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Co-ordination of State Scientific Services

IN his recent presidential address to the Royal Society, Sir Frederick Gowland Hopkins referred at some length to the Medical Research Council and its relations to the Agricultural Research Council and the Advisory Council of the Department of Scientific and Industrial Research. Stressing the relations which have from their inception existed between the three councils and the Royal Society, Sir Frederick suggested that their creation and the definition of their respective duties and relations had brought into being a great national research organisation, to be viewed as a whole and fully worthy of the confidence of the Society and of Great Britain. Although even to-day it is not fully understood by statesmen that endowment of research is among the most profitable of national investments, scientific men are now in real control of scientific policy in Britain even when it deals with enterprises endowed by the State.

This reference to the relations which exist between various research councils and research associations deriving part, at least, of their endowment from the State, is welcome in view of certain charges which have recently been brought against them, arising out of the conduct of investigations which are of general interest not only to industry or to social institutions but also to the defence forces of the realm. Two of the most characteristic features of modern scientific development are, indeed, on one hand the extent to which co-operation between different classes of scientific workers—medical men, physicists, biologists, chemists, engineers and others—is again and again required for the solution of a scientific or industrial problem, and on the other, the extent to which discoveries or advances in one field or industry find direct and ready application in many other quite unrelated sciences or industries.

It is accordingly obvious that the Privy Council, under the aegis of which the work of the Medical Research Council, the Agricultural Research Council and the Department of Scientific and Industrial Research is conducted and secured from the dangers of political vagaries and the inhibitions of departmental interference, should take measures to avoid overlapping of effort and the duplication of any expenditure of national revenue. Careful provision has been made to secure adequate contacts within the triad of councils. A nexus of responsibilities has been

established. The three secretaries, for example, are under obligation to meet together on specific occasions for a general discussion of policy; one member at least of the Medical Council must always be on the Agricultural Council, and there are other means of securing co-operation. In spite of the diversity of researches and enterprises associated with each of these councils, effective co-ordination has been possible to a remarkable extent. The dissolution by the Committee of the Privy Council in 1929 of the three co-ordinating research boards for chemistry, physics and engineering, which were originally established in 1920, is in itself evidence of the success with which research is being co-ordinated.

The realisation of the many-sided interests and applications of particular pieces of scientific research undoubtedly led to the adoption of the policy of appointing special *ad hoc* committees from time to time for the consideration of practical problems. Such committees are sometimes departmental committees, but the particular department which initiates or bears the responsibility for their work may afford little or no indication of the extent of the interest or application of that work, which might in fact have been equally initiated by several other departments or research organisations.

The specific charge has recently been made in "Patriotism Ltd.", a publication of the Union of Democratic Control, that the Department of Scientific and Industrial Research has expended a large sum of money on fundamental war research work and on the reorganisation of the research work of the fighting services, and also that the Medical Research Council is similarly financing scientific preparations for war. A careful scrutiny of the published reports shows that in actual fact the whole of the expenditure of the Department of Scientific and Industrial Research has been in research work the results of which have been and are available for industry. It is similarly true that the Medical Research Council has not since the War period undertaken or financed any researches for purely warlike purposes such as, for example, investigation of the effects of chemical warfare.

In view of what has already been said about the general interest of the results of many scientific investigations, it would be highly unlikely that the results of some of the investigations undertaken from purely industrial or medical motives would not have a great interest for some of the fighting services. Equally, in view of the care which any

sound administration must take to secure that neither Civil votes nor the Defence votes are used to pay for the same work to be done twice over, it would be surprising to find that no work had been undertaken by the Department of Scientific and Industrial Research or the Medical Research Council at the request of one of the defence services.

As a matter of fact, the evidence even of the examples cited in justification of its charges by the publication to which we refer indicates that the converse may equally be true. Reference is made, for example, to problems of visual research, on which the Medical Research Council have published a report on "Colour Vision Requirements in the Royal Navy". The results of these investigations, though of special application to service conditions, have also great interest for the merchant marine, the railways, and in relation to road traffic and to some industrial operations.

This matter of visual research illustrates a further possibility which criticism has to weigh. The Medical Research Council has on occasion availed itself of favourable opportunities afforded by conditions in the defence services for the investigation of problems of interest to the Council. This applies particularly in regard to investigations on the value of psychological tests for the selection of personnel for particular forms of skilled work. Such investigations are, of course, initiated directly for the assistance of industry. The investigations on special aptitudes required in rifle shooting were not undertaken at the instance of the military authorities but of the academic psychologist who did the work, and who saw in rifle shooting an operation combining manual, visual and psychological factors which was particularly suited to his study, and naturally found soldiers the most convenient source of material.

Equally it is unfair to charge the Medical Research Council with financing war research when it borrowed special apparatus and trained personnel from the Chemical Defence Research Department for the investigation of the dust clouds that are associated with particular industrial processes and that are likely to be injurious to the workers. Similarly, the Council has drawn on the special knowledge of acoustical problems acquired by the Services in relation to anti-aircraft defence to assist its work on the physiology of hearing, which is primarily aimed at the alleviation of deafness.

It is impossible to assess fairly the work of the

Medical Research Council in such matters if constant regard is not paid to the obvious fact that there are few branches of medical research in which new knowledge will not advance military as well as civilian science. "Patriotism Ltd." also refers to investigations carried out under the Industrial Health Research Board on the value of psychological tests for accident proneness, in which tests were made on a group of air pilots, naval artificers and dockyard apprentices as well as omnibus drivers. The results of some of these tests have already been published in a report by E. Farmer, E. G. Chambers and F. J. Kirk, on "Tests for Accident Proneness", and they have already been utilised by the National Institute of Industrial Psychology as a basis for a series of practical tests which can be utilised alike for the selection of the best drivers from among a number of applicants, selection of the men most suitable for training as motor drivers, for discovering what is lacking in drivers of poor ability in order to remedy their deficiencies if possible, or for advising those who intend to learn to drive what degree of ability they are likely to develop. The value of such practical tests as a means of reducing road accidents is obvious, and the studies upon which they are based are a direct contribution to the welfare of the community, which justifies the use of any available material for its acquisition.

The criticism which has been levelled at the Medical Research Council and the Department of Scientific and Industrial Research arises fundamentally from that failure to grasp the passing of the essential distinction between combatant and non-combatant which holds up progress in disarmament. If the fundamental lesson of the War years 1914-1918, that under modern conditions war has become industrialised and now involves whole populations and not merely armies, navies or air forces, were widely appreciated, disarmament itself would receive a firmer backing and such criticism as that we have been discussing would never be advanced.

There is, however, one point of significance on which the chapter in "Patriotism Ltd." does well to focus attention. It would be indefensible if results of civil research held available for use by industry were not also made available for the defence services. It would be equally indefensible if work undertaken at the instigation of the fighting services, but not specially paid for by contributions from their vote, were not published and made available for use in industry.

There does not appear to be any reason to suppose that publication encounters any opposition, so far as the researches undertaken under any of the co-ordinating *ad hoc* committees and the like are concerned. The Department of Scientific and Industrial Research, however, has initiated a number of co-operative research associations which are financed partly by the Department and partly by the industries concerned. These associations, being on a voluntary basis, are by no means completely representative of the industries they serve, and a good deal of jealousy is encountered from time to time on the part of firms which are members of such associations as to the results of their investigations being available for non-members. Direct opposition of industrial firms to a policy of publication can in fact place the Department in a delicate situation, and since the work of a number of the associations has a direct bearing on problems confronting the defence forces, it can easily happen that industry itself may be responsible for withholding complete publication of the results of such investigations.

Under modern conditions, therefore, it is essential that the research activities which are partly or wholly endowed by the State should be planned and co-ordinated in relation to the needs of the State as an organic whole and not on sectional lines. Any attempt to discriminate too rigidly between the needs of a particular department of State and industry is likely to involve us in acute difficulties if duplication of effort is not to result. This is, of course, not to deny the essential principle that, for example, such departments of State as the Medical Research Council or the Department of Scientific and Industrial Research, should not directly support researches which are primarily of interest to the fighting services and the expense of which should be borne by their own vote.

Sir Frederick Gowland Hopkins has pointed out that scientific men are now in real control of scientific policy in Great Britain, even when it deals with enterprises endowed by the State. Accordingly, much undoubtedly does depend upon the sincerity and loyalty with which scientific workers discharge their trust. Except with their connivance and responsibility, funds allocated for civil purposes cannot be used for the endowment of researches for the benefit of the fighting services which should properly be a charge on votes for the latter purpose. On their integrity the community must rely for ensuring that the civil vote is used

entirely for civil purposes, whether or not defence purposes are served at the same time.

