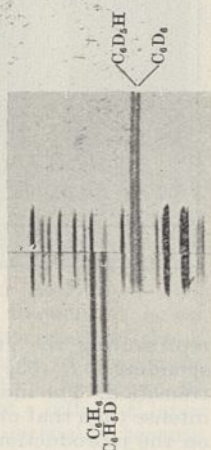


FIG. 1.

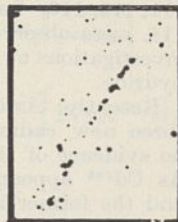
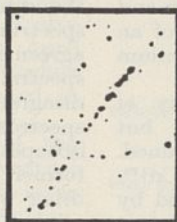


FIG. 1. Stereoscopic photomicrographs of the track of a recoil proton in photographic emulsion. Length of the track is 72 μ ($\approx 2.6 \times 10^6$ e.v.)

and thus were registered the protons ejected by the neutrons from paraffin (Fig. 1). Radioactive isotopes were being produced in red phosphorus by neutron bombardment. A glass tube containing radon (about 250 mc.) and some powdered beryllium served as the source of neutrons. Every 10 minutes the bombarded phosphorus was brought into the immediate neighbourhood of the photographic plate for a period of

10 minutes. The total time of the experiment was about 12 hours.

As a result there was revealed the presence of 15 recoil protons the energy of which is represented graphically in Fig. 2 (protons of energy 10^6 e.v. and

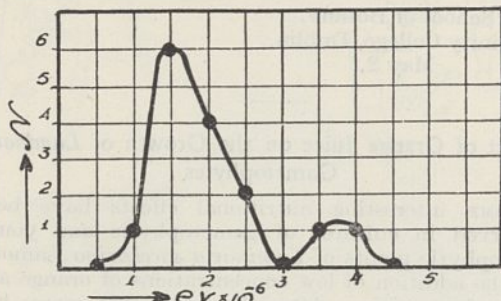


Fig. 2.

above are detected by this method). The greatest energy of the observed protons was $\sim 4 \times 10^6$ e.v. Thus the upper energy limit of the neutrons spontaneously emitted by some disintegration products of phosphorus is at any rate $\geq 4 \times 10^6$ e.v.

In conclusion, I wish to express my best thanks to Mr. A. Jdanoff for his kind help.

I. GUREVICH.

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Physical-Technical Institute,
Leningrad.
March 10.

¹ C.R., 193, 2089; 1934.

Hence $\lambda_{XC} = \lambda_{BC} = \lambda_{AC} = 0$, and all the commutators vanish. Therefore any two operators which represent physical variables must commute. This result can only be reconciled with the accepted exchange relations by taking the numerical value of Planck's constant to be zero. This destroys the whole structure of the modern form of the quantum theory.

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May 18.

Chromosomes of the Tulip in Mitosis

In a recent study of the development of the male gamete in the style of *Lilium regale*, O'Mara¹ states that no equatorial plate is formed, but that at metaphase the chromosomes lie scattered in the pollen tube. Welsford², on the other hand, illustrates in *L. Martagon* (her Fig. 16) the complement normally arranged on a plate.

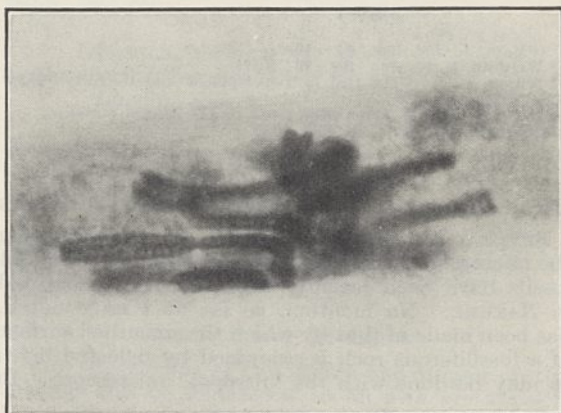


Fig. 1. Pollen tube division of *Tulipa Greigi* from an artificial culture of pollen, 24 hours after sowing on 14 per cent cane sugar agar.

I have obtained pollen tube divisions in *Tulipa Greigi* in artificial culture, using McClintock's acetocarmine method (Fig. 1). The metaphases are perfectly normal, with a definite equatorial plate, and the anaphases resemble those of the pollen grain except that the poles of the spindle are considerably farther apart.

In my experiment, the artificial medium may permit of the formation of wider pollen tubes than in *L. regale*. It is unlikely, however, that an irregular metaphase would give the regular anaphase distribution required to produce the viable gametes of this species. More probably, therefore, a true metaphase plate is formed, though the stage may be rapid and not easy to find.

The technique which I have used further reveals the structure of the mitotic chromosomes in a way not otherwise possible. The method can only be applied to the study of mitosis in pollen grains and pollen tubes, but the thick wall of the pollen grain apparently modifies the action of the fixative.

By this fixation the chromosomes show striations which are independent in each chromatid, and are presumably caused by a slight separation of the coils of the spiral chromosome thread. It is not possible to determine the direction of coiling, but there is evidently no change of direction, since there are no breaks in the spacing of the coils.

The Fundamental Paradox of the Quantum Theory

ACCORDING to the general principles of the quantum theory, physical variables a, b, c, \dots are represented by symmetric linear operators A, B, C, \dots in Hilbertian space; and the representation satisfies the following conditions:

$$a^2 \rightarrow A^2, \lambda a \rightarrow \lambda A, (\lambda \text{ being an ordinary number})$$

$$a + b \rightarrow A + B.$$

Since $ab = \frac{1}{2}(a + b)^2 - \frac{1}{2}(a - b)^2$, it follows that $ab \rightarrow \frac{1}{2}(AB + BA)$.

Similarly,

$$abc \rightarrow \frac{1}{4}(AB + BA)C + \frac{1}{4}C(AB + BA),$$

$$ca.b \rightarrow \frac{1}{4}(CA + AC)B + \frac{1}{4}B(CA + AC),$$

$$bc.a \rightarrow \frac{1}{4}(BC + CB)A + \frac{1}{4}A(BC + CB).$$

The general principles will therefore lead to a contradiction unless these three operational representations of abc are all equal. This implies that

$$A(BC - CB) = (BC - CB)A,$$

with two similar equations. Hence the commutator $(BC - CB)$ of any two operators representing physical variables must commute with every operator representing a physical variable. Therefore, by Schur's lemma, $(BC - CB)$ must be a numerical multiple, $\lambda_{BC}I$, of the unit matrix I , in any irreducible matrix representation.

Now, if $ab \rightarrow X$,

$$\lambda_{XC}I = XC - CX = \frac{1}{2}(AB + BA)C - \frac{1}{2}C(AB + BA)$$

$$= \lambda_{BC}A + \lambda_{AC}B.$$

The following measurements show the sizes of the structures involved :

Length of arm of chromosome	17.0 μ
No. of spirals	33
Diameter of chromatid	1.2 μ
Calculated diameter of chromosome	
thread = $\frac{17.0}{33} \mu =$	0.52 μ .

Evidently the structures shown by this technique are comparable with those illustrated by Vajdovsky at metaphase in *Ascaris*³ and by Darlington at telophase in *Fritillaria*⁴. The whole volume of each chromatid is taken up by a chromosome thread 0.5 μ in diameter compactly coiled to give a rod approximately twice its diameter.

These findings are therefore incompatible with those of Sharp⁵ and other workers of the chromonema-matrix school.

M. B. UPCOTT.

John Innes Horticultural Institution,
Merton Park, London, S.W.19.
May 1.

¹ O'Mara, J., *Bot. Gaz.*, 94; 1933.

² Welsford, E. S., *Ann. Bot.*, 28; 1914.

³ Wilson, E. B., "The Cell in Development and Heredity" (New York, 1925), Fig. 59.

⁴ Darlington, C. D., *Proc. Roy. Soc., B*, 117 (in the press).

⁵ Sharp, L. W., *Bot. Gaz.*, 88; 1929.

Use of Reflected Light in the Examination of Fossils

SEVERAL very ingenious methods for facilitating the microscopic examination of the structure of plant fossils have been recently described and illustrated in NATURE. No mention, so far as I have noted, has been made of that by which the smoothed surface of a fossiliferous rock is examined by reflected light, as may be done with the 'ultrapak' microscope. In

fossils; but the results, obtained with a few minutes' preparation from coal fossils, usually so hard to deal with, seemed to me most surprising. Higher magnifications giving 300-400 diameters with oil-immersion lenses are also feasible.

HENRY H. DIXON.

School of Botany,
Trinity College, Dublin.
May 2.

Effect of Orange Juice on the Growth of *Laminaria* Gametophytes

SOME interesting nutritional effects have been observed in cultures of gametophytic and young sporophytic plants of *Laminaria saccharina* Lamour. by the addition of low concentrations of orange and other fruit juices. After the *Laminaria* spores had been introduced into petri dishes containing 25 c.c. of filtered sea-water, orange juice was added in the proportion of 1 c.c. of a 1 per cent extract to each dish. Control cultures were kept under identical conditions of light and temperature.

Normally, on germination the contents of the spore pass through the germ-tube into the enlarged distal end, giving the early stage of the 'effective plant'. In cultures containing sea-water alone, the young gametophytes remained in this condition for a period varying from a few days to some weeks. In cultures to which orange juice has been added, this temporary resting stage is greatly reduced.

Previous investigators have shown that sexual organs may be produced either in the one-celled condition or from any cell of a filamentous gametophyte. The filamentous form of gametophyte is produced either when temperature and light intensity are high, or when phosphate is present in excess of nitrate¹. The presence of orange juice stimulates the formation of filamentous gametophytes and also the production of sexual organs (Fig. 1, a and b).

Algologists have frequently observed that, in culture, the plants floating in the surface film of the medium show reactions different from those of the submerged plants. It is, perhaps, not without significance that in cultures to which orange juice has been added, the greatest growth is usually observed in the submerged germlings.

Analyses of sea-water made at different times of the year show a marked diminution in the amounts of dissolved nitrate and phosphate present during the spring and early summer. Experiments carried out with cultures supplied with 1 c.c. of

0.01 molar potassium nitrate, potassium iodide and potassium phosphate in addition to the fruit juices show an acceleration of growth and development which is equally marked (Fig. 1, c and d). Vigorous young sporophytes have been produced in these treated cultures.

Further experiments are in progress to determine the effect of different concentrations of various fruit

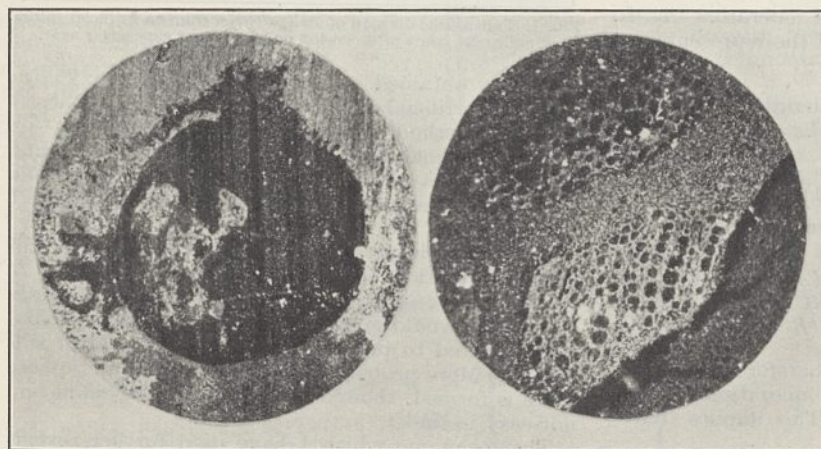


Fig. 1. Photomicrographs of coal. Left hand: Megaspore or megasporangium on smoothed surface of Wigan coal parallel to bedding. $\times 32.5$ diam. Right hand: Transverse section of stem seen on smoothed surface of Westphalian coal. $\times 75$ diam.

this instrument, as many will know, the light is introduced laterally into the body of the microscope, reflected downwards by an annular mirror and brought to a focus by an annular condenser in front of the objective.

The accompanying photomicrographs (Fig. 1) were made by this way from ordinary coal. The method is equally applicable to siliceous and calcareous

juices; of the addition of ascorbic acid (vitamin C) contained in these juices and of other growth-

Chemistry of Oestrogenic Substances

IN view of the results published by E. Friedmann in NATURE of April 20, we decided to investigate the effect upon ovariectomised rats of the two compounds specifically mentioned by him as oestrogenic, namely, sodium benzylidenepyruvate and sodium furylidene-pyruvate. These were prepared and purified exactly as described by Friedmann¹. They were dissolved in water, the strength being 100 mgm. in 3 c.c., and administered in 6 doses of 0.5 c.c., each compound being injected into 5 rats. The technique employed was that described in the paper by Allan, Dickens and Dodds².

A similar experiment was performed using the two free acids (100 mgm. dissolved in 3 c.c. of sesame oil and divided into 6 doses of 0.5 c.c.), five rats being used for each of the two acids.

Examination of the vaginal smears showed that there was no oestrogenic activity either with aqueous solutions of the sodium salts or with solutions of the free acids in oil when injected in amounts of 100 mgm. per rat.

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¹ Friedmann, E., *Helv. Chim. Acta*, **14**, 783; 1931.
² Allan, H., Dickens, F., and Dodds, E. C., *J. Physiol.*, **63**, 348; 1930.

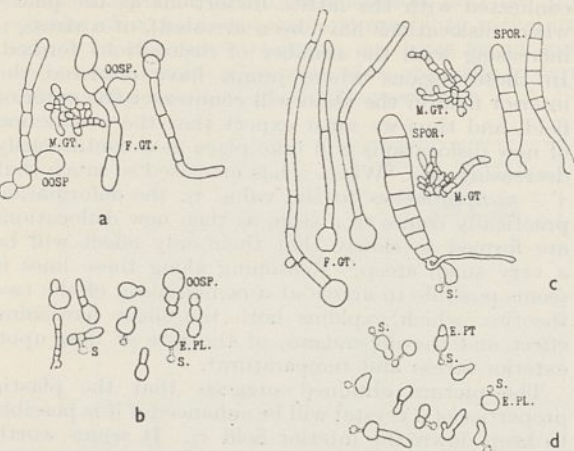


FIG. 1. Cultures 40 days old of germinating spores of *Laminaria saccharina* Lamour.

- a, Gametophytes from culture in sea-water to which 1 c.c. of 1 per cent extract orange juice was added.
- b, Gametophytes from control culture, sea-water alone.
- c, Gametophytes and young sporophytes from culture of sea-water and added inorganic salts, with 1 c.c. of 1 per cent extract orange juice.
- d, Gametophytes from control, sea-water and inorganic salts.

s., Spore; e.pl., 'effective plant'; oosp., oosphere; m.gt., male gametophyte; f.gt., female gametophyte; spor., young sporophyte.

promoting substances² which are known to contain nucleic acid or its derivatives.

P. W. CARTER.

Botanical Department,
University College,
Aberystwyth. May 15.

¹ Harries, *Ann. Bot.*, **46**, 893; 1932.
² Mockeridge, *Biochem. J.*, **14**, 732; 1920. *J. Exper. Biol.*, **4**, 301; 1927.

Birds and Butterflies

IN reference to the palatability of butterflies, it may be interesting to record that the Australian grey butcher bird, *Cracticus torquatus*, does not object to eating butterflies. A tame bird which I have had under observation, though pinioned, manages to catch skippers of the species *Anasynta sphenosena*, when these are flying round flowers within reach. I have also seen the bird catch the same species in the early morning before the butterflies have become active. The butterflies are seized with the bill, beaten once or twice against the ground or against some hard object, and then swallowed whole. The fact that on one occasion the bird caught and ate a skipper soon after it had been fed with its customary ration of raw meat indicates that it was not hunger that persuaded the bird to take the butterfly.

The same bird also eats the introduced sand hill snail, *Helix pisana*. The victim may be either crushed with the powerful bill or beaten against the ground, but an anvil stone such as used by the English thrush is not utilised. Much of the shell is swallowed, to be disgorged later in the pellet. Examination of these pellets also shows that ants are freely eaten.

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Public Library, Museum and
Art Gallery,
Perth, Australia.
April 12.

Research and the Library

THE suggestions of Drs. Berry and Bonser on this subject¹ will be of interest to all who are appalled by the unabating flood of scientific literature.

There are two points to which I would direct attention. First they state: "It has long been the practice of chemical journals to accept only new matter, and this cut down to the briefest account. This principle can be adopted with advantage in other scientific subjects". Chemistry is an exact science, and what may be an excellent method of presenting its results may not be best for a biological subject. In zoology a statement of results or observations is valueless unless it is followed by a discussion in which the new results are correctly orientated in relation to previously known facts. Facts by themselves mean nothing; only when they are seriated into a hypothesis do they take on any value.

The adoption by certain zoological journals of the criteria of chemical journals has had the unfortunate effect of restricting discussion and has produced a multitude of isolated pieces of information. Thus I cannot agree with Drs. Berry and Bonser when they suggest that accounts of the debates of certain societies should not be published, for by ordered discussion alone can science be advanced. The mere accumulation of details and isolated facts is not scientific advancement.

A scientific paper should consist of three parts: an introduction explaining why and how the investigation was undertaken; the observations; and finally their interpretation. If all papers were so composed and there was adequate discussion of all points raised, not only would the publication of

incomplete work be checked, but also the number of papers published would be halved, for the discussion would show the writer that half the facts he would normally record are insignificant details having no bearing on his general argument.

Secondly, the suggestion of Drs. Berry and Bonser that there is a tendency for the young research worker to be judged upon the number of his papers rather than on their quality, gives rise to many thoughts which cannot be touched on here. But it does prompt the question as to how much research is done with the idea of the advancement of some branch of science and how much for added professional qualification. To-day, even for minor posts, candidates are expected to have research qualifications; and quantity rather than quality will continue to count unless those responsible for making such appointments are prepared either to seek such expert advice on the publications of the candidates as they would for a senior post, or to pay less attention to this aspect of the qualifications.

Whether the apparent respect paid to all forms of research is genuine is another matter, for the reward for the most brilliant research would appear to be, not the means and leisure to continue it, but a post involving such administrative or teaching duties as to make further research impossible.

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¹ NATURE, 135, 664, April 27, 1935.

Plasticity of Rock Salt and the Taylor and Becker-Orowan Theories of Crystalline Plasticity

IN Prof. Taylor's theory of crystalline plasticity¹ the process of slip is conceived as the result of the propagation through the lattice of a definite type of deviations from the 'ideal' structure, so-called dislocations². The path of a single dislocation in general is limited by the faults or flaws in the crystal and it is assumed that the number N of propagated dislocations increases during the course of the process. Every dislocation is the centre of a field of stress; the various dislocations influence each other's motions and it is shown that centres will escape from each other only if the applied exterior stress exceeds a certain value, increasing with N . Hence the stress necessary for further deformation increases with the deformation already attained ('shear hardening'). It is suggested by Taylor that the dislocations might arise as a consequence of thermal agitation, but no explicit explanation is given of the progressive increase of N .

Now, in the Becker-Orowan theory, gliding is conceived as starting from 'jumps', originating at favourably situated flaws under the combined influence of the exterior stress τ (enhanced by the so-called stress-concentration effect), and of thermal agitation (producing local stress fluctuations³). This conception leads to a relation between τ and the rate of flow, from which also the minimum value τ_f necessary to produce an observable rate of shear at a given temperature can be estimated. It is put forward by Orowan (i.e., p. 639) that these local jumps initiate dislocations of similar type as considered in Taylor's theory. If such dislocations, once formed, move only over a finite distance and are then arrested at 'opaque' flaws, it would seem to us

that they will give rise to an 'interior' field (similar to that introduced by Taylor, though now essentially connected with the lattice distortions at the places where dislocations have been arrested), of a stress τ_i increasing with the number of dislocations formed. In those regions where jumps have occurred the interior field in the main will counteract the exterior field, and thus we must expect that the production of new dislocations will take place at a continuously decreasing rate. When τ_i has increased so much that $\tau - \tau_i$ approaches to the value τ_f , the deformation practically comes to a stop, as then new dislocations are formed so slowly that their only effect will be a very small creep. Reasoning along these lines it seems possible to arrive at a combination of the two theories, which explains both the shear hardening effect and the dependence of the rate of flow upon exterior stress and temperature⁴.

The picture obtained suggests that the plastic properties of a crystal will be enhanced if it is possible to keep down the interior field τ_i . It seems worth while to consider from this point of view the remarkable fact, observed by Smekal⁵, that on stretching a piece of rock salt the actual gliding among several equivalent sets of glide planes chooses that set, for which the direction of gliding occupies the shortest way in the piece. If it is assumed that a certain proportion of the dislocations which arrive at the surface layer of the crystal are able to 'escape', so that they do not contribute to the interior field, the interior field for a given total shear will be the smaller when the number of dislocations that can arrive at the surface is greatest, which will be the case for the shortest glide path.

To some extent, similar reasoning may perhaps help to understand the much discussed influence of water on the plasticity of rock salt. If the water has a 'healing' effect on the surface layers, those dislocations which were arrested by flaws in these layers can escape, and thus a decrease of τ_i will be effected. This means that a definite exterior stress can give rise to the birth of a larger number of dislocations and thus to a larger shear.

The above suggested 'explanation' of the Joffé effect as a 'surface effect' apparently fits in with the conceptions of W. Ewald and M. Polanyi⁶. If it were assumed, as has been proposed by Smekal and co-workers⁷, that the water penetrates into the crystal, an increase in plasticity could be effected also if the 'opacity' of internal flaws for the passage of dislocations were diminished, thus increasing their mean 'free path' L . This second explanation would be similar in nature to that accepted by Taylor for the influence of temperature on the degree of plasticity.

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March 18.

¹ G. I. Taylor, *Proc. Roy. Soc., A*, **145**, 362, 388, 405; 1934.

² Compare also M. Polanyi, *Z. Physik*, **89**, 660; 1934.

³ R. Becker, *Physik. Z.*, **26**, 919; 1925. E. Orowan, *Z. Physik*, **89**, 605, 614, 634; 1934.

⁴ This will be set forth in more detail in Chapter V (section 11) of a "Report on Viscosity and Plasticity" published by the Royal Academy of Sciences at Amsterdam in its *Verhandelingen* (section I, **15**, No. 3; 1935).

⁵ A. Smekal, *Z. Physik*, **93**, 166; 1935.

⁶ W. Ewald and M. Polanyi, *Z. Physik*, **28**, 29; 1924. M. Polanyi, *ibid.*, **89**, 660; 1934.

⁷ See, for example, K. Wendenburg, *ibid.*, **88**, 727; 1934.

Electrical Properties of Wires of High Permeability

IN the course of an investigation into the properties of wires of the high permeability nickel-iron alloys of the mumetal group, we have found some interesting results when such wires are made to carry alternating current at audio-frequencies.