It has to be remembered that scientific workers in Government service can only enter a protest against policy by leaving the service. A State department could not tolerate criticism or opposition from its own servants, and the responsibility for determining what constitutes honourable conduct in regard to specific duties lies with the profession as a whole. Accordingly, a healthy position and loyalty to the highest ideals are ensured as much by a widespread public spirit on the part of scientific workers generally as by the conscientiousness of individual workers. The existence of such a public spirit would not only afford full professional support to those members in actual Government service in the unlikely event of need, but also would induce scientific workers to take an active part in educating public opinion as to the true functions of research in the modern State.

Obtrusive Legislation

THOSE who have reason to know that infertility has an economic value, and that deliberate family limitation has been a factor of some importance contributing to their own social elevation, and wish to share with others the information and the practices which have been helpful to themselves, who hold the view that sex is not to be justified solely because of its relation to reproduction, and who think that parentage should be deliberate and voluntary and not casual and accidental, must necessarily wish to examine with the utmost care any proposed legislative measure which deals with the subject of contraception.

At the present time, a Bill, presented by the Lord Dawson of Penn, and entitled "An Act to Restrict the Sale, Display and Advertisement of Contraceptives", is before the House of Lords and comes up for its second reading almost immediately. A superficial examination of this Bill would yield the conclusion that no serious objection could be taken to its terms. Its purpose is to make it illegal (1) to sell or offer for sale in any street or public place, or by means of an automatic machine so placed that it can be used by persons in any street or public place, any contraceptive; (2) to go to the premises of any person and there sell or offer for sale any contraceptive, unless the sale or offer is made in pursuance of a previous request of that person, or the premises are used

by a dealer in contraceptives who buys to sell again; (3) to display in or outside any shop so as to be visible to persons outside the shop any contraceptive, or any picture or written description of any contraceptive; (4) to send or deliver, or cause to be sent or delivered, to any unmarried person who has not attained the age of eighteen years any circular or other document containing information of any kind whatsoever relating to any contraceptive.

From the fact that the Bill is sponsored by Lord Dawson, who has long been an advocate of birth control, and several years ago, at the Church Congress at Birmingham, stated publicly that he was in favour of contraception, it may be assumed that the Bill is intended only to shield inexperienced youth from the stimulus of the pornographic; it certainly would make it impossible for such to indulge in sexual intimacy completely freed from its more grievous repercussions. To rid the streets of touts and hawkers, and to force a certain kind of shop to adopt a different form of window-dressing is a truly commendable ambition, and if the sole effect of the Bill could be that those people who should use contraceptives would, in the future, obtain them easily from reliable and responsible sources, no one could cavil at it. No one would, if it were the case that birth control clinics were an integral part of the municipal and State medical services, as they might be. But, can one be sure that the difficulties this Bill creates in the matter of obtaining contraceptives will really affect the incidence of promiscuity? May it not be that its main effect will be an increase in illegitimacy and in venereal disease?

The obtrusive display of contraceptives may be objectionable, but from the point of view of the State it is nothing like so wicked as bringing unwanted children into the world. It may be assumed that in the immediate future, at any rate, the Bill, becoming law, would certainly tend to reduce the purchase of, and therefore the use of, contraceptives, not only by unmarried youths but also by those who, in the interests of themselves and of society, should use them for the limitation of their own families. The very ugliness and the vulgarity of the shop window can possess an educational value, revealing to the ignorant necessitous the fact that contraceptives exist. In the opinion of many, this Bill, in the light of modern scientific thought upon the subject of birth control, must appear to be somewhat reactionary and deplorable; it interferes with the

liberty of the individual, it hits others besides those at whom it is aimed, and it must interfere with the democratisation of contraception—one of the most socially valuable of all biological inventions. The further history of this Bill will show whether or not there is in the present Parliament anyone who can claim the privilege of wearing the mantle of Bradlaugh.

Position of British Broadcasting

The B.B.C. Year-Book, 1934. Pp. 480. (London: British Broadcasting Company, 1934.) 2s.

THERE is much of interest in this year-book. We learn that for every fee of 10s. paid by a listener for his licence the Government takes 5s. 5d. and the B.B.C. gets 4s. 7d. By issuing publications helping broadcasting, the B.B.C. manages to increase this sum to 5s. 10d. per licence. A considerable amount of the energy of the management, therefore, must be spent in helping forward their publishing business. It seems a pity that the B.B.C. has no capital resources and that all capital expenditure must be provided out of income. Considering its national importance, it is not good policy that it should be cramped in this way.

It would be interesting to know the reason why Hertfordshire is the county of England which has the greatest number (20) of licences for every 100 inhabitants. It is easier to see why Oxfordshire, Cambridgeshire and Surrey come second with 17. On p. 89 we are told that some 4,000 schools take broadcasting lessons, 80 per cent being elementary. Obsolescence of sets, reorganisation and transfer of teachers are given as causes why some of these lessons have been discontinued. There can be little doubt that the difficulty experienced in obtaining a trustworthy standard set for reception has greatly hindered progress. We are glad that the Council of the B.B.C. and the Department of Scientific and Industrial Research have prepared a list of sets on the market suitable for school use. Negotiations are also being made with the Radio Manufacturers' Association regarding the development of a hire service and maintenance system. We are sure that if these facilities were available more schools would employ the new medium.

Parts of the technical section of the year-book are of special interest to the electrician. There is an excellent chapter on the calculation and measurement of field strength. Not only are the best practical formulæ given but their limitations

are also pointed out. The usual formulæ postulate that the electrical conductivity of the earth is homogeneous throughout its mass. They also neglect the existence of hills and buildings. The proper corrections to be applied to the formulæ can only be learnt by experience. The would-be calculator need not, therefore, be disappointed if the measured values differ very appreciably from those calculated.

We were disappointed to find that little reference is made to the scientific and engineering research work being carried out by the B.B.C. The science of broadcasting is an outcome of applied physics, and judging by the rapid progress made in similar applications where research laboratories are considered necessities, scientific workers would like assurance on this point. The B.B.C. must know, as well as the manufacturer, the more urgent problems that have to be solved, and it has many facilities for experimenting which are not available to the industry. Continuous scientific and mathematical research is necessary if the B.B.C. stations are always to be in the front rank. In the next edition we should like to see the names of the engineers and scientific investigators employed by the B.B.C. and an account of the researches they have made and the progress achieved during the year.

The Institution of Electrical Engineers has formed a committee to combat electrical interference with broadcast reception. It is composed of representatives of all the many interests concerned, including the B.B.C. and the Post Office engineers. Various subcommittees have been formed to examine the problem and see how it can be remedied. The disturbances that arise due to various classes of interference-causing apparatus are specially considered.

We were glad to read about the short-wave work carried out last year both on the transmitting and on the receiving side. Particular attention was paid to the relative effectiveness of the many forms of aerial which are available at present. The closing down of 5 XX and 5 GB when the new Droitwich station is completed will provide accommodation and space suitable for research work. Experimental work has been carried out at the receiving post at Tatsfield in Surrey. A new receiver suitable for relaying programmes from distant short-wave stations has been developed.

Problems on acoustics were continuously studied during the past year. Every new building that

has to be adapted for studio purposes gives rise to new problems which can only be solved by research. One of the problems is how best to insulate a studio from the sound waves coming from the other studios and from street and other noises.

We are glad to read that the B.B.C. is affording help to further the progress of the art of television. For some years past experimental work has been going on with 30-line television transmitted by the ordinary transmitters used by the B.B.C. A new line of research—television of the high definition type—is now being undertaken. This type cannot be transmitted on the ordinary wavelengths owing to the width of the side-band which is necessary. These experiments are being conducted on ultra-short wave-lengths by means of a special transmitter erected on the roof of Broadcasting House. This transmitter is capable of transmitting side-bands of 500 kc./s. (about 600 metres) on either side of the carrier wave. No. 16 Portland Place has now been prepared as a large television studio, with a suitable sound accompaniment. A stage is provided for the actors and an auditorium for the visitors. Everything is ready for television programmes to be transmitted from this studio.

The breakdown record for all the B.B.C. stations is quite satisfactory. The breakdown time consists largely of the time necessary to replace valves in those cases where it is not possible to switch in a spare valve without closing down. The whole breakdown time in 1933 is equivalent to an average of 57 minutes per annum per transmitter.

British Dyes

The Synthetic Dyestuffs and the Intermediate Products from which they are Derived. Being the seventh edition of "Cain and Thorpe" entirely rewritten and enlarged. By Prof. Jocelyn Field Thorpe and Dr. Reginald Patrick Linstead. Pp. xv+472. (London: Charles Griffin and Co., Ltd., 1933.) 30s. net.

DYESTUFFS are of interest from two aspects, that of science and that of economics—we had almost written politics. The story of the attempts, now happily attended with complete success, to create a British dyestuffs industry during and subsequent to the War is an oft told one. Whereas 90 per cent of the colours used in Great Britain came from Germany in 1913, it is possible to write twenty years later, in 1933, that

90 per cent of the production required for the home market is made in Great Britain.

An Act of Parliament was passed in 1920 prohibiting the importation of dyes and intermediates, except under licence, for a period of ten years, and a machinery, in the form of a committee, was established for granting licences which comprised representatives of both users and makers, the former being in the majority. In addition, a representative committee was set up under the Board of Trade to advise in regard to the development of the industry. This machinery has worked well, largely owing to the goodwill shown by all parties.

Since the expiry of the period contemplated in the Act, this has been renewed from year to year under the Expiring Laws Continuation Act, until in 1933 the whole question of dyes was referred to the new Import Duties Advisory Committee, which took evidence from all the interests concerned. Its considered report advised the Government that protection of dyes on the existing lines should become part of the permanent legislation of Great Britain and a bill giving effect to this intention has recently been passed by Parliament. The dyestuff legislation has been strongly opposed on political grounds ever since its inception: this has had an adverse effect on the recovery of the industry, which in consequence has been faced at times with considerable uncertainty as to the future. It is hoped that the final settlement of the matter will remove dyes once and for all from the arena of politics, and so give the industry full scope to develop as the result of its intensive research programme.

The book before us, which prompted these comments, was first launched by Cain and Thorpe in 1905, the former having had practical experience in industry. During the arduous days when we were trying to build up the industry in Great Britain and train chemists from other spheres in the intricacies of dyes, it played a part of definite utility, as witnessed by the rate at which the various editions were exhausted.

The last few years have seen many changes in the relative importance of the various groups of dyes, so that it has become necessary entirely to rewrite the subject for this, the seventh, edition, giving much more prominence to certain branches. It is some years since Dr. Cain passed away; Prof. Thorpe has now the assistance of a younger colleague, Dr. Linstead, who has already made a name as a research worker in this field.

The book follows familiar lines; naturally it is largely structural formulæ, without which this branch of chemistry could not be intelligible—more than a word of praise is due to all concerned for the clear manner in which these are produced. The three sections into which it is divided comprise the intermediates, the dyestuffs and a practical one giving precise directions for the preparation of a considerable number of substances.

Criticism in detail of such a compendium is of interest only to the expert; it will be of more value perhaps to indicate the lines along which most progress is being made. Outstanding is the general movement towards the production of faster dyestuffs, particularly the vat dyes of the anthraquinone series. This has in part been made practicable by the greater availability of anthraquinone itself, prepared from naphthalene by the very striking modern aero-oxidation method. The story would be incomplete also without mention of the discovery of 'caledon jade green', the best green vat dyestuff. The second line of development has been the production of dyestuffs suitable for viscose and acetate silks, which has been attended with a success obvious to all of us. Mention may be made of the 'ingrain' colours produced from the coupling components direct on the fibre, of the self-mordanting 'neolan colours' and of the 'indigosol' solubilised leuco esters.

The main facts of the dyestuffs story have been driven home to the nation—research and always more research, research which makes us prepared for war and strong in peace, always finding new wonders of applied organic chemistry. Nature is full of colours; as James Joyce writes, "they glow and fade, hue after hue, sunrise gold, the russet and green of apple orchards, azure of waves": yet man has been able to surpass them in brilliancy if not in beauty with his synthetic dyes.

The work will take its place on our shelves as the standard textbook on its subject. E. F. A.

Structure and Development of Man

Human Embryology and Morphology. By Sir Arthur Keith. Fifth edition. Pp. viii + 558. (London: Edward Arnold and Co., 1933.) 32s. 6d. net.

THIS, the fifth edition of Sir Arthur Keith's textbook, will be heartily welcomed, as it has occupied for many years a somewhat unique

position. It embodies various distinct improvements over the fourth edition which appeared in 1923, but in spite of the accumulation of new facts and new points of view since that date, the author is to be congratulated on having been able to preserve the volume from undue expansion. His clear and popular style of exposition conveys to the readers whom he has in view—students of medicine—the end results of the work of embryologists better than perhaps any other textbook. The text is reduced to the minimum consistent with clarity. Much detail has necessarily been omitted, but the needs of the medical student have been in this respect kept in view. Although ideas differ regarding the relative importance of facts of observation and interpretation, Sir Arthur Keith's selection, in view of his long and varied experience, may be accepted, at least so far as organogenesis is concerned, as satisfactory.

The old title of 1901 is perhaps rather out of date. Descriptive embryology has now become largely merged in a new and more comprehensive morphology, and in this connexion the author's introduction of a new chapter on "Experimental Embryology" is to be commended. The text of the old description has not been greatly altered, but it is fully brought up to date, and the addition to each chapter of a bibliographical appendix—coupled with notes—constitutes a valuable improvement. The notes provide material for a different class of reader from the elementary text. Many deal with more abstruse and doubtful points, and open vistas regarding the most recent advances, while the references to literature send the inquiring student to the sources where he will find—what the keener senior student desires—some knowledge of the actual evidence in sections and reconstructions from which the story has been compiled, and upon which the purely diagrammatic illustrations are founded. These last have not been greatly added to, but we welcome some newcomers which show the same ingenious and informing quality as the old.

The chapters on organogeny maintain the old level of clear elementary description which has given this textbook the success it has attained. The section on the early stages of development is perhaps scarcely so successful. It is relatively more popular and introductory. This is inevitable without the use of more comparative data critically considered, but as a brief introduction it may serve sufficiently well the aim of the book as a whole.

T. H. B.

Short Reviews

Thermodynamics Applied to Heat Engines: a Textbook covering the Syllabuses of the B.Sc. (Eng.) and A.M.I.Mech.E. Examinations in this Subject. By E. H. Lewitt. (Engineering Degree Series.) Pp. x+347. (London: Sir Isaac Pitman and Sons, Ltd., 1933.) 12s. 6d. net.

A VERY useful account is given in this book, from an engineering point of view, of the application of thermodynamics to the theory of the steam engine, mechanical refrigeration, steam nozzles, steam turbines, fuels and the internal combustion engine. Students reading for the final examination for an engineering degree should find the accounts of these applications helpful. The author states that the "subject has been methodically developed from the fundamental laws of experimental physics". His attitude towards some of these fundamentals may be gauged from the quotations following, which the reviewer gives without comment:

"It has been calculated that a gas will occupy no volume at a certain low temperature known as absolute zero temperature . . . The accuracy of the assumption . . . is extremely doubtful, as the gas would liquefy . . . before this low temperature is reached."

"A perfect gas is the name given to the natural state of any substance of which the evaporation from the liquid state is complete."

"Liquids and solids have one specific heat only; but a gas is regarded as having two distinct specific heats . . ."

"Boyle found experimentally that when a gas is heated at a constant temperature the pressure multiplied by the volume remains constant."

"Entropy cannot be regarded as a physical property of the fluid; it is an imaginary property which was devised by Rankine and is used by engineers as a means of providing a quick solution for problems dealing with the adiabatic expansion of vapours." A. F.

Experimental Electrical Engineering and Manual for Electrical Testing: for Engineers and for Students in Engineering Laboratories. Vol. 1: By Prof. V. Karapetoff. Revised by Prof. Boyd C. Dennison. Fourth edition, completely revised and reset. Pp. xxviii+781. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 37s. 6d. net.

THIS volume is written for engineers and for students in engineering laboratories. It contains very few mathematical formulæ and very little theory. It will be useful to electricians in testing laboratories and to students who have a wide elementary theoretical knowledge of the subject. As a work of reference it will be of value; the methods of testing given are good and many of them are standard methods in the United States. The methods given of diagnosing the causes of faulty running in machinery can also be com-

mended. We notice that in this edition the chapters on telephone practice have been omitted and also the chapter on primary cells. The book therefore deals more exclusively with heavy engineering.

Direct and Alternating Currents: Theory and Machinery. By Prof. E. A. Loew. Pp. xiii+656. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) 27s. net.

IN this volume the author reviews the theory of the electric circuit and the operating principles of electric machinery. The applications of electricity are now so numerous that it is very difficult to decide what to describe and what to omit. That everything has to be included in one volume makes it necessary to pass lightly over much theory, and since the student will in his future practice come across many types of equipment some of which it is necessary to describe, there is practically no space for modern theory. Luckily the laws and principles necessary to understand the performance of everyday electrical machines are few in number. The author has made a happy selection and the book will be useful to the technical student.

Practical Acoustics for the Constructor. By C. W. Glover. Pp. xi+468+27 plates. (London: Chapman and Hall, Ltd., 1933.) 25s. net.

THERE is little excuse nowadays for a badly designed hall, church or theatre—badly designed, that is to say, from an acoustic point of view. The principles which govern acoustic design are very well understood, and the number of books dealing with architectural acoustics is legion. Mr. Glover's addition to the list may be recommended as a thoroughly practical volume, designed for the use of practising architects. The information given is very full and detailed, and the work forms a most useful book of reference. There is a remarkable bibliography appended to the volume. A. F.