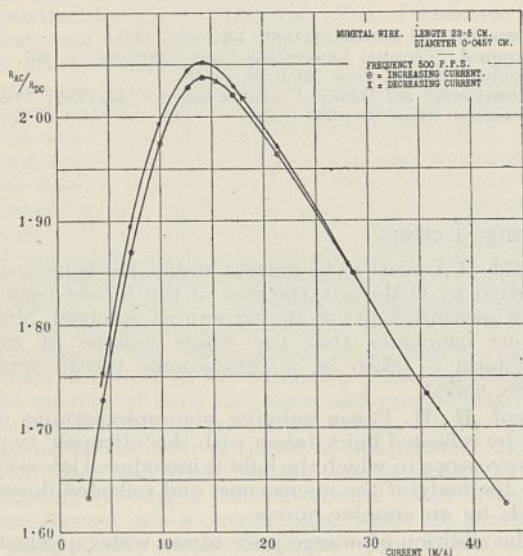


FIG. 1.

There is a pronounced 'skin effect' even in fine wires, owing to their abnormal permeability, at frequencies as low as 50 periods per second, at present the limit of our experiments. In addition, the application to the wire of a small external axial magnetic field of the order of that of the earth, causes a strikingly large change in its impedance.

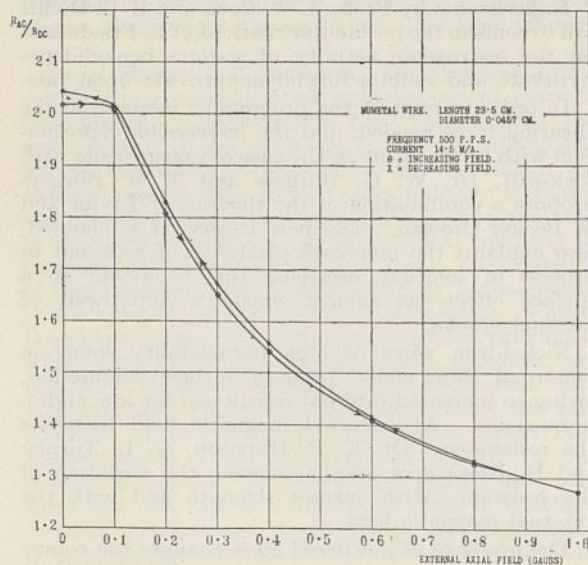


FIG. 2.

When the external field is constant it is found that the effective (A.C.) resistance varies with the value of the alternating current in the wire, and for any frequency always comes to a maximum for some

particular current which for convenience we may call the optimum current for the wire at that frequency. As an example, in a mumetal wire, 23.5 cm. long and 0.0457 cm. in diameter (dimension ratio 510) suitably heat-treated, the variation of effective resistance with current at a frequency of 500 p.p.s. is shown in Fig. 1. It will be observed that there is a slight but appreciable hysteresis effect.

When the current in the wire is kept constant at the 'optimum' value of 14.5 milli-amperes, and the external axial magnetic field is varied, the variation of effective resistance is shown in Fig. 2. A small hysteresis effect is again noticeable. For currents either larger or smaller than the optimum, the corresponding field-resistance curves lie below that shown in Fig. 2, and their maximum gradients are smaller.

Changes in reactance as current or external field is varied also occur, but are in general smaller than those of effective resistance.

By using a wire with a larger dimension ratio, the changes of effective resistance in fields less than 0.2 gauss may be considerably increased. As an example, a wire of length 15.25 cm. and diameter 0.0179 cm. (dimension ratio 850) carrying a.c. at 500 p.p.s. and lying horizontally at right angles to the magnetic meridian, suffered a decrease in effective resistance of about 18 per cent when turned through 90° in the horizontal plane. This, combined with a power factor in the wire of 0.97, means an impedance change of about 17 per cent, if the small reactance change be ignored.

A detailed account of these experiments will shortly be published elsewhere.

We are indebted to the Admiralty for permission to publish this note.

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 G. L. TURNEY.
 H. ROWE.

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 H.M.S. *Vernon*,
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 April 5.

Thermal Oxidation of Formaldehyde

CARRUTHERS and Norrish¹ have observed that the polymerisation of formaldehyde is induced by formic acid, produced in the photochemical oxidation. An induced polymerisation apparently accompanied by an induced decomposition occurs in the thermal oxidation, at temperatures as high as 317°. This reaction possesses many features of interest from the point of view of the theory of chain reactions. Direct analysis has shown that the rate changes with time as predicted by the theory for chains with degenerate branching². Furthermore, in a series of mixtures, the initial rate depends on the third power of the formaldehyde concentration and is independent of oxygen concentration down to pressures of a few millimetres. In a single experiment, however, these conditions do not hold good, and with a sufficiently high initial velocity, good unimolecular constants can be obtained over a large range.

It is not easy to explain this effect by a catalysis due to the final products, but Semenoff³ has shown that such behaviour is to be expected in reactions where there is a mutual interaction of chains. Perhaps the most unusual feature occurs in the experiments with vessels of different diameter. No considerable

difference could be observed in the amounts of CO and CO₂ produced in a given time in a series of vessels ranging from a 161 c.c. bulb down to a 1 mm. capillary tube, despite the fact that polymerisation in the narrow tubes was sufficiently rapid to cause a considerable diminution in pressure instead of the usual increase due to the reaction $2\text{H.CHO} + \text{O}_2 \rightarrow 2\text{CO} + 2\text{H}_2\text{O}$. However, when a tube packed with powdered Pyrex glass was substituted, the course of the reaction changed and the gaseous product consisted almost entirely of CO₂. Packing has a similar effect on the course of the oxidation of acetylene⁴, but the rate of production of CO falls off rapidly

when the diameter is decreased below 6 mm.⁵ This critical region of diameters, if it exists, must lie well below 1 mm. in the case of formaldehyde, yet the other characteristics of the reaction are certainly indicative of a chain mechanism.

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¹ Carruthers and Norrish, *NATURE*, **135**, 582; 1935.

² Semenov, "Chemical Kinetics and Chain Reactions", p. 367.

³ Semenov, *Z. phys. Chem.*, **28** B, 54; 1935.

⁴ Kistiakowsky and Lenher, *J. Amer. Chem. Soc.*, **52**, 3785; 1930.

⁵ Spence, *J. Chem. Soc.*, 686; 1932.

Points from Foregoing Letters

THE addition of echo sounding gear to the *Johan Hjort* enabled that vessel to reveal unsuspected features of the flooring of deep fjords, and to locate swarms of spawning cod in the neighbourhood of Lofoten. These, writes Oscar Sund, were mainly in a layer of 10-12 metres thick at a constant depth where a somewhat lower oxygen concentration and greater acidity could also be detected.

Prof. S. K. Mitra and P. Syam report the detection of radio waves returned from a height of only 55 km. Although these have only been detected occasionally, the authors believe that the ionised layers to which the effect is due exist usually in a diffused form which strongly absorbs longer waves, and affects the virtual height of the Kennelly-Heaviside region above it.

An error in sign (later corrected) in Prof. Sommerfeld's original paper on the attenuation of radio waves had led to the prediction of a zero field intensity at finite distances from a radio transmitter. K. A. Norton points this out and gives a new empirical formula for the field intensity, applicable, however, only to a plane earth.

The existence of a cadmium isotope of mass 118 has been deduced from the band spectrum of the light emitted by cadmium hydrides, but has not been identified by means of the mass-spectrograph. Gösta Stenvinkel and Erik Svensson claim that the evidence from the spectrum of the light emitted by the hydrides is conclusive, as is shown by its ability to detect the existence of other known isotopes of cadmium and zinc, for which the mass-spectroscopic evidence is conflicting.

The introduction of heavy hydrogen in place of the ordinary variety in organic compounds changes the Raman spectrum of the light scattered by those compounds. From the shift observed in certain spectrum lines of benzene, A. Klit and Dr. A. Langseth associate some of the spectrum lines with the structural characters of the benzene molecules.

The neutrons spontaneously emitted by phosphorus previously bombarded with other neutrons (from a radon-beryllium source) may possess more than four million volts energy. In I. Gurevich's view, neutron emission is a secondary process, and not a primary process as suggested by Curie, Joliot and Preiswerk.

From the general principles of the quantum theory, Prof. G. Temple deduces the paradox that any two 'operators' which represent physical variables must commute. This would make Planck's constant zero.

The arrangement of the chromosomes during cell division in the pollen tube of the tulip is found by

Miss M. B. Upcott to be normal, unlike the behaviour reported by O'Mara in the case of the *Lilium regale*. From measurements of the structures involved, Miss Upcott concludes that the whole volume of the chromatid is taken by a chromosome thread compactly coiled.

Prof. H. H. Dixon submits photomicrographs of coal by reflected light, taken with the 'ultropak' type of microscope in which the light is introduced laterally into the body of the microscope, and reflected downwards by an annular mirror.

The addition of orange juice to sea-water quickens the development of the sea-weed, *Laminaria saccharina* (sugar wrack) in its early stages, the greatest growth being observed in submerged germlings. P. W. Carter gives diagrams showing this effect, and also that of the addition of potassium salts.

As a contribution to the discussion on the palatability of butterflies, L. Glauert writes that he has observed the Australian butcher-bird catching specimens of the species *Anasynta sphenosena* even when not driven by hunger.

Experiments by Profs. J. W. Cook and E. C. Dodds fail to confirm the recent observations of E. Friedmann on the oestrogenic activity of sodium benzylidenepyruvate and sodium furylidenepyruvate upon rats.

In order to explain the progressive increase in the shearing force needed, and the irreversible deformation with temperature in the case of experiments with rock-salt, Dr. W. G. Burgers and J. M. Burgers propose a combination of the theories of Taylor and of Becker-Orowan. The new theory, it is claimed, also explains the increased plasticity of rock-salt in process of solution, ascribing this behaviour to a surface effect, as against Smekal's hypothesis of internal cracks.

Nickel-iron wires of high permeability show an abnormal 'skin effect' (mainly surface conduction, owing to increased internal resistance) for low audio-frequencies. An external magnetic field increases the resistance. Dr. E. P. Harrison, G. L. Turney and H. Rowe give graphs showing the variation of the resistance with current strength and with the external magnetic field.

The presence of powdered glass changes the course of polymerisation and decomposition of formaldehyde (at temperatures up to 317°), producing carbon dioxide instead of carbon monoxide and water. Dr. R. Spence interprets this effect as due to the breaking of the reaction chains owing to deactivation of active molecules by collision with increased surface.

Research Items

Giant Hand-Axe from Sheringham, Norfolk. An altogether remarkable and gigantic hand-axe, discovered embedded in the beach below Beeston Hill, Sheringham, by Mr. J. P. T. Burchell, has been figured and described by Mr. J. Reid Moir (*Proc. Prehistoric Soc. East Anglia*, 7, Pt. 3). The implement measures in its greatest length $15\frac{1}{2}$ inches, in greatest width $6\frac{1}{4}$ inches, in greatest thickness $5\frac{1}{4}$ inches. Its weight is approximately $14\frac{1}{2}$ lb. It was derived originally from the base of the Cromer Forest bed, which rests upon the surface of the chalk. The implementiferous bed runs in beneath the Forest Bed strata and the glacial deposits which form the cliff, some 200 ft. in height. The material of the axe is of flint, the colour of the flaked surfaces being jet black. The ridges and outstanding parts are abraded, and it is striated in places. There is a small area of the cortex remaining, which shows a ferruginous staining. It is a specimen of the 'plattiform' type, that is, rhomboidal in section in the anterior portion and showing the remains of both the dorsal and ventral planes or platforms of the rostro-carinate stage. In two other specimens cited for purposes of comparison, coming from East and West Runton, one is clearly of the 'plattiform' type, but the ventral plane is partly transformed into a cutting edge, while the second is equally clearly of the 'batiform' type, in which the section through the anterior portion is triangular in section, the lower angles of the triangle representing the cutting edges. Hand-axes showing these characteristics have been discovered not only in England but also widely distributed over the earth's surface. The numerous specimens discovered in the basement bed, belonging to the early Pleistocene epoch, are as highly specialised as are those of any later prehistoric period and represent a very definite and necessary stage in implemental development. No adequate explanation of the purpose which the gigantic size of the Sheringham axe could serve has been offered.