The Great God Waste. By John Hodgson. Pp. viii+127. (Eggington, Beds.: John Hodgson, 1933.) n.p.

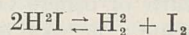
ARGUMENTS are more likely to prove weighty in the absence of exaggerated presentment, and may easily show fallacies in depending upon statistics. Issue may be joined with the remark, that taxation impoverishes one class to enrich another; and the glorification of leisure as the *dolce far non troppo*, in place of an honest day's work, as hitherto understood, is to be deplored. Mr. Hodgson has wandered up and down and to and fro, with the amazing resultant discovery, that the U.S.S.R. deserves praise at the expense of the rest of the world. The trend of events during the last few months serves to discount the value of much of Mr. Hodgson's text. P. L. M.

Heavy Hydrogen and Heavy Water

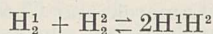
IN a lecture delivered before the New York Section of the American Chemical Society on December 8, Prof. H. C. Urey gave some further information as to the properties of the heavy hydrogen isotope of mass 2.01356, that of light hydrogen being 1.00778 (both on the $O^{16} = 16$ scale).

Attempts had been made to separate the hydrogen by fractional distillation of the liquid, calculation showing that the vapour pressures should be different, but the method was not successful because the low surface tension of liquid hydrogen makes it difficult to prevent its escape as mist in the fractionating column. A method depending on diffusion into flowing mercury vapour was no more effective. Some details of the actual method of separation, depending on electrolysis with water-cooled nickel electrodes in cells each containing 300 c.c. of potash solution in water from commercial cells enriched to 0.5–1 per cent of "deuterium oxide", are given. The current is 25 amp., and 30 cells are placed in series across 110 volts. Electrolysis is carried on until the volume is reduced to one third, when the residual electrolyte is removed, two thirds distilled from the potash, and combined with the undistilled liquid. Electrolysis to one third is again carried out, and beginning with the second stage, the hydrogen and oxygen gases are recombined to give a liquid containing 0.3–0.4 per cent of "deuterium oxide". The progress of the fractionation is followed by observation of the refractive index.

Investigations on the equilibrium



gave results agreeing with calculations which show, for example, that the ratio of the equilibrium constants with light and heavy hydrogen should be 1.222 at 700° abs. The equilibrium constants for the reaction



gave 3.28 (3.27), 3.73 (3.77) and 3.75 (3.82) at 298.1° , 671° and 741° , abs., the calculated values being in brackets¹. Experiments by Crist and Dalin showed that no interaction between heavy hydrogen and the light hydrogen of water over which the gas was confined had occurred in a few weeks; the different result reported by Oliphant² may have been due to the presence of a catalyst.

Experiments by Rittenberg and Urey on the electrolytic separation of hydrogen isotopes pointed to a kinetic explanation of the phenomenon; unless the differences in electrode potentials are much greater than those indicated by calculations, it does not seem possible that the separation is due to this cause³. The physiological properties of heavy water are supposed to depend on possible differences in ionisation constant and in reaction velocities as compared with ordinary water.

A design of electrolytic cell for concentrating heavy water has been described by Harkins and Doede⁴ but no details of performance are given. The specific rates of discharge of light and heavy hydrogen atoms on various metal cathodes have been measured by Topley and Eyring⁵ and the results considered with reference to the theory of over-voltage: they are not inconsistent with the view that the separation is almost entirely due to the zero-point energy difference. The slow process at the cathode does not appear to be combination of atoms to molecules.

A method for determining the concentration of the heavy oxygen isotope O^{18} in water during treatment⁶ depends on decomposing the heavy water with heated iron and combining the liberated hydrogen with ordinary oxygen from hot copper oxide and condensing the water (X) so formed. The iron oxide is then decomposed by heating in ordinary hydrogen and the water formed (Y) condensed. The water X was found to be identical with the initial heavy water, whereas Y was identical with ordinary water. Hence there is no appreciable concentration of O^{18} in the electrolytic process.

Several investigations of the properties of heavy water, in addition to those already reported in these columns⁷, have been published. The solubilities of one or two salts in heavy water are distinctly lower than in ordinary distilled water⁸: 1.000 gm. of ordinary water dissolves 0.359 gm. of sodium chloride at 25° and 1 gm. of water containing 92 per cent of hydrogen as H^2 dissolves 0.305 gm., a difference of 15 per cent, whilst the corresponding figures for barium chloride show a difference of 19 per cent.

The densities, refractive indices (n_{20}^d and n_{20}^c), molar refraction for D line, viscosity (η), surface tension (γ), dielectric constant (D), magnetic susceptibility (χ) and molar susceptibility of water containing 31, 63.5 and 92 per cent hydrogen as H^2 (assuming the density 1.1056 for pure H_2^2O) have been measured, and the values extrapolated to pure H_2^2O . Selwood and Frost's values⁹ are (the values for ordinary water in brackets): n_{20}^d , 1.3281 (1.3329); n_{20}^c , 1.3265 (1.3309); η_{20} , 14.2 mp (10.87 mp); γ , 67.8 (72.75); $\chi \times 10^6$ /gm. (92 per cent water), -0.65 (-0.72); molar susceptibility $\times 10^6$, -13 (-13).

Lewis and Macdonald found the viscosity at several temperatures (5° – 35°) higher than that of ordinary water, but their value at 20° , 12.60, is not in agreement with Selwood and Frost's. The dielectric constant is lower than that of ordinary water: $D^2/D^1 = 0.982$ at 10° , 0.990 at 25° . The abnormality as compared with ordinary water decreases with rise in temperature for all properties investigated.

The refractive index¹⁰ affords a convenient method of determining the proportions of H_2^2O

and H_2O^{10} : the effect of the O^{18} isotope is opposite in sign from that of H^2 , and the measurement of the density and refractivity gives the complete isotopic composition (H^1 , H^2 , O^{16} , O^{18}) of a sample of water. The mutarotation of α -*D*-glucose in heavy water shows that the displaceable hydrogen atom of the sugar is immediately replaced by H^2 from the water, and the mutarotation is due to a change in which the double bond in a carbonyl group, $=\text{C}=\text{O}$, is replaced by a ring formed by the migration of a hydrogen atom¹¹.

By the interaction of heavy water with magnesium nitride, ammonias in which the hydrogen atoms are predominately H^2 (deutero-ammonias) are produced, which have higher melting points, boiling points and latent heats than ordinary ammonia¹².

Further experiments on the physiological effects of heavy water¹³ show that the filaments of *Spirogyra* in water of specific gravity 1.000061 are characterised by lack of movement, absence of abscission or cell disjunction, and greater longevity. The usual effect with ice and steam water was confirmed¹⁴. The results suggest a stabilising action of water containing H^2 , perhaps an effect on the colloids in the organism, the water bound in such colloids being known to be denser than free water. A slightly higher *pH* (as determined with bromthymol blue) for this sample of

water was found. In other experiments¹⁵, decreased enzyme activity and fermentation in isotope water, a more extensive spread of *Oscillatoria* (perhaps due to a *pH* of 6.77 as determined by the glass electrode), and the following results with *Spirogyra nitida* were found: a representative filament of 31 cells in isotope water had 43 cells after 6 days, of which 3 were dead; a filament of 37 cells in ordinary water showed no cell division at the end of 6 days and 20 cells died; in ice water renewed twice daily, a filament of 50 cells showed 15 abnormal at the end of five days, whilst the filament in freshly condensed water renewed twice daily showed all its 50 cells dead or shrunken in the same period; the control filament (pond water) had 47 cells initially and 64 normal cells after six days.

- ¹ Cf. A. and L. Farkas, *NATURE*, **132**, 894, Dec. 9, 1933.
- ² *NATURE*, **132**, 675, Oct. 28, 1933; cf. Polanyi and Horjuti, *ibid.*, **519**, Nov. 25.
- ³ cf. Collie, *NATURE*, **132**, 568, Oct. 7, 1933.
- ⁴ *J. Amer. Chem. Soc.*, **55**, 4330, 1933.
- ⁵ *J. Amer. Chem. Soc.*, **55**, 5058, 1933.
- ⁶ Selwood and Frost, *J. Amer. Chem. Soc.*, **55**, 4335, 1933.
- ⁷ *NATURE*, **132**, 536, Oct. 7, 1933.
- ⁸ Taylor, Caley and Eyring, *J. Amer. Chem. Soc.*, **55**, 4334, 1933.
- ⁹ Selwood and Frost, *J. Amer. Chem. Soc.*, **55**, 4335, 1933. Lewis and Macdonald, *ibid.*, 4730. Lewis, Olson and Maroney, *ibid.*, 4731; Lewis and Luten, *ibid.*, 5062.
- ¹⁰ Crist, Murphy and Urey, *J. Amer. Chem. Soc.*, **55**, 5060, 1933. Lewis and Luten, *ibid.*, 5061.
- ¹¹ Pascu, *J. Amer. Chem. Soc.*, **55**, 5056, 1933.
- ¹² Taylor and Jungers, *J. Amer. Chem. Soc.*, **55**, 5057, 1933.
- ¹³ Barnes, *J. Amer. Chem. Soc.*, **55**, 4332, 1933.
- ¹⁴ *NATURE*, **132**, 536, Oct. 7, 1933.
- ¹⁵ Barnes and Larson, *J. Amer. Chem. Soc.*, **55**, 5059, 1933.