Racial History in Scandinavia. Dr. Stanislas Zejmiejmis has constructed an anthropological map of Scandinavia, and from this has reconstructed the racial history of the peninsula in the light of archaeological and historical material. He has drawn his anthropological data mainly from military statistics and other published material, which he has analysed in accordance with the anthropological methods of Czekanowski (*L'Anthropologie*, 45, 1-2). The existence of four physical types is established as 'fundamental' in the sense of Czekanowski: Mediterranean, Nordic, Lapoid and Armenoid. The Mediterranean provinces, which play an important part in the peninsula, are centrally situated at Dalecarlia in Sweden, and Hedmark and Oppland in Norway. They are surrounded by provinces of transition in which the Mediterranean type diminishes in favour of the Nordic or Lapoid. The essentially Nordic provinces form not one, but two zones, the first in southern Sweden (Skaraborgs, Jänköpings, Oestergötlands, Göteborgs, Aelvsborgs), the second in Norway (North and South Trøndelag), lying on each side of the lenticular centre. Outside these provinces are territories in which is found a strong proportion of the Lapoid element. In the north of Norway (Tromsø and Finmark) this reaches as high as 33 per cent. In Sweden the proportion is not so great; in the south,

Scania and the adjacent regions correspond to the Norwegian Rogaland. The Armenoid does not play an important part, and nowhere does it exceed 3-5 per cent. The most ancient stratum of the prehistoric population (for example, Stägenäs of the Ancyclus period) is Mediterranean, possibly Cro-Magnon. It is followed by the Lapoids of the south, who possibly are to be related to Ofnet. The northern Lapoids are distinct and later, being Laps. The Nordics appear with the last great neolithic migration into Scandinavia. The brachycephals of southern Scandinavia are to be closely associated with Maglemose and the Danish kitchen-middens. The Nordics belong to the following Littorina period when the climate of Europe, becoming drier, was favourable to their nomadic habits. The Norwegian Nordics are of secondary origin. The Armenoids appear to have arrived at the end of the neolithic or beginning of the bronze age.

Spearman's General Factor in Mental Activity. *Character and Personality*, 3, No. 2, contains an article, "On the Nature of Spearman's General Factor", by Prof. Wm. McDougall. He presents Prof. Spearman's case for the existence of a general factor, usually represented by the letter *G*, which enters into all mental activity and is revealed in mental testing, and he considers the problem of determining the nature of *G*. Two questions arise. First, in what kind of operation does *G* most clearly manifest itself? Secondly, what is the underlying cause or condition which thus manifests itself? To the first question a satisfactory answer can be given, but the second presents a number of problems. Spearman favours "a quantity of intellectual energy" as the answer. McDougall criticises this view, and suggests that both the supply and the direction of energy should be considered, and that a definition of *G* as "power of effective concentration of energy" is nearer the truth. The study of the effect of emotional excitement on cognitive activity, and the lack of any common factor so far from tests on animals, leads to the conclusion that 'integration' is the answer to the problem. "In proportion to the degree of integration achieved the whole mind works as one system which dominates and controls all its parts." Prof. McDougall does not claim that his solution is final, but his arguments are stimulating and convincing.

Chinese Fishes. In the *Journal of the Shanghai Science Institute* (Section 3, vol. 1, 1934), Mr. Shigeru Kimura publishes a "Description of the Fishes collected from the Yangtze-kiang, China, by late Dr. K. Kishinouye and his Party in 1927-1929". The collection is very large and of considerable interest, coming from the tributaries of Yangtze-kiang, from Szechwan Province, and consisting of fishes belonging to 63 genera and 28 families. There are among them 11 new species, one of which is a handsome member of the Salmonidæ, *Hucho bleekeri*, represented by one specimen only from a mountain stream. The name *Hucho* is from *Hu-yu*, meaning tiger-fish, a name given by the natives to various different forms. Seven new species belong to the Cyprinidæ, and one each to the Cobitidæ, Siluridæ and Bagridæ. The paper is well illustrated by plates in black and white, and there is a map showing the localities from which the material was collected.

Crustacea of the Vanderbilt Expeditions. The fifth volume of the "Scientific Results of the World Cruise of the Yacht *Alva*", 1931, with William K. Vanderbilt commanding, deals with Crustacea (*Stomatopoda* and *Brachyura*). By Lee Boone. *Bull. Vanderbilt Marine Mus.*, 5; 1934. Huntington, L. I., New York, U.S.A. Printed Privately). It describes the zoological material personally collected by Mr. Vanderbilt during a series of cruises in his yachts, and deposited in his marine museum. The latest collections were made by the yacht *Alva*, and the present work is as beautifully printed and illustrated as were the former volumes. Miss Lee Boone describes every species in detail, many of them being very rare, citing the type of each and where it is to be found, its distribution and reference to previous descriptions. There are three new species of crabs: *Acteomorpha alva*, an interesting form representative of a little-known genus of the family Leucosiidae and resembling in appearance the cancrioid genus *Actæa*: *Lissocarcinus elegans*, a new swimming crab connecting the sub-family Caphyrinae with the Lupinae; and *Actæa aphrodita*, a pretty little crab from the coral reefs of Bali. Colour plates and notes of several forms were made at the time of collecting by Mr. W. E. Belanske, staff artist of the expedition, under the direction of Mr. Vanderbilt, and are deposited in the Vanderbilt Marine Museum.

Storage of Avocado Pears. As Memoir No. 1, the Low Temperature Research Station of the Imperial College of Tropical Agriculture publishes a study of storage possibilities with Avocado pears, which includes points of both scientific and commercial interest. The authors, Dr. C. W. Wardlaw and Mr. E. R. Leonard, point out that most of the orchards of this plant in the West Indies are stocked with plants grown from seed so that there is great variety in the produce, a diversity which extends to their behaviour in storage conditions and makes their behaviour quite impossible to predict in relation to an export trade. They emphasise, therefore, that the first step, if an export trade is to be built up, is to select certain definite varieties, which these preliminary tests show to possess possibilities, to use these only for purposes of propagation, and to study the behaviour of experimental consignments of these varieties under export conditions. It is suggested that these preliminary exports should be kept at a steady temperature of 45° F. At this temperature many of the local varieties manifest phenomena of 'chilling' which have considerable interest. Maturation processes still continue in the internal tissues in these chilled fruits, but the biochemical processes take an abnormal trend. The onset of chilling is shown to be closely associated with a phase of the process of ripening in the fruit.

Taxonomy of Wild Hybrids. In his presidential address to the Botanical Section of the American Association for the Advancement of Science (*Science*, 81, 161), Prof. K. M. Wiegand discussed the subject of wild hybrids from the taxonomic point of view. He cited his experience with the genus *Amelanchier* in eastern North America, in which, after many sortings of herbarium specimens, he finally reduced them to six piles (species) and a seventh pile including heterogeneous forms with intermediate or combination characters, local distribution and other features of hybrids. In Newfoundland, where the conditions had been disturbed by forest cutting, a mixture of hybrids was found, but in less disturbed areas the

plants were more uniform. The conditions of hybridity in various other genera, such as *Crataegus*, *Rubus* and *Quercus*, are discussed, and it is concluded that hybridisation has probably played little part in evolution. The eastern American species are regarded as nearly all going back to the Glacial period or much earlier, and species formation as a very slow process. While this doubtless contains much truth, it is possible that the evolutionary importance of polyploidy, and particularly amphidiploidy, has been underestimated.

Life-History of *Endophyllum sempervivi*. A very full account of the life-history of a rust fungus on house-leek plants has recently been published by Dorothy Ashworth (*Trans. Brit. Mycol. Soc.*, 19, Part 3, 240-258, February 1935). Investigations have been made into almost all the phases of activity of the fungus. Binucleate sporidia germinate to form germ tubes, which penetrate the epidermal walls of the host. Uninucleate mycelium is produced, and spermagonia appear in spring. Masses of aëcidial primordia occur at the base of each spermagonium, and after the production of secondary primordia, the hyphae become binucleate by nuclear migration. Aëcidiospores formed from these mycelial threads have four nuclei, and give rise to a tri-septate promycelium from which four sporidia or basidiospores are abstracted. It is interesting to note that aëcidia can be formed without the intervention of the spermatia; diploid mycelium can be produced as a result of hyphal fusions. *Endophyllum sempervivi* is a perennial fungus, and the mycelium appears to be always uninucleate until aëcidia begin to develop. It is not typical of the rust fungi in that aëcidiospores produce basidia directly, without the intervention of uredo- or teleuto-spores.

Ship Waves. T. H. Havelock (*Proc. Roy. Soc.*, A, April 10) has made some calculations on the wave-making resistance of simplified ship forms, taking into account fluid friction. In the absence of fluid friction, the energy absorbed in making waves is the same whether the model is moving bow first or stern first, even when the model is not symmetrical fore and aft. The main effect of fluid friction is to lower the relative wave-making effects of the after parts of the surface, and in some cases calculated the effectiveness of the stern is lowered by about 40 per cent. This reduction introduces a difference between the wave resistances for ahead and astern motion. Calculations are also made of the wave profile using the corrections for fluid friction, and these agree well with observation.

Rotation of Molecules in Liquids. X-ray studies have shown that the molecules of a liquid possess a spatial distribution comparable with that occurring in a crystalline solid. The centre of gravity of a liquid molecule can be imagined as oscillating about a point which is itself slowly moving. Furthermore, there exists a coupling between neighbouring molecules, and hence the latter cannot be considered as completely free to rotate. Instead, they are constrained to perform rotatory oscillations about an axis the orientation of which varies slowly. The effect of this constraint on the molecular polarisation and the Kerr effect of a liquid substance has been examined by P. Debye (*Bull. Classe Sci., Acad. roy. Belg.*, 31, 166; 1935). The calculation shows that the coupling, measured by the energy required to rotate a molecule through 90°, is quite large, being as much as 10 *kT* for water. The fact that the

molecular polarisation and the Kerr effect of a substance in solution are both less than for the same substance in the vapour state also follows from the theory. Thus the effect of dissolving monochlorobenzene in hexane is completely explicable on the basis of a coupling energy equal to $0.75 kT$.

Negative Ions in the Glow Discharge. Little work has been done on negative ions in the glow discharge, and they are commonly neglected in theories of the discharge. J. L. Spencer Smith has carried out careful work on the glow discharge in iodine (*Phil. Mag.*, April and May, 1935), and he finds that in this vapour negative ions are present in large numbers and exert a strong influence. In one series of experiments various regions of the discharge were investigated by the Langmuir probe method, and an analysis of the probe currents showed that negative ions are present in numbers about equal to the positive ions. In further work, negative ions from the discharge were drawn through a perforated probe electrode into an independently exhausted space and analysed by a magnetic field. I^- , I_2^- and I_3^- ions were found. The beams of negative ions obtained in this way were used for some approximate measurements of the collision probability between negative ions and neutral iodine molecules by measuring the absorption of the beams in iodine vapour.