Ernst Haeckel (1834-1914)

By PROF. E. W. MACBRIDE, F.R.S.

THE career of Prof. Ernst Heinrich Haeckel, the centenary of whose birth falls on February 16, belongs to the heroic stage of the history of the theory of evolution. In 1862, at the early age of twenty-eight, he was appointed to the chair of zoology in the University of Jena, a post which he held until his death in 1914.

Haeckel's life bears a strong resemblance to that of Huxley, for like Huxley his life's task was propaganda in favour of the theory of evolution against the then prevalent theory of the origin of species by a series of supernatural interpositions of the Divine Being. Like Huxley too, he was an ardent advocate of the animal origin of the human race. But there were marked differences between the two men; Haeckel was a harder hitter than Huxley, and withal a much more reckless one, since he was apt to make wild statements on the basis of insufficient data, as, for example, when he stated that if there were a line to be drawn between animals and men, the lower races must be included amongst the apes. The most recent anthropological studies seem to indicate that in the essential make-up of their minds the most primitive men are very like ourselves: the data and presuppositions from which they start are different and so are their customs and traditions, but granted these postulates the conclusions at which they arrive are natural enough. But on the whole, Haeckel was a sounder biologist than Huxley:

whilst he embraced with enthusiasm Darwin's arguments about natural selection, he was never deceived into thinking that the mere survival of some and the death of others could account for progressive evolution: he saw quite clearly that the vital question was the origin of the 'variations' which distinguished the survivor from his less fortunate brother, and in this matter he followed Lamarck. When he popularised his views in his famous "History of Creation" he dedicated the work to "Jean Lamarck and Charles Darwin".

Haeckel excelled Huxley also in the amount of actual zoological work which he accomplished. Thus he wrote a descriptive monograph of the Radiolaria collected by H.M.S. *Challenger*, giving the characters of no less than 3,600 new species. This work occupied him for ten years. He also monographed the calcareous sponges, but the greatest task which he attempted was to sketch, assuming the truth of the evolution theory, the actual course which evolution had pursued in producing modern plants and animals. His conclusions were embodied in his "Allgemeine Morphologie", of which the "History of Creation" may be regarded as a popular edition. Of course, the state of zoological and botanical knowledge at the time that these books were written was far too incomplete to permit of any but the vaguest sketches of the course of evolution, but there can be nothing but admiration for Haeckel's bold

adventure. In the circumstances, it was the right course to pursue: it summarised pre-existing knowledge and provided both a foundation and a framework for future work, and some of the most important and fundamental of Haeckel's ideas have stood the test of time. Thus he divided living beings into Animals, Plants and Protista; regarding the last group, which included the simple unicellular organisms, as the common seed-bed from which both animals and plants have sprung. The discovery of green ciliates like some species of *Stentor* and *Vorticella*, and of colourless carnivorous Dinoflagellates which devour young oysters, in addition to the ordinary brown species which live like brown seaweeds, has more than justified Haeckel's classification.

Haeckel's most far-reaching hypothesis was, however, his famous 'biogenetic law'. He invented the terms phylogeny and ontogeny—the first, according to him, designated the palaeontological history of the race, the second the history of the development of the individual from the egg to the adult condition. The law connecting these two was the 'Biogenetic fundamental principle': stated in his own words, it ran thus: "Ontogeny is a short and quick repetition, or recapitulation of Phylogeny determined by the laws of inheritance and adaptation". Haeckel pointed out that if this principle be admitted, there is some hope of tracing, in outline at least, the actual course of evolution; whereas if we were to confine ourselves to palaeontological evidence, we should only see glimpses of evolution in special cases. The past history of the Vertebrata may be traced from fossils with considerable exactitude since vertebrates possess an internal skeleton which is often preserved and which gives in its scars and processes, evidence of the muscles which once accompanied it and consequently of the actions and habits of the animal which possessed the skeleton. The external skeleton of extinct Crustacea which clings tightly to every protuberance of the body, also reveals a good deal about the activities of its former possessor. But what scanty light do the shells of extinct Mollusca and the tests of ancient Echinoderms throw on the internal structure of their owners! Who would dream from their evidence that radiate Echinoderms were derived from bilateral ancestors?

In our judgment the formulation of this biogenetic law was the greatest service which Haeckel did to the science of zoology, and the more we reflect on it the greater the service will appear. Haeckel was, of course, aware that these reminiscences of ancestral life could be modified, blurred or occasionally completely obscured. He knew that for the elucidation of life-histories only the comparative method would avail; and just as in the comparison of two ancient documents the truth will shine through the errors peculiar to each one, so with life-histories.

The acceptance of this law as giving a picture of evolution drew with it certain conclusions as to the causes of evolution. Haeckel described

variations as 'adaptations'. There were, he said, two classes of these, namely, (1) small ones which were the result of habits and which were *transmitted to posterity with greater certainty the longer they had lasted* (this is pure Lamarckian doctrine), and (2) great adaptations which appeared suddenly and the causes of which were unknown to us, though in some cases they appeared to have originated with intra-uterine influences. These latter are now, of course, called mutations, and it was the first category alone which Haeckel believed to be significant for evolution, for the growth of the individual suggests that evolutionary growth was slow, functional and continuous.

The biogenetic law proved a tremendous stimulus to zoological research. Of course, it encountered opposition; its enthusiastic votaries desired, like all enthusiasts, to reach the 'promised land' at once: they failed to realise that ancestral history could only be elucidated by prolonged, careful and comparative research. They could not deny themselves the pleasure of making wild guesses as to ancestry based on the study of some one life-history and in time 'Haeckelismus' became a term of reproach. But the principle was essentially sound; from all opposition it emerged triumphant: it has been transferred to ever wider fields and has been found to throw light even on the development of the mental life of man. A certain school of biologists at the present day affects to denigrate it and that for obvious reasons, for if it is sound then one thing is certain, mutations have played no part in evolution. But ancestral history stands out so clearly in some life-histories that none but the wilfully blind can deny its presence. Amongst the Ctenophora, for example, there are two aberrant forms, *Tjafiella* and *Cæloplana*. The first resembles a sponge, the second a flat-worm; yet both begin their free existence as typical little Ctenophores, globular in form with 8 meridional bands of cilia radiating from the upper pole. But if ancestral history is the foundation of some life-histories is it not reasonable to assume that it lies at the base of all?

The real originator of the theory that evolution proceeded by jumps and that "Discontinuity in variation was the cause of discontinuity in species" was the late Dr. Bateson. In his first and best work on the development of *Balanoglossus* he found himself driven to the conclusion that Echinoderms and Vertebrates had radiated from a common stock and his faith in 'recapitulation' failed him, although it is interesting to record that this conclusion has been sustained by recent research and that from the most unlikely quarter, namely, biochemistry. He then made "*il gran rifiuto*" and fell back on sports and monstrosities as the material of evolution. At the meeting of the Zoological Congress in Cambridge in 1898, Bateson put forward his views. Haeckel was present at the meeting and some sentences of his still linger in our memory. He said that if views like these are to be accepted, "Kehren wir lieber zu Moses zurück".

Prehistoric and Primitive Surgery

THE Vicary lecture before the Royal College of Surgeons was delivered on December 8 by Dr. L. W. G. Malcolm, conservator of the Wellcome Historical Medical Museum, who chose as his subject "Prehistoric and Primitive Surgery".

The surgery of prehistoric and primitive times cannot be treated on rational lines when it is considered in time and space. There is all the difference in the world between the ideas of primitive man and those of the founders of rational medicine and surgery—the Greeks. It does not appear that there is any community of ideas in the primitive world unless considered from the ritualistic point of view.

Omitting for the most part reference to prehistoric Europe, to which detailed attention, especially in regard to trephining, has been paid by Dr. Wilson Parry, the available evidence shows that certain major operations have been performed by the prehistoric and primitive surgeons, involving a greater or less degree of skill and knowledge of anatomy; but such methods of treatment as bandaging, poulticing, lancing, bone-setting and the rarer amputation, massage, especially in relation to child-birth, cupping and bleeding, blistering and cauterising, fomentation and the vapour-bath were more or less common knowledge of the tribe, as the product of a real, if perhaps uncritical, experience.