New Method of Distinguishing Amylases. Basing himself upon the observations of Wijsman (*Rev. Trav. Chim.*, 9, 1; 1890), K. Venkata Giri has recently suggested a simple qualitative method of characterising different amylases which may prove to have a wide range of usefulness (*J. Indian Inst. Sci.*, 17A, 11, 127-129). A small drop of the enzyme is added to an agar gel carrying a suspension of starch and allowed to diffuse for 24-28 hours at laboratory temperature. The gel is in a Petri dish, and at the end of this period a dilute solution of iodine is poured on for a few minutes, until the diffusion zones show clearly. In the case of β -amylase the central diffusion zone is coloured violet; in the case of α -amylase it is colourless. The results of its use with taka-diastase, salivary amylase and pancreatic amylase are described.

Standard Methods for Testing Wood Preservatives. In 1930, a conference was held in Berlin to discuss the possibility of arriving at a standard method for testing the toxicity of wood preservatives in the laboratory. At this conference there was general agreement as to the form which the tests should take, and a report of the decisions taken was published in NATURE (126, 921; 1930). A committee was set up at the meeting to organise a series of co-operative tests to determine how far the suggested method could give consistent results when carried out in different laboratories by different workers, and to settle details of technique. The results of the committee's work have been published in *Angewandte Chemie* (48, 21; 1935) in which is given an account of the experiments made in order to compare the activity of various isolations of the different test fungi chosen, and of the results obtained in different laboratories in comparative tests on identical samples of sodium fluoride and creosote. A detailed description of the standard method adopted for carrying out the recommended wood block test (*Klötzchenmethode*) is also included, together with a note on the 'agar' method (*Rohrchenmethode*). It is to be hoped that, in future, laboratory tests upon the

toxicity of wood preservatives will be carried out, so far as possible, by this standard method, so that results obtained in different laboratories may be directly comparable.

Boundary Friction of Oxidised Lubricating Oils. Dr. Redgrove's paper on the "Boundary Friction of Oxidised Lubricating Oils", read before the Institution of Petroleum Technologists on April 9, is in fact an account of experiments conducted during the period 1927-31. Conclusions then reached agree substantially with those obtained as a result of more recent research, even though the particular problems under consideration were attacked from an entirely different angle. Since small percentages of the higher fatty acids improve lubricating qualities of mineral oils under boundary conditions, experiments were made to ascertain whether the less volatile petroleum acids exerted a like beneficial effect. Preliminary investigations with blends of a mixed base distillate oil and 1 per cent of fatty acids showed that there was a definite variation of coefficient of friction with temperature. A special apparatus was, therefore, designed in which temperature could be rigidly controlled, and results proved that the lower molecular weight fatty acids do not reduce the coefficient of static friction of mineral lubricating oils under boundary conditions. Moreover, they showed that the true criterion of lubricating values is rather the effective length of the hydrocarbon chain, normal to the bearing surfaces, attached to the adsorbed polar group, than the volume of the molecule. The greater the length of this hydrocarbon chain, the greater the flexibility of adsorbed molecules. Such a theory in conjunction with thermal vibration explains the low coefficient of friction of mixtures containing the higher molecular weight saturated fatty acids. Certain oxidation products of mineral lubricating oils are believed to be multipolar, and to them is due the elimination of the friction/temperature rise normally characteristic of non-oxidised mineral lubricating oils. If, however, asphalt is formed and deposited on the bearing surfaces as a result of the oxidation, then an increase in the coefficient of static friction is likely to occur.

Systematic Displacements of Lines in Stellar Spectra. The radial velocity of a star as determined from the line displacements in its spectrum is found to depend slightly on the lines chosen for measurement. The lines of different elements give different results, though in general these differential effects are only very small. They may be caused by the influence of interstellar matter or by conditions in the stars themselves. The latter cause of the effect has been studied by Adams and McCormack (*Astrophys. J.*, 81, 119; 1935) in the case of nine stars of different types, all of which are sufficiently near to eliminate the effect of interstellar absorption. The chief lines affected are the *H* and *K* lines of calcium, the sodium *D* lines and a pair of *Al I* lines, all of which give systematic differences of the order of -5 km./sec. from the normal stellar lines. It is suggested that the hypothesis of a gradually expanding envelope surrounding the star affords the best explanation of these results. Three of the stars (including γ Cygni) are exceptionally interesting. The neutral *Fe* lines give larger results than those from ionised *Fe*, and *Ce II* gives larger values still. In such cases the hypothesis of radial convection currents affecting lines of different levels differently seems to be the only adequate explanation.

Iron and Steel Welding

THE enormous change in the general outlook on welding which has taken place during the last twelve or fifteen years was never so well exemplified as by the attendance of some nine hundred persons at the first meeting of the symposium on the welding of iron and steel organised by the Iron and Steel Institute with the co-operation of fifteen other scientific and technical societies, and held at the Institution of Civil Engineers on May 2-3. Sir Harold Carpenter presided, and pointed out that the whole question of welding had been raised by Dr. H. J. Gough for the consideration of the Department of Scientific and Industrial Research.

The object of the symposium was of a two-fold character. It was designed in the first place, and mainly, to discover what is now known, and in the second place to map out fields of work for future development. Although welding is still in large measure an empirical art, a considerable amount of fundamental scientific work is now being done, and the results of this have been brought together in a collection of papers which represents by far the most important and comprehensive collection of information on the welding of the ferrous metals which has ever been made. The papers were divided into a series of groups, of which the first dealt with present-day practice and problems connected with welding in the engineering industries. Shipbuilding, bridge and structural engineering, railway material and pressure vessels, formed one sub-section of this group, the other dealing with the aeronautical and automobile industries, the production of chain, the electrical, heavy engineering and machinery industries and the welding of iron and steel castings and of wrought iron.

Group 2 was concerned with the practice and technique of welding, including the apparatus and plant required. The metallurgy of welding, and the questions of specifications, inspection and testing formed Groups 3 and 4. It will come as a surprise to many to discover how much real research is being done, and how fundamental are the advances

which are being made, at any rate in certain directions.

From the various papers and discussions certain suggestions emerge regarding the lines on which future development and research might usefully proceed. These include:

(1) The development of plant for electric welding in which the current is automatically adjustable to suit the rate of deposit, together with the necessary control of the arc.

(2) Despite the work which has already been done, there are still very considerable gaps and discrepancies in our information regarding the factors which affect the fatigue resistance of all types of welded joints, particularly in comparison with similar solid, bolted or riveted constructions, and extensive research work on this point is most essential.

(3) The investigation of the effect on the fatigue strength of various types of treatment and electrodes and the comparative influence of alternating and direct current.

(4) The development of forms of welded construction which are based on a real knowledge of the fatigue properties of the welds for dynamically loaded structures (such as bridges).

(5) Work on the welding of the high carbon and alloy steels.

(6) Work on non-destructive methods of testing welded joints.

No aspect of welding, so far as it is applied to iron and steel, was omitted from this highly successful symposium. The most grateful thanks of producers and users of welded structures are due to those responsible for the meeting on one hand, and the authors of the papers on the other. The only note of a critical nature which can possibly be struck is the fact that the material presented was of such enormous dimensions that the time available for its discussion was inevitably greatly restricted. A further discussion of this material at some future date would form a fitting corollary to the meeting already held.

F. C. T.

Royal Observatory, Greenwich

ANNUAL VISITATION

THE Astronomer Royal read his report to the Board of Visitors of the Royal Observatory, Greenwich, on the occasion of the annual visitation of the Observatory on June 1.

The construction of the new reversible transit circle has been completed by Messrs. Cooke, Troughton and Simms, Ltd., and the instrument is undergoing final tests. The construction of the two glass circles of 28 inches diameter, and the etching of divisions spaced at intervals of 5 minutes of arc have been carried out successfully. When completed, the new transit circle will be housed in the Christie enclosure next the Yapp 36-inch reflector. A contract for a slit spectrograph for use with the latter telescope has been placed with Messrs. Adam Hilger, Ltd. This spectrograph is designed for use with one or three prisms at will, the optical parts being made

from ultra-violet glass giving good transmission down to 3500 Å.

During the year, 9,576 transit observations were made, including 130 observations of the sun and 94 of the moon. The observations of the moon continue to show a decrease in the correction to the longitude given by Brown's Tables, which were introduced into the *Nautical Almanac* in 1923. Nova Herculis was observed on the meridian six times above pole and twice below pole. The position for 1935.0 is α 18^h 5^m 39.85^s, δ +45° 50' 54.2" (Epoch 1934.99). 42 plates were exposed on Nova Herculis in the slitless spectrograph attached to the Yapp 36-inch equatorial reflector. All these have been calibrated for photometry, and where possible a comparison star has been included. These plates will provide material for the study of the distribution of energy throughout

the spectrum. In addition, work has been carried out with the new telescope on the programme of colour temperature work.

The spectroheliograph at Greenwich was used on 179 days. A photometer has been added to the instrument in such a way that the intensities of prominences and bright patches on the solar disc can be measured in terms of the brightness of the undisturbed disc in wave-lengths outside the absorption line concerned. Measures of prominences have been made both in H α and H β . Work on the intensities of the Fraunhofer lines has been commenced. A hut has been built in the Christie enclosure, in which a 16-inch celostat has been mounted. Sunlight is fed into the basement below the 36-inch equatorial, where it is analysed by a 4-inch concave grating.

Magnetic observations have been carried out at Abinger throughout the year. The mean values of the magnetic elements for the year 1934 are as follows:

Declination,	W. 11° 41.1'
Inclination,	66° 39.7'
Horizontal Intensity,	0.18533
Vertical Intensity,	0.42955

Some innovations have been introduced with the meteorological observations. Regular observations of the amount of solid matter suspended in the air were commenced on July 1, 1934. In November last, the worst month, a mean weight of 178 mgm. of solid impurity was found in each 100 cubic metres of air. Compared with the figures recently published for the previous year at other stations, it would appear that the pollution at Greenwich is fully as great as that at any London station, and is not on the average surpassed by any reporting station in Britain, although in Central Glasgow the pollution is worse at the worst times of the day. The gaseous pollution of the atmosphere by sulphur dioxide has also been measured daily from January 1, 1935.

The mean temperature for the year was 51.9°, which is 2.4° higher than the average for 1841–1915. There were 79 entirely sunless days, and only 39 entirely cloudless nights, that is, nights on which Polaris left an unbroken trace on the night sky camera.

A number of improvements have been introduced in the detailed working of the observations for time with the small reversible transit circle. Three observers are employed, instead of one, and the observations are corrected for personal equation to the mean of three observers. (It is hoped shortly to construct a personal equation machine and obtain absolute personalities.) Again, the chronograph and relay system has been brought up to date, and an oscillograph is now used to determine lags in the reception of wireless signals. The accordance between Greenwich time and that sent out by foreign observatories is now much closer than was the case a few years ago. The mean difference for 1934 between Greenwich and Paris is -0.018^s , and that between Greenwich and Nauen is $+0.013^s$, the sign + meaning late on Greenwich.

During the past year, Mr. Furner, assistant, retired after forty-six years' service, and Mr. Blackwell was appointed junior assistant.

Concluding his report, the Astronomer Royal referred to the atmospheric pollution, which hampers astronomical work. Silvered mirrors and circles tarnish rapidly, and soot and grit are deposited. A further difficulty is due to the increasing brightness of the sky at night, which results from the use of mercury lamps for street lighting. Photographic work with rapid plates at low altitudes in the sky is impossible in certain directions in which the new lighting is extensively used, and representations have been made to the Greenwich Borough Council on the subject of street lighting.

R. v. d. R. W.

Alchemy and Music

THE first combined meeting of the Chemical and Musical Societies in the history of the ancient University of St. Andrews was held in the Chemistry Lecture Theatre of the United College, St. Andrews, on April 24, when Prof. John Read, professor of chemistry, delivered an illustrated lecture under the title: "The Frankfurt Emblems: a Research in 17th Century Alchemy". The culminating event of the evening was the singing, possibly for the first time in three hundred years, of some unique alchemical music which Prof. Read encountered some time ago in his alchemical studies, and which has formed the subject of a recent research by Mr. F. H. Sawyer, lecturer in music in the University of St. Andrews.