The leechcraft of the professional medicine-man, or shaman, is in a different category. Although he has a knowledge of everything the lay medicine-man may practice, he is able to control the basis of magic, the universal power or soul-*mana*. Magical therapeutics may be traced from the earliest times down to the present day. The magical ritual had an accompanying expression in some therapeutic measure, for example, blood-letting or massage. When a medicine-man, for example, trephined a head, he was performing a rite to satisfy the religious beliefs of the tribe; but as the tribe progressed in knowledge, the ritual process was abandoned and an allegorical object substituted as an offering to the god. Thus a gourd with a hole in it was offered to the god, who accepted it as a trephined head in lieu of the actual operation.

Turning to the rational surgery of primitive and prehistoric peoples, trephining of the skull was practised by the pre-Columbian inhabitants of Peru, the methods employed falling into four groups: scraping, sawing, cutting, and drilling, the last being rare. The objects of the operation were to treat a depressed fracture, such as might be caused by a sling-shot, to relieve pain or for superstitious reasons. The evidence on the whole does not support the use of a plate to fill the hole, or of suture. The operation is reported to-day, especially in North Africa, Polynesia, India and Peru.

The lesion now known as the sincipital T is found on skulls from the dolmens near Nantes in France. It takes the form of a long antero-posterior groove along the sagittal suture, terminating near the obelion where the transverse branch is encountered. It has been recorded among the ancient Canary Islanders as due to the cauterising of a scarification with a flint knife, and a similar lesion has been found in a pre-Columbian female skull from Peru. In the Middle Ages this operation was performed on demented individuals, usually female, to allow the application of heated objects to the skull. It reduced "the amount of cold humours in the head".

The disease *uta*, a phase of leishmaniasis, has left traces on certain skulls from South America. The primitive surgeon would appear to have amputated the diseased part of the face in one example. The effects of this treatment are represented in the realistic Peruvian prehistoric pottery.

In major surgical operations, the most astounding is the Cæsarian operation performed by a native of Uganda in 1879. The wound healed entirely on the eleventh day. A similar operation has been recorded among the Chippeway Indians, but without detail. Ovariectomy is said to be performed in India and among the aborigines of Australia; but exact evidence is lacking. Although the Aztecs and Incas must have acquired a knowledge of anatomy from the practice of extracting the heart from the living sacrificial victim, they do not seem to have been led thereby to perform operations on the internal organs.

Hernia was treated among the Pueblo Indians of America by the use of pads and bandages, and the Basket-makers used a flattish oval pad. This was worn by new-born infants by means of long strings to prevent umbilical hernia. Umbilical hernia is extremely common among primitive peoples, especially in Africa; but they do not appear to do anything for it.

From the prehistoric pottery it would appear that the Incas performed some remarkable operations on the limbs. The cliff-dwellers of North America, who suffered severely from fractures, were skilled in the use of splints for thigh and arm, a purpose for which the Aztecs used the leaves of the century plant, moist clay serving as a cast. The aborigines of South Australia coat the fractured limb in a kind of plaster of Paris. Among the North American Indians, manipulation and particularly traction, manual and mechanical, were employed in the reduction of dislocations. Relaxation was produced by the use of stramonium, alcohol, infusions of tobacco and other drinks.

Three methods of blood-letting are practised by primitive peoples: suction, scarification and venesection. Ingenious methods of venesection were employed. One found among the Indians of

the Isthmus and Brazil was to shoot a stone-headed arrow into the vessel. This method is also found in New Guinea. Venesection is employed in the armpit, the forehead, the vertex and various other parts of the body. In Peru the veins at the root of the nose were opened. The use of the cupping vessel is widespread.

The stopping of a blood-vessel presents difficulties; but the methods employed are amazing in their variety, including powdered gum, charcoal, ashes, eagle's down, bandages of bark, coconut fibre, etc. A kind of tourniquet of bark cloth is recorded in Loyalty Islands, Tahiti, Samoa and Tonga. The prevalent method of cleansing wounds among the American Indians was by sucking out the pus, a method which gave the shaman opportunity to display his magic power by showing a pebble which he had sucked from the wound.

While it has been shown from the examples quoted above that the primitive peoples of America had a certain idea of rational surgical procedure, the remainder of the primitive world, with few exceptions, did not exhibit the same degree of surgical appreciation. The races and tribes of Africa who practise an advanced procedure have derived their knowledge from other races—all

tribes south of the Sahara, for example, have been influenced by Arabian surgery. There is, however, a remarkable number of mutilations which involve a certain knowledge of surgery. These are usually ritualistic in origin, such as circumcision (male and female) and infibulation. There are no less than fourteen different methods of operating on the male genitalia employed in various parts of the primitive world. Among other forms of mutilation is amputation of the fingers, which was practised by the Aurignacian peoples of palæolithic times and is recorded by imprints on rocks in California, Arizona, Peru, Africa and Australia. Cicatrization is also a sacrament. Other mutilations in a variety of forms are practised on the nose and cheeks. Piercing the tongue is not common, but excision of the tongue is practised in West Africa.

A review of the subject leads to the belief that the resistance of primitive people is abnormal, compared with that of modern civilised races. Their apparent indifference to pain and the infrequency of blood-poisoning indicate that modern races pay for their civilisation in terms of lessened resistance, pathology and neurology.

The lecturer expressed his acknowledgments to Dr. R. Moodie and Dr. L. Freeman.

Artificial Production of a New Kind of Radio-Element

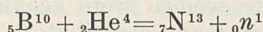
By F. JOLIOT and I. CURIE, Institut du Radium, Paris

SOME months ago we discovered that certain light elements emit positrons under the action of α -particles¹. Our latest experiments have shown a very striking fact: when an aluminium foil is irradiated on a polonium preparation, the emission of positrons does not cease immediately, when the active preparation is removed. The foil remains radioactive and the emission of radiation decays exponentially as for an ordinary radio-element. We observed the same phenomenon with boron and magnesium². The half life period of the activity is 14 min. for boron, 2 min. 30 sec. for magnesium, 3 min. 15 sec. for aluminium.

We have observed no similar effect with hydrogen, lithium, beryllium, carbon, nitrogen, oxygen, fluorine, sodium, silicon, or phosphorus. Perhaps in some cases the life period is too short for easy observation.

The transmutation of beryllium, magnesium, and aluminium α -particles has given birth to new radio-elements emitting positrons. These radio-elements may be regarded as a known nucleus formed in a particular state of excitation; but it is much more probable that they are unknown isotopes which are always unstable.

For example, we propose for boron the following nuclear reaction:



${}_7\text{N}^{13}$ being the radioactive nucleus that disintegrates with emission of positrons, giving a stable

nucleus ${}_6\text{C}^{13}$. In the case of aluminium and magnesium, the radioactive nuclei would be ${}_{15}\text{P}^{30}$ and ${}_{14}\text{Si}^{27}$ respectively.

The positrons of aluminium seem to form a continuous spectrum similar to the β -ray spectrum. The maximum energy is about 3×10^6 e.v. As in the case of the continuous spectrum of β -rays, it will be perhaps necessary to admit the simultaneous emission of a neutrino (or of an antineutrino of Louis de Broglie) in order to satisfy the principle of the conservation of energy and of the conservation of the spin in the transmutation.

The transmutations that give birth to the new radio-elements are produced in the proportion of 10^{-7} or 10^{-6} of the number of α -particles, as for other transmutations. With a strong polonium preparation of 100 millicuries, one gets only about 100,000 atoms of the radioactive elements. Yet it is possible to determine their chemical properties, detecting their radiation with a counter or an ionisation chamber. Of course, the chemical reactions must be completed in a few minutes, before the activity has disappeared.

We have irradiated the compound boron nitride (BN). By heating boron nitride with caustic soda, gaseous ammonia is produced. The activity separates from the boron and is carried away with the ammonia. This agrees very well with the hypothesis that the radioactive nucleus is in this case an isotope of nitrogen.

When irradiated aluminium is dissolved in

hydrochloric acid, the activity is carried away with the hydrogen in the gaseous state, and can be collected in a tube. The chemical reaction must be the formation of phosphine (PH_3) or silicon hydride (SiH_4). The precipitation of the activity with zirconium phosphate in acid solution seems to indicate that the radio-element is an isotope of phosphorus.

These experiments give the first chemical proof of artificial transmutation, and also the proof of the capture of the α -particle in these reactions².

We propose for the new radio-elements formed

by transmutation of boron, magnesium and aluminium, the names *radionitrogen*, *radiosilicon*, *radiophosphorus*.

These elements and similar ones may possibly be formed in different nuclear reactions with other bombarding particles: protons, deuterons, neutrons. For example, ${}^7\text{N}^{13}$ could perhaps be formed by the capture of a deuteron in ${}^6\text{C}^{12}$, followed by the emission of a neutron.

¹ Irène Curie and F. Joliot, *J. Phys. et. Rad.*, **4**, 494; 1933.

² Irène Curie and F. Joliot, *C.R.*, **198**; 1934.