Alchemy, said Prof. Read, has been variously defined as the pretended art of transmuting base metals into gold, as the chemistry of the Middle Ages, and so forth; but in its broadest aspect it was a system of philosophy which claimed to penetrate the mystery of life as well as the formation of inanimate substances. Like modern science, alchemy had its theories, notably the theory of the four elements, with the allied conception of the Philosopher's Stone, and the sulphur-mercury theory of the constitution of metals. Alchemical theory, however, like alchemical symbolism, is a complex and intricate subject, rendered even more difficult

by its protean character of change. The age of alchemy extended approximately from the early years of the Christian era until the end of the seventeenth century.

Among many features of interest in the declining years of alchemy are the piquant illustrations, so racy of the alchemical soil of the seventeenth century. The Twelve Keys of the mysterious Basil Valentine, in particular, were handled repeatedly by new artists, who provided them with an honoured place in alchemical publications of this time. Each of the Keys consists of an emblem with an allegorical description.

Judging from the age-long popularity of Ben Jonson's play, "The Alchemist", which was first produced in 1610, there was a considerable public throughout the seventeenth century for attractive expositions of alchemy. Frequenters of the playhouses of those days were familiar with that technical language of contemporary alchemy and astrology which is so much 'heathen Greek' to the modern playgoer. Thus, the production of titillating alchemical works, abounding in pictorial illustrations, came probably as a response to a wide demand.

The first issue of the Basilian emblems appears to have been made from Frankfurt; and other

notable alchemical works with similar pictorial embellishments were published, either in their original or later editions, from this famous centre of early book illustrations. There was method in this apparent madness of obscure expression; as Basil Valentine remarked, the obscurity of expression was imperative because the substance of the magic Philosopher's gold-making Stone was within reach of everyone, "and there is no other way of keeping up the divinely ordained difference between rich and poor". If alchemy had survived, remarked Prof. Read, it would have become political.

Certain works published at, or near, Frankfort during the seventeenth century, largely under the name of Michael Maier, are rich in such allegorical illustrations, which Prof. Read terms for convenience "the Frankfurt Emblems". This Michael Maier was a very remarkable man. Besides being a musical alchemist, he became physician and private secretary to the Emperor Rudolph II at Prague, and apparently occupied a high position in the Society of Rosicrucians, or Brethren of the Rosy Cross. The publishing firm of Lucas Jennis, of Frankfort, took a prominent part in issuing the works in question, several of which were reviewed in some detail by Prof. Read. The emblems were often provided with a Latin epigram, together with a cryptic title and a discourse in the same language. "Atalanta Fugiens" ("Atalanta Fleeing"), published by Michael Maier at Oppenheim in 1618, contains fifty such epigrams set to music by the versatile author. These so-called 'fugues' are in reality rounds or part-songs for three voices, bearing a marked general resemblance to the well-known, but less dignified, "Three Blind Mice". In allusion to the classical legend of Atalanta and the golden apples, the three parts are quaintly termed "Atalanta, or the Fleeing Voice", "Hippomenes, or the Pursuing Voice", and "The Apple in the Path, or the Delaying Voice".

At the end of Prof. Read's lecture, Mr. Sawyer, who has made a detailed study of this unique alchemical music, explained its construction and characteristics, after which some of the canons were sung under his direction by members of the St. Andrews University Musical Society. It is to be presumed that these 'incantations' were intended to be sung at critical moments during the concoction of the Philosopher's Stone, such operations being directed also by prayer and astrological influences. In one of the 'fugues', for example, the Stone is likened unto coral, and the epigram opens in the following words:

*Planta maris vegetans Siculi sub fluctibus uda
Ramos sub tepidis multiplicavit aquis . . .*

Or, in English, "The plant of the sea, flourishing moist under Sicilian waves, has multiplied its branches beneath the warm waters . . ." Another 'fugue' takes as its theme the thesis that "Fire loves not gold-making but gold". The music had a quaint and appealing quality which seemed to accord with its esoteric purpose.

Prof. Read's illustrative lantern slides, made from the original engravings, included a contemporary representation (1609) of an alchemical laboratory, displaying a selection of musical instruments among the stills and furnaces, with an attached legend stating that "music disperses sadness and malignant spirits".

University and Educational Intelligence

CAMBRIDGE.—It is announced that the Museum of Zoology will shortly benefit from the bequest of the late W. D. D. Crotch. The capital passing to the University is about £6,000, and a Grace recommending that a new endowment be added to the Crotch Fund, created out of the bequest of his brother, the late G. R. Crotch, will be submitted to the Regent House.

Mr. J. T. Saunders, of Christ's College, has been appointed a member of the Freshwater Biological Association of the British Empire.

The Gordon Wigan Prize in chemistry for 1934 has been awarded to J. E. Carruthers, of Emmanuel College, for a dissertation entitled "The Photo-oxidation of Gaseous Formaldehyde".

Prof. O. T. Jones has been appointed to represent the University on July 3 and the following days at the opening of the new Museum of Practical Geology and at the celebration of the centenary of the Geological Survey of Great Britain.

The following representatives of the University at conferences abroad have been appointed:—Prof. A. C. Seward, Master of Downing, professor of botany, at the Botanical Congress, Amsterdam, next September; Prof. E. H. Minns, Disney professor of archaeology, and Mr. L. C. G. Clarke, curator of Museum of Archaeology and Ethnology, at the tercentenary of Peter Pazmany University, Budapest, next September; and Prof. G. H. F. Nuttall, emeritus professor of biology, at the tercentenary of the French Academy this month.

LONDON.—The Court has received gifts towards the Ceremonial Hall to be built on the University site in Bloomsbury from the Worshipful Companies of Needlemakers, Carmen and Spectacle Makers. The City Corporation has made a grant of £5,000 (spread over five years) to Birkbeck College towards the new College buildings also to be erected on the University site in Bloomsbury. The Chadwick Trustees have renewed their grant of £200 a year for three years in aid of the Edwin Chadwick Department of Municipal Engineering and Hygiene at University College, and Messrs. Bovril, Ltd., have instituted at King's College two research studentships in physiology at £350 a year, and will defray in addition the cost of the special materials, apparatus and assistance needed.

The Principal of the University of London announces, in his report on the work of the University during 1934-35, that the first block of the buildings in Bloomsbury, of which the foundation stone was laid by His Majesty the King two years ago, should be ready for occupation next year. This block is to contain the Senate House, administrative offices and part of the library. Presumably, therefore, next year will see the removal of the University's home from South Kensington, where it has been sheltered for so many years by the Imperial Institute. Towards the finance of the great building scheme the local authorities are contributing sums amounting in the aggregate to £700,000. Gifts promised by the City of London Corporation and forty-six of the City Companies towards the cost of the Great Hall reach a total of £174,000, while the Goldsmiths' Company is giving £50,000 towards the new building for the Goldsmiths' Library. Among many other benefactions mentioned in the report is an undertaking by the Carnegie Corporation to provide 22,000 dollars a

year for three years for the Institute of Education, to aid in the development of the Institute's relations with students from the Dominions and Colonies; this is to be used for short-period fellowships for students from the Dominions and for payment of a university teacher from the Dominions to act as "Adviser to Overseas Students". An interesting and important development on the 'external' side of the University concerns the recognition of colleges for the purpose of the external degree in engineering. As external candidates will in future have to submit course work carried out in an approved institution, colleges in various parts of Great Britain have applied for, and forty-two have already obtained, approval for this purpose. Certain overseas colleges are contemplating similar action.

OXFORD.—Mr. T. W. Chaundy has been reappointed lecturer in mathematics for five years from October 1. Mr. C. N. Hinshelwood, Dr. A. S. Russell and Mr. H. J. George have been appointed, or reappointed, lecturers in chemistry for the same period.

Dr. Donald Pollock has undertaken to provide £500 a year from October 1 towards the stipend of the Donald Pollock reader in engineering science, a new readership.

Congregation on May 28 recorded its thanks to the Czechoslovak Government for its loan six months ago, for three years, of 1,636 mgm. of radium for use in the Clarendon Laboratory.

Degrees of D.C.L., *honoris causa*, will be conferred on June 26 on Lord Bledisloe, Sir Herbert Samuel and Sir John Reith, and the degree of D.Sc. on Prof. Peter Debye.

The Romanes Lecture on "Then and Now: or the Changes of the Last Fifty Years" will be given on June 14 by Prof. Gilbert Murray.

Science News a Century Ago

Death of Edward Troughton

Edward Troughton, the famous Fleet Street instrument maker, whose name is still borne by the firm of Cooke, Troughton and Simms, Ltd., died on June 12, 1835. Like the other eighteenth century mechanicians Sharp, Graham, Bird and Ramsden, Troughton came from the north, being born in Corney, Cumberland, in 1753. At first brought up to farming, at seventeen years of age he became an apprentice to his elder brother John in London, and the two for a short time were partners as mechanicians. On his brother's death, Troughton carried on the business alone until 1826, when he took into partnership William Simms (1793-1860). So early as 1778, Troughton had introduced a new method of graduating arcs of circles, which was eventually to lead to the award to him of the Copley Medal, and he gradually gained a reputation as an instrument maker second to none. Instruments of his were erected in observatories at Paris, the Cape, St. Helena, Madras, Cracow, Cadiz, Brussels, Edinburgh, Cambridge and Greenwich.

A man of simple and frugal habits, Troughton was never married, and towards the end of his life, it is said, he was seldom absent from his dingy parlour at 136 Fleet Street, London, where he sat with a huge ear trumpet at hand, wearing clothes stained with snuff, and a soiled wig. Elected fellow of the Royal Society in 1810, he was an original member of the Royal Astronomical Society, and a marble

bust of him by Chantrey, subscribed for by his friends, was placed in the Royal Observatory, Greenwich. His grave is in Kensal Green Cemetery.

Wilkinson on Gunpowder

According to the *Athenæum* of June 20, 1835, the Friday evening meetings of the Royal Institution for the summer closed on June 12 with a lecture on the history and manufacture of gunpowder by Mr. Henry Wilkinson, who had on several former occasions delivered lectures on warlike machines of the ancients, etc. Mr. Wilkinson was of opinion that gunpowder was known to the ancients, and that it was highly probable that Alexander the Great actually met with gunpowder and firearms in India. He quoted the Gentoo laws to show that they contain a prohibition of gunpowder and firearms, and from this and other authorities referred to, he seemed to be of opinion that gunpowder had been known in China and Hindustan, far beyond all period of investigation. His lecture was accompanied by some interesting experiments on the action of fulminating powders on gunpowder.

Progress on the London and Greenwich Railway

In the *Mechanics Magazine* of June 13, 1835, is a communication from a correspondent who wrote: "On Monday last a number of shareholders and directors of this undertaking met at the works near the Blue Anchor-road to witness the experimental running of the Company's locomotive engine 'The Royal William'. A distance of one mile was performed in about four minutes. A glass of water, filled to the brim, was placed on the block holding the rail, to ascertain the degree of vibration, when the engine, with the tender with water and coal, and several passengers, the whole train weighing at least 14 tons, passed along. Not a drop of water was spilled, nor was any vibration perceptible. Persons who stood under the arches when the engine passed over, were astonished to find that the noise was no greater than what would be occasioned by the passing of a hackney coach".

Airy and the Royal Observatory, Greenwich

In the latter part of 1834, Airy, then at Cambridge, had been asked whether he would accept the office of Astronomer Royal, but a change of Ministry caused a delay in the negotiations. The various steps which finally led to his appointment are given in his autobiographical notes for 1835. "The Ministry," he wrote, "had again been changed in the spring, and the Whigs were again in power. On June 11th Lord Auckland, who was again First Lord of the Admiralty (as last year) again wrote to me to offer me the office of Astronomer Royal, or to request my suggestions on the filling up of the office. On June 15th I wrote my first reply, and on June 17th wrote to accept it. On June 18th Lord Auckland acknowledges, and on June 22nd the King approved." On August 13 Airy had a meeting with Lord Auckland and Mr. Charles Wood, the Secretary of the Admiralty. "At this meeting Lord Auckland and Mr. Wood expressed their feeling, that the Observatory had fallen into such a state of disrepute that the whole establishment ought to be cleared out. I represented that I could make it efficient with a good First Assistant; and the other Assistants were kept. But the establishment was in a queer state. . . ." Airy took charge of the Observatory in October 1835, having for his first assistant Robert Main.

Societies and Academies

PARIS

Academy of Sciences, April 24 (*C.R.*, 200, 1445-1500). The president announced the death of Louis Jobin. PAUL LANGEVIN: Concerning an experiment suggested by M. Dufour. RICHARD FOSSE, PAUL DE GRAEVE and PAUL EMILE THOMAS: The identification of small quantities of formol. The method proposed is based on the insoluble compound formed with naphthol, namely, di-naphtholmethane. A precipitate is formed with 0.1 mgm. of formol at a dilution of 1/100,000. GEORGES CLAUDE: The campaign of the *Tunisie*. LOUIS LÉGER and Mlle. MARCELE GAUTHIER: The spore of the Harpellaceae, parasitic fungi of insects. J. PRZYBOROWSKI and H. WILENSKI: The errors of the first and second category in the verification of hypotheses concerning Poisson's law. STANISLAS GOLAB: Transformations by polar reciprocals in Finsler's geometry. PIERRE LEJAY and TSANG HUNG-CHI: The interpretation of the observations of the value of gravity carried out in the centre of China. The anomalies given in earlier communications are summarised in a chart. JEAN J. TRILLAT and HANS MOTZ: The errors of interpretation in electronic diagrams of organic substances. Doubt is thrown on results hitherto obtained with electronic analysis, on account of the ease with which the surfaces examined become covered with a greasy film. The conditions must be such that the possibility of formation of superficial fatty films is eliminated. PIERRE JOLIBOIS: A new experiment in electrolysis. RENÉ BARTHELEMY: Cathodic television with automatic synchronism. ROBERT BLONDEL and PAUL LAFFITTE: The constitution of the antimony-tin-zinc alloys. OMER LIÉVIN and JEAN HERMAN: The autoxidation of the hydroxides of iron, manganese and cobalt. MME. MADELEINE DELÉPINE-TARD: The bromo-dipyridine derivatives of iridium. MARCEL GODCHOT and Mlle. GERMAINE CAUQUIL: The action of organo-magnesium compounds on ethyl l-aminocyclohexanecarbonate. RAYMOND PAUL: Methods of preparation of the α -alkylfuranes. Mlle. SIMONNE CAILLÈRE: The specific characters of bowlingite. From the chemical analysis, thermal analysis, and X-ray diagrams, it is concluded that bowlingite is a fibrous form of saponite, its chemical composition being between those of montmorillonites and chlorites. JEAN ORCEL and PIERRE FASTRÉ: The curves of dispersion of standards of reflecting power utilisable in the microscopic study of metallic minerals. MARCEL ROUBAULT: The chemico-mineralogical characters of the tertiary eruptive rocks of Kabylie de Collo (Department de Constantine, Algeria). ANDRÉ DUPARQUE: The petrographic characters of the Permian coals of the Belgian Congo. Both the macroscopic and microscopic characters of the Permian coals from the Belgian Congo correspond closely with those of the Westphalian bituminous coals. PIERRE GRASSÉ and Mlle. ALICE FAURE: The reproduction of the parabal apparatus of *Trichomonas caviae*. MME. VÉRA DANTCHAKOFF: The factors determining the position of the gonads in the fowl.

AMSTERDAM

Royal Academy (*Proc.*, 38, No. 3, February 23, 1935). C. WINKLER: Researches on the hind brain. Loss of the cerebral hemispheres is followed by atrophy of the apical convolutions of the hind brain. J. H. GISOLF and P. ZEEMAN: Intensity measurements

with a reflection echelon. Method for determining the relative intensities of hyperfine components of a spectral line. A. A. NIJLAND: Mean light-curves of long-period variables. (22) *R. Draconis*. The light varies with a period of 244 days and an amplitude of 5.40 magnitudes. F. M. JAEGER and J. A. VAN DIJK: Complex salts of α - α' -dipyridyl with zinc and cadmium. (2) Crystallographic data on the complex salts formed by α - α' -dipyridyl with various zinc and cadmium salts. F. M. JAEGER and J. BEINTEMA: Symmetry and structure of the crystals of the hydrochlorides of triamino-triethylamine. An X-ray examination of the cubic $N(C_2H_4.NH_3Cl)_3$ and the hexagonal $N(C_2H_4.NH_3Cl)_3.HCl + H_2O$. A. H. BLAAUW: Growth of the iris bulb after various summer treatments (1). An investigation of the best method of treatment of bulbs of various sizes on behalf of the bulb cultivator. P. J. BOUMA and G. HELLER: Outlines of a general theory of the colour metric (3). H. H. BRONS: Perturbations in the $\Sigma^2 \rightarrow \Sigma^2$ bands of N_2^+ . Measurements on the (5, 7) and (3, 5) bands in which perturbations occur in the upper state. V. HLAVATÝ: Conformal geometry (1). Gauge invariant connexion. G. H. R. VON KOENIGSWALD: Preliminary communication on the occurrence of tectites in Java. Discovery of tectites in Java at sites of definitely known geological age. TH. RAVEN: New finds of quaternary mammals in the Netherlands (2). *Equus caballus*, L., *E. robustus*, Pomel, *Asinus fossilis*, Owen, and *Megaceros euryceros latifrons*, subsp. nov. MISS H. DE BEER: Morphological significance of the thorns of the different species of *Citrus*. The thorn at the side of the bud is analogous to a branch and not to a leaf. J. P. KLEIWEG DE ZWAAN: The connexion between head and face measurements among the Minangkabau-Malays of Central Sumatra. C. E. BENJAMINS, H. A. E. v. DISHOCK and J. L. M. GERMAN: Studies on the active substance of grass pollen (1). Activation of a small molecular weight active group by colloidal substances. H. ALDERSHOFF: Successful attempts to transmit to monkeys by cutaneous inoculation the poliomyelitis and encephalitis post-vaccinalis occurring in Holland. It is suggested that the cause of post-vaccinal encephalitis is not the vaccine virus but some other, myelo-encephalitogenic virus which enters the scarifications during or after vaccination. H. DE JONG, D. J. KOK, A. GEESINK and F. J. NIEUWENHUYZEN: Experimental catatonias, produced by auto-intoxication (1). Experimental catatonias after artificial obstruction of the lumen of the intestine. Ligation of the intestines of dogs produced catatonias through auto-intoxication. A. DE BUCK and N. H. SWELLENGREBEL: Seasonal longevity of *Anopheles maculipennis* in Holland with reference to their ability to act as malarial vectors. G. GIESBERGER: Correction to a paper on saliva-, pancreas- and Aspergillus-amylase (Taka diastase) as a mixture of two kinds of amylases. J. BONNER: Some colloidal properties of the pectins. The preparation of pure sodium pectate, ash-free pectic acid, a pectinic acid and a sodium pectinate and the determination of some of their colloidal properties.

GENEVA

Society of Physics and Natural History, March 7. M. GYSIN: The copper minerals of Kinsenda (Belgian Congo) (1). The bornite-chalcopyrite associations. The copper mineral of Kinsenda contains patches of chalcopyrite and bornite. A part of the bornite contains fine lamellar inclusions of chalcopyrite

arranged in the bornite planes of cleavage (100), an association resulting from the decomposition of a bornite-chalcopyrite solid solution formed at a high temperature and therefore hypogene. These complex grains are often associated with compact chalcopyrite; the mutual contacts of these two minerals suggest simultaneous formation. There are also small lodges of supergene bornite in the chalcopyrite regions. E. BRINER, B. SUSZ and E. PERROTET: Chemical reactivities and Raman spectra in the eugenol group and the vanillins. The Raman spectra of the substances of this group have been determined from the point of view of relationship with their chemical activities. E. GUYENOT and MME. J. DUSZYNSKA: Sterility and virility of pituitary origin in the guinea pig. The study of about twenty sterile and masculinised females has shown alterations of the ovary accompanied with thyroid hyperactivity, of hypertrophy of the suprarenal capsules and of neoplastic productions which appear to arise from a disturbance of the secretion of the anterior pituitary. P. ROSSIER: (1) The variation of the relative width of the lines of stellar hydrogen with the spectral type. (2) Variation of the relative width of the lines of calcium and of stellar hydrogen as a function of the spectral type. (3) The ratio of the widths of the two lines $H\epsilon + H$ and K in stellar spectrograms. (4) The spectral type of some stars of class A. A. AMSTUTZ and A. BORLOZ: The synthesis of the emerald. The authors had deposited a sealed letter at the meeting of the Society on May 4, 1933. The letter was opened and read. It dealt with the synthesis of the emerald in a suitable apparatus by melting the oxides of aluminium and silicon with beryllium fluoride as a flux. LÉON W. COLLET and ARNOLD LILLIE: (1) The internal Prealps between the River Arve and the River Giffre. The authors have discovered that the internal Prealps between the Rivers Arve and Giffre have much greater extent than indicated in the present geological map. (2) The existence of lacustrine limestones in the Nummulitic of the Colde Bostan. The discovery of lacustrine beds of Lutetian age at the Dents Blanches de Champéry permits a correlation with similar beds at the Dents de Morcles. ED. PAREJAS and E. MOLLY: Study of some Tchertcher (Abyssinia) limestones. Among the Jurassic limestones collected by E. Molly are pseudo-oolitic limestones containing Crinoids, Echinoidea, Corals, Rotalides, Miliolides and Textularia. These formations, the facies of which resembles that of certain limestones of the upper Jurassic and of the Swiss Jura Berrasian, must have been formed under the same conditions as the latter. A fragment of Nerine shows some affinities with *N. Desvoidyi*. R. VERNIORY: The Mesozoic of the external Prealps (Faucigny hills). F. BATELLI, DON ZIMMET and P. GAZEL: The action of cardoon extract on the heart. DON ZIMMET, L. JANCO and B. GHINSBERG: The action of extract of striated muscle on the development of the egg of the frog (*Rana temporaria*).

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 21, 69-141, Feb. 12). H. J. MULLER and S. M. GERSHENSON: Inert regions of chromosomes as the temporary products of individual genes. It is suggested that the inert regions of the X- and Y-chromosomes consist of non-genic material derived from a very few specific active genes, rather than of a row of degenerated genes. Breakages occur in such regions more readily than between genes in the so-called active region.