³ Irène Curie et F. Joliot, *C.R.*, meeting of Feb. 29, 1934.

Obituary

SIR DONALD MACALISTER, BART., K.C.B.

BY the death at Cambridge on January 15 of Sir Donald MacAlister of Tarbert, in his seventy-ninth year, a great personality has passed out of the academic and medical life of Great Britain. He was a Scottish highlander descended from the MacAlisters of Tarbert in Argyllshire, a family which for about five centuries possessed considerable lands in Kintyre and the heads of which were hereditary keepers of Tarbert Castle. Although originally a branch of the great clan MacDonald, they held their Tarbert possessions in charter from the Campbells with whom they cast in their lot in politics and war.

Sir Donald MacAlister was born in Perth on May 17, 1854, and received his school education there and in Aberdeen and Liverpool, the changes in family residence being necessitated by his father's business activities. In 1873 he entered St. John's College, Cambridge, and in 1877 was senior wrangler and first Smith's prizeman in addition to receiving many other University distinctions. A year later he was elected a fellow of his college and having meantime turned to the study of medicine he graduated M.B. in 1881 and M.D. in 1884. Settling in Cambridge as a consulting physician, he was appointed Linacre lecturer on physic and a member of the staff of Addenbrooke's Hospital and thus became actively engaged in medical teaching. His earliest professional studies had been in the domain of pathology, but this was soon superseded by pharmacology and therapeutics, subjects in which he retained a keen and active interest to the end. In recognition of his special attainments he was chosen president of the Section of Therapeutics at the Toronto meeting of the British Medical Association and for many years was chairman of the "British Pharmacopœia" Committee, the 1898 and 1914 editions of which owed a great deal to his collaboration.

Although deeply interested in scientific and medical research and keenly appreciative of their results, Sir Donald MacAlister was never a 'research worker' in the ordinary sense of the term. His cast of mind and abilities were more those of the statesman and administrator and it was in these directions that he found a congenial field

for his activities and that he reached his highest distinction. In Cambridge he took a large share in the administrative work of the University and in 1889 was elected its representative on the General Medical Council. He soon became one of its most influential members and when he resigned from it last year on account of failing health, he had served for forty-four years, twenty-seven of which were in the presidential chair. As president his advice was frequently sought by the Privy Council and other Government departments concerned with the administration of medical education, pharmacy and the public health, and in these matters he gradually came to exercise a far-reaching influence.

It was, however, not in medical matters only that Sir Donald MacAlister's influence on higher education and its administration was felt. His exceptionally wide knowledge and culture rendered him highly sympathetic to all the many departments of university studies and activities; this led to his being chosen chairman of the Universities Bureau of the British Empire, chairman of the Commission on the University of Belfast, and to much other similar public work. In 1907 he was appointed by the Crown to the high office of Principal of the University of Glasgow and shortly thereafter was made K.C.B. In 1924 he was created a baronet in recognition of his many public services. When he went to Glasgow he had no special acquaintance with Scottish university affairs, but in a surprisingly short time he had acquired a complete grasp of them no less in their business than in their teaching aspects, and this soon found expression in numerous changes and reforms. During his principalship he inspired such confidence in the citizens of Glasgow that money was freely forthcoming for the establishment of many new chairs and lectureships and for general university expansion. Nor were the social and athletic sides of student life overlooked. A new Union costing £65,000 was built, new playing fields were provided and three residential halls for men and one for women were acquired by the University. From many contributors he received personally a large sum of money which was devoted to the building of a chapel in memory

of those members of the University who perished in the War, and this will ever remain a beautiful memento of his principalship.

Besides being the recipient of honorary academic degrees too numerous to mention in detail, Sir Donald MacAlister was decorated by the French and Italian Governments, and from his fellow-citizens he received the freedom of the city of Glasgow in recognition of his great services to their University and in testimony of their personal esteem. In 1929 he resigned the principalship after twenty-two years service and was unanimously elected Chancellor of the University in succession to the late Earl of Rosebery and Midlothian. His success as an administrator was largely due to an inborn aptitude for affairs, to a retentive memory for details and to a clear conception of the objects to be attained, but these were greatly enhanced by his industry, his devotion to duty and, as time went on, his wide experience.

WE regret to announce the following deaths :

Prof. H. L. Chablani, professor of economics in the University of Delhi, on January 14, aged forty-four years.

Prof. Fritz Haber, formerly director of the Kaiser Wilhelm Institute for Chemistry and professor of physical chemistry in the University of Berlin, known for his work on the thermodynamics of gas reactions, on February 1, aged sixty-five years.

Dr. William Page, general editor of the "Victoria History of the Counties of England", and a commissioner of the Royal Commission on Historical Monuments (England), on February 3, aged seventy-two years.

Capt. J. White, C.B., R.N., formerly dean of the Royal Naval College, Greenwich, previously professor of applied mechanics at the College, on January 28, aged sixty-three years.

News and Views

"Letters to the Editor"

DURING the year 1933, no less than four hundred communications appeared in NATURE under the heading of "Letters to the Editor", the big majority of which were the first announcements to be published of new work—news from the actual contributors to advances in science. Of this total, 201 were from scientific workers in universities and similar research centres in Great Britain and Ireland, and the remainder, 199, were from workers abroad distributed by continents as follows: Europe 78, America 57, Asia 37, Australia 14, Africa 13. In this week's issue of NATURE we are devoting 20 columns to 'letters' and the size of the journal has been increased to provide the necessary space. These 20 columns are, we believe, representative of the correspondence normally appearing in NATURE. The various items record current advances in biochemistry, atomic physics, radio communication, chemistry, biology and so on, and they are written by workers in Allahabad, Cambridge, Copenhagen, Dehra Dun (India), Groningen, Liverpool, London, Maine (U.S.A.), Nanking, Oxford, Schenectady, Stockholm, Sydney and Uppsala. Science truly is not confined by national boundaries. We think it a high compliment that scientific workers all over the world should regard our columns as the appropriate place to announce the progress of their labours and to discuss scientific matters and topics in which science and its methods are involved.

THIS part of the function of NATURE as an international journal of science has increased steadily in recent years. For some time past, the section of the journal devoted weekly to "Letters to the Editor" usually occupies 12 columns and frequently has been increased to 14 columns or more. Already this year we have printed 88 columns of 'correspondence', including the 20 columns appearing in this issue. Yet the waiting list is still large. The

amount of space which can be given to 'letters' in a normal issue of NATURE must of necessity be limited if the journal is to discharge the remaining part of its function as a general journal of science, and we may even be obliged in the future to ask correspondents to limit their 'letters' to about five hundred words, or one column of space. For the present, we would urge them most strongly to be concise and precise in their communications, so far as is consistent with making them intelligible to the general reader. A certain amount of specialised matter is inevitable in announcements and discussions, particularly of recent advances, but severely technical communications, of interest to a few workers only in the same highly specialised field, are out of place in a general journal such as NATURE, which endeavours to keep its readers informed of the broad lines of progress in all scientific subjects.

Dr. C. V. Drysdale, C.B., O.B.E.

DR. C. V. DRYSDALE, director of scientific research at the Admiralty, whose impending retirement is announced, has long been recognised as an authority on electrical measurements. In the early part of this century, while in charge of the Electrical Engineering Department of the Northampton Polytechnic Institute, he devoted considerable attention to measurements in the alternating current circuit, and his work on the dynamometer wattmeter, and particularly the development of the double element instrument for the measurement of polyphase power, is now well known. This was followed by several important contributions to technical literature on alternating current measurements, and included his pioneer work on the design of instrument transformers. The regenerative dynamometer together with the cone stroboscope were also devised at about this time for the equipment of the laboratories. He also investigated the possibilities of using iron cores

in dynamometer instruments and had some of the first iron-cored wattmeters built to his design which gave remarkably good performance. The simple phase shifting transformer was also designed and built, being originally intended to facilitate testing the performance of wattmeters at low power factors, and eventually this apparatus made possible his adaptation of the direct current potentiometer to the measurement of alternating potentials. This was the first self-contained instrument for this purpose, and in connexion with it he designed the first vibration galvanometer with tuning effected by variation of the magnetic control. He also gave considerable attention to accurate resistance measurement and devised a new form of standardising bridge which was a combination of the Kelvin and Carey Foster principles, and allowed of precise comparisons between standards over a wide range of values to be made with great accuracy and rapidity, and in connexion with this bridge he developed a novel and accurate ohm standard ingeniously compensated for temperature change. Some time later he designed low resistance standards with very small time constants for use in alternating current circuits.