W. L. DOYLE and C. W. METZ: Observations on the structure of living salivary gland chromosomes in *Sciara*. In body fluid or isotonic salt solution, these giant chromosomes are invisible; they are represented by optically empty tracts, occupying so much as 80-90 per cent of the nuclear content. Shrinkage occurs and bands appear on fixation. In the normal living state, the segments representing the chromioles may be disc-like and the granules thought to be genes may appear as the result of fixation or other injury. THEODORA NUSSMAN SALMON and ALBERT F. BLAKESLEE: Genetics of sensory thresholds: variations within single individuals in taste sensitivity for PTC (phenyl thiocarbamide). The taste threshold for this compound varies considerably from individual to individual and even in most individuals during the course of a day and from day to day. This confirms a suggestion that refined methods are unnecessary in determining taste thresholds. ALBERT F. BLAKESLEE and THEODORA NUSSMAN SALMON: Genetics of sensory thresholds: individual taste reactions for different substances. Taste reactions to 17 substances were investigated for 47 individuals. It is concluded that the correlation between acuteness of taste for two substances, though generally positive, is low, and there are many exceptions. No two of the 47 subjects were alike in all their thresholds. DONALD F. JONES: Somatic segregation due to hemizygous and missing genes and its bearing on the problem of atypical growth. The term hemizygous has been given to an unpaired gene and is here applied to autosomic genes which have lost the other member of the pair. Mosaics and other forms of abnormal growth may be due to such losses of chromosome material. G. D. BIRKHOFF and M. R. HESTENES: (1) Generalised minimax principle in the calculus of variations. (2) Natural isoperimetric conditions in the calculus of variations. M. H. STONE: Subsumption of the theory of Boolean algebras under the theory of rings. N. JACOBSON and O. TAUSKY: Locally compact rings. P. W. BRIDGMAN: Electrical resistances and volume changes up to 20,000 kgm./cm.² The development of new steels has made it possible to extend the pressure range from 12,000 to 20,000 kgm./cm.². The resistance of black phosphorus decreases rapidly, reaching 0.0069 of its value at atmospheric pressure at 20,000 kgm./cm.²; there is probably a minimum at 23,000 kgm., followed by an increase, as with the alkali metals. The temperature coefficient changes sign at 12,000 kgm., becoming positive and eventually reaching three quarters of the value characteristic of most pure metals. Tellurium gives similar results. Copper sulphide, however, shows a decrease of resistance of only 11 per cent, and there are irreversible effects. Pressure-volume-temperature measurements for lithium, sodium and potassium suggest a fundamental change in the metal at high pressure. J. O. HIRSCHFELDER and E. WIGNER: Separation of rotational co-ordinates from the Schrödinger equation for N particles. CHESTER STOCK: *Plesiomiacis*, a new creodont from the Sespe Upper Eocene, California. L. R. BLINKS, R. D. RHODES and G. A. MCCALLUM: Protoplasmic potentials in *Halicystis*. (5) The reversal of potential by unbalanced NaCl. W. J. V. OSTERHOUT: How do electrolytes enter the cell? A discussion, from the point of view of physical chemistry, of experiments on the marine alga *Valonia* suggests that, whereas there is little penetration by ammonium ions, ammonia and its hydroxide enter freely, apparently by combining with an acidic constituent (HX) of

the protoplasm. Strong electrolytes may possibly also enter by combining with one or more constituents of the protoplasm. A. A. ABRAMOWITZ: (1) Degeneration of xanthophores in *Fundulus majalis*. Over blue or white backgrounds, the xanthophores are in a concentrated state and there is a decrease up to 50 per cent in the number of carotenoid cells; over yellow or black backgrounds, where the pigment is dispersed throughout the cells, there is a small increase in the number of cells. (2) Regeneration of chromatophore nerves. A cut across the fin rays in the tail of the killifish, *Fundulus heteroclitus*, produces a persistent dark band beyond the cut due to denervation of the pigment cells. Rate of regeneration of these autonomic pigment motor fibres can be studied fairly accurately by keeping the fish on a dark background for a fortnight and then exposing them for five minutes daily to a white background and estimating the progressive decrease of the dark band.

Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

Sunday, June 9

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—Miss M. R. J. Edwards: "Whales and other Sea Animals".

Wednesday, June 12

RESEARCH DEFENCE SOCIETY, at 3.—(at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1). Annual General Meeting.

Sir Frederick Hobday: "The Relief of Animal Suffering" (Ninth Stephen Paget Memorial Lecture).

BRITISH SCIENCE GUILD, at 4.30.—(at the Royal Society of Arts, John Street, Adelphi, London, W.C.2). Annual General Meeting.

J. Davidson Pratt: "Gas Defence".

Thursday, June 13

ROYAL ASIATIC SOCIETY, at 4.30.—Miss D. A. E. Garrod: "In Search of Stone Age Man in the Near East".

ST. MARY'S HOSPITAL, London, at 5.—J. Henderson Smith: "Virus Disease in Plants: a Comparison with Virus Disease in Animals".*

Friday, June 14

ROYAL ASTRONOMICAL SOCIETY, at 3.—Dr. H. N. Russell: "The Analysis of Spectra and its Application in Astronomy" (George Darwin Lecture).

The British Science Guild. Engineers' Study Group on Economics: First Interim Report on Schemes and Proposals for Economic and Social Reforms. Pp. 44. (London: British Science Guild.) 1s.

Iodine for Livestock. By Frank Ewart Corrie. Pp. 32+7 plates. (London: Nitrate Corporation of Chile, Ltd.) Free.

Patents, Designs and Trade Marks. Fifty-second Report of the Comptroller-General of Patents, Designs and Trade Marks, with Appendices, for the Year 1934. Pp. 24. (London: H.M. Stationery Office.) 4d. net.

The Museums Association. Report of the Council for Year 1st April 1934 to 31st March 1935. Pp. 12. (London: Museums Association.)

British Chemical Abstracts. Issued by the Bureau of Chemical Abstracts. Index 1934. Pp. 692. (London: British Chemical Abstracts.)

OTHER COUNTRIES

Canada: Department of Mines: Mines Branch. Petroleum Fuels in Canada: Deliveries for Consumption, Calendar Year 1933. Prepared by John M. Casey. (No. 759.) Pp. 12. (Ottawa: King's Printer.) 10 cents.

The Imperial Council of Agricultural Research. Scientific Monograph, No. 9: Mechanical Cultivation in India: a History of the Large Scale Experiments carried out by Burmah-Shell Oil Storage and Distributing Company of India, Limited. By C. P. G. Wade. Pp. viii+124+12 plates. (Delhi: Manager of Publications.) 3.14 rupees; 6s. 6d.

Publications of the Manila Observatory. Vol. 2, No. 5: The Upper Air of Manila. By the Rev. Charles E. Deppermann. Pp. 29. (Manila: Bureau of Printing.)

Koninklijke Vereeniging "Koloniaal Instituut", Amsterdam. Vier en twintigste Jaarverslag 1934. Pp. 109. (Amsterdam: Koloniaal Instituut.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Jaarverslag 1934. Pp. 27. (Batavia: Koninklijk Magnetisch en Meteorologisch Observatorium.)

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 14, No. 3: Examen Rosarum Sueciae Granskning av den Svenska Florans Rosa-Former. 1: Norrland och Dalarna. Av L. P. Reinhold Mattsson. Pp. 380. Serien 3, Band 14, No. 4: The Longer Trade Cycles. By Axel F. Enström. Pp. 24. Serien 3, Band 14, No. 5: The Distribution of Stars in the Scutum Region of the Milky Way. By Carl Schalen. Pp. 47. (Stockholm: Almqvist and Wiksells Boktryckeri A.-B.)

Government of India: Department of Industries and Labour (Public Works Branch). Triennial Review of Irrigation in India, 1930-33. Pp. 62. (Delhi: Manager of Publications.) 1.4 rupees; 2s.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 87. Orthoptera of the Upper Rio Grande Valley and the adjacent Mountains in Northern New Mexico. By Morgan Hebard. Pp. 45-82. (Philadelphia: Academy of Natural Sciences.)

Publications de l'Observatoire de Genève. Rapport sur les concours de réglage de chronomètres de l'année 1934. Pp. 25. (Genève: Observatoire de Genève.)

Astrophysica Norvegica. Vol. 1, No. 4: On the Trajectories of Electric Particles in the Field of a Magnetic Dipole with Applications to the Theory of Cosmic Radiation. By Carl Stormer. Pp. 115-168+17 plates. Vol. 1, No. 5: A Simplified Treatment of some Fluid Oscillations. By C. L. Gudske. Pp. 169-197. (Oslo: Jacob Dybwad.)

Geological Survey of the Anglo-Egyptian Sudan. Bulletin No. 2: Water Supplies in the Anglo-Egyptian Sudan. By G. W. Grabham. Pp. 42+5 plates. (Khartoum: Sudan Bookshop; London: Sudan Government Office.) 8 P.T.; 1s. 8d.

Forestry Pamphlet No. 3: Timber, its Structure, Properties, Seasoning and Preservation. Pp. 18+5 plates. (Trinidad: Government Printing Office.) 12 cents.

The British South Africa Company. Publication No. 3: Mazoe Citrus Experimental Station; Annual Report for 1933. Pp. xviii+92. (Mazoe: Mazoe Citrus Experimental Station.)

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1934. Pp. 21+4 plates. Mitteilungen der Hamburger Sternwarte in Bergedorf. Band 7, Nr. 38. Pp. 87-121. Band 7, Nr. 39. Pp. 123-138. Sammlung von Hilfstafeln der Hamburger Sternwarte in Bergedorf. J: Tang 0° 0'—Tang 1° 0'. Pp. J64. K: Cos 0° 0'—Cos 1° 0'. Pp. K64. (Bergedorf: Hamburger Sternwarte.)

Observatoire de Paris, Section d'Astrophysique, à Meudon. Cartes synoptiques de la chromosphère solaire et Catalogue des filaments de la couche supérieure. Vol. 1, Fasc. 3, Année 1933. Par L. D'Azambuja. Pp. 34. (Meudon: Observatoire de Paris.)

Official Publications Received

GREAT BRITAIN AND IRELAND

Education (Scotland). Report for the Year 1934 by the Director on the Royal Scottish Museum, Edinburgh. Pp. 14. (Edinburgh: Royal Scottish Museum.)

Royal Observatory, Edinburgh. Forty-fifth Annual Report of the Astronomer Royal for Scotland, 1934. Pp. 8. (Edinburgh and London: H.M. Stationery Office.) 2d. net.

Institute for Research in Agricultural Engineering: University of Oxford. Farm and Machine. Vol. 2: Comprising the Report of the Institute for the Year ended September 1934, and Miscellaneous Papers on Agricultural Engineering. Pp. 98+8 plates. (Oxford: Institute for Research in Agricultural Engineering.) 2s. 6d.

Armstrong College, Newcastle-upon-Tyne. Standing Committee for Research: Report, Session 1933-1934. Pp. 45. (Newcastle-upon-Tyne: Armstrong College.)

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1629 (T. 3486): Accelerators of Aeroplanes in Vertical Air Currents, Part 2. By H. R. Fisher. Pp. 16+8 plates. (London: H.M. Stationery Office.) 1s. net.

Board of Education. Educational Pamphlets, No. 103: Education for the Printing and Allied Trades. Pp. 111. (London: H.M. Stationery Office.) 2s. net.

CATALOGUES

Catalogue of Scientific Books and Publications of Learned Societies, including a Valuable Collection of Pamphlets formed by the late Sir Arthur Schuster. (No. 450.) Pp. 94. (Cambridge: W. Heffer and Sons, Ltd.)

Catalogue of Important Works on Agriculture, Botany and Zoology. (No. 22.) Pp. 16. (London: John H. Knowles.)

Watson's Microscope Record. No. 35, May 1935. Pp. 24. (London: W. Watson and Sons, Ltd.)

Practical Hints on Patents. By M. E. J. Gheury de Bray. Fourth edition, entirely revised and considerably enlarged. Pp. 48. (London: The Imperial Patent Service.)

Catalogue of Books on all Technical Subjects and Applied Science. Pp. 120. (London: W. and G. Foyle, Ltd.)

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