DR. DRYSDALE'S activities were not, however, entirely confined to work in electrical measurements, for at one time he gave considerable attention to the testing of magnetic materials and investigated the rotary hysteresis in iron and steel and developed an ingenious permeameter for testing magnetic materials in bulk. He also contributed papers on the radiation from black-bodies and made some important determinations of the mechanical equivalent of light which were communicated to the Royal Society. To him also belongs the credit of initiating the teaching of technical optics, in what is now the Technical Optics Department of the Northampton Polytechnic Institute, and into this work he carried the same enthusiasm and originality that characterised his electrical work. He devoted much attention to the curvature method of teaching optics and devised many original methods of optical testing and the apparatus for carrying them out. When the War came his services were placed at the disposal of the Admiralty in connexion with submarine detection and destruction, and here his sound theoretical knowledge and brilliant inventiveness found considerable scope and resulted in the appointment from which he is now retiring. Dr. Drysdale is also known as the president of the Malthusian League and as the author of numerous papers on eugenics.

Sir William Preece (1834-1913)

WILLIAM HENRY PREECE, the distinguished electrician, was born at Bryn Helen, Carnarvon, on February 15, 1834. Educated at King's College School and King's College, London, he came under the influence of Faraday at the Royal Institution and, deciding to become an electrician, in 1852 he entered the office of Edwin Clark. The following year he was appointed a junior engineer on the staff of the Electric and International Telegraph Co. and afterwards was telegraph engineer of the Channel

Islands Telegraph Co. and the London and South-Western Railway Co., introducing many improvements in railway signalling. In 1870 he joined the staff of the Post Office, becoming in 1892 the engineer-in-chief, a position he held until 1899. His work in telephony began in 1877 and it was he who brought to England the Bell telephone with which Kelvin and Haughton gave an amusing demonstration at the Plymouth meeting of the British Association that year. As much scepticism existed regarding the capacity of the telephone, Preece arranged for the transmission of the notes of a bugle from Southampton to the Royal Institution during a lecture he delivered. A large and distinguished audience was present and at the appropriate moment Preece asked Tennyson to listen at the telephone. After doing so for a few moments, the poet remarked gruffly, "I hear nothing." Preece, catching up the telephone, after adopting a listening attitude, said, "I can hear, 'The Campbells are Coming' ", and then proceeded with his lecture, none in the audience realising that the bugler had mistaken the date, and that Preece himself, like Tennyson, had heard nothing.

PREECE'S work on telephony led him in 1885 to make experiments on induction signalling and in 1892 he sent messages across the Bristol Channel from Penarth to Flat Holme. His work in this direction came to an end, however, with the use of the Hertzian waves. "Strange to say," wrote Silvanus Thompson, "he entirely missed the significance of the wireless signalling by Hertzian waves shown by Lodge at the British Association meeting at Oxford in 1894, and yet when Signor Marconi arrived upon the scene in 1896 using the same method and the same devices of oscillators, spark gaps, coherers and tappers, Preece received him with open arms and put the resources of the Post Office at his disposal with results known to all the world." By the time Preece retired three years later, wireless messages were being sent across the English Channel and between some of H.M. ships. Preece, who was admitted F.R.S. in 1881, twice served as president of the Institution of Electrical Engineers and in 1898 was elected president of the Institution of Civil Engineers. He was knighted on his retirement and was afterwards consulting engineer to the Colonies. His death took place at Penrhos, Carnarvon, on November 6, 1913.

Russian Ascent into the Stratosphere

SYMPATHY will be felt for the three Russians, Fedoseenko, Vasenko and Usyskin, pilot, engineer and student respectively, who met their deaths on January 30 in an attempt to investigate further the phenomena of the upper atmosphere. It was announced in the Press that a new height record of about 70,000 ft. had been established for a manned balloon, a conclusion arrived at from the record of the damaged barograph. The pressure reached, however, has not yet been published. Apparently the accident was due to heavy weather as the prime cause, for it appears that the balloon travelled about 350 miles in a south-easterly direction from Moscow in the

first four or five hours of its flight. Two of the occupants were unwell and in dropping rapidly through cloud, the collection of ice on the gondola, together with that falling on it from the lower part of the balloon structure itself, and other chafing actions, eventually parted the gondola from the balloon. The chief object of the flights, organised by the Society for Aviation and Chemical Warfare, was to investigate cosmic rays and it has been said that thirty instruments for various purposes were being carried. The balloon expanded had a diameter of 115 ft. and the whole weighed 2 tons. The metal parts were of rustless steel. The lowest pressure record of 50 mm. (61,000 ft.) for a balloon rests at present with the stratostat *U.S.S.R.* piloted by M. Prokofiev last September.

Photographs and Early Maps of the Fenland of East Anglia

IN the Art Gallery of Messrs. W. Heffer and Sons, Ltd., Cambridge, there is an exhibition of ancient maps of the Fenland and of recent aerial photography of the same region. This exhibition, which will be open until February 12, directs attention to the activities of the organising body, the Fenland Research Committee, which was founded under the presidency of Prof. A. C. Seward in 1932, for promoting the intensive investigation of the complex history of the Fenland basin. The members represent the interests of archaeological, botanical, geological and historical science, co-operating closely in attacking the very complex problems of the developmental history of the Fenland basin. Co-ordinated excavations have already been made and a number of publications have appeared. One extremely important side of the work of the Committee is the aerial photography of the entire region. This reveals on the silt area of the fens beside the Wash a hitherto unsuspected density of remains of the Romano-British occupation and of later times. Field systems, dwellings, river-beds, droves and creeks are visible in great profusion and clarity, and the examination, interpretation and mapping of these remains will be a major activity of the Committee for some time to come. The preparation of suitable field maps for use in this task is a heavy charge on the Committee and the exhibition is intended to stimulate public assistance to the provision of part or all of the sum of £500 required.

Beam Wireless Communication with China

ON February 3 a new Marconi beam wireless station was opened at Chenju, near Shanghai, to give direct radio communication with Great Britain, and it is anticipated that within the next year Shanghai will be in telephonic communication with London. This will add yet another link to the already widespread ramifications of the international radio telephone service available from London. In announcing the opening of the new station, the *Times* recalled the fact that the first wireless station in China was erected by that journal at Wei-hai-wei in 1904 in order to receive dispatches during the Russo-Japanese war from its correspondents on board a

steamer specially chartered for the purpose. The Marconi Co. later undertook the establishment of communication for the Chinese Government, and the recent extension referred to above is due to the enterprise of the Ministry of Communications. The whole of the technical material used for the Chenju station was purchased in Great Britain with funds from the British Boxer indemnity, and Chinese engineers have co-operated most effectively in the installation.

Electric Discharge Lamps

SOME interesting characteristics of the new electric discharge lamps were described and demonstrated in a lecture given before the North-West Area Section of the Illuminating Engineering Society at Manchester on January 30 by Mr. H. R. Ruff, of the Research Department of the British Thomson Houston Co., at Rugby. Mr. Ruff showed that highly-coloured wall papers are completely robbed of their colour by a form of lamp using sodium vapour, appearing as though executed only in black, white and grey. On the other hand, an electric discharge lamp using mercury vapour was shown to contain strong yellow, green and blue elements—with the result that coloured papers show up quite well by this light. Numerous installations of these lamps are being made in streets throughout Great Britain, and they are also proving to have interesting possibilities for use in factories. A certain amount of care is, however, necessary when applying them to processes with revolving machinery, owing to the formation of stroboscopic effects, by which wheels appear to be turning in a contrary direction. These lamps provide about 16,000 lumens for a consumption of 400 watts and can be adapted to ordinary supply circuits using either alternating or direct currents, although the former is more convenient. The efficiency is $2\frac{1}{2}$ -3 times that of a filament lamp. A new form of vacuum lamp containing mercury which emits a moderate amount of ultra-violet light and is thus useful from the hygienic point of view was also shown.

Constitution of the Upper Atmosphere

PRESENT conceptions of the physical and chemical constitution of the upper atmosphere were summarised in a most entertaining way by Dr. G. C. Simpson in the twenty-fourth Bedson lecture delivered at Armstrong College, Newcastle-upon-Tyne, on February 2. Dr. Simpson dealt first with the thickness of the troposphere over the earth's surface, and the temperature distribution within it, and throughout the stratosphere, including the discoveries of Lindemann and Dobson since 1920 from observations of meteors, also ozone concentration and distribution relative to (surface) atmospheric pressure. The evidence of sound wave and wireless wave reflections was then reviewed, and finally the evidence from auroral observations on the influence of sunlight, and on the composition of the atmosphere. Clouds in the stratosphere, and the dissociation of oxygen and nitrogen molecules at 100 km. and above were

all touched upon. Throughout his lecture, Dr. Simpson stressed the uncertainty of prophecy in these matters, but his exception of weather forecasting caused amusement. Most of the learned societies of the district were represented in the audience, which was highly appreciative of the visit.

Neon Signs

THE discharge tubes used for advertising are a development of the old Geissler and Crookes tubes in which various beautiful effects were produced when evacuated tubes filled with certain gases were excited by an induction coil. In the January Engineering Supplement to the *Siemens Magazine*, there is an interesting article on the construction and the physical theory of commercial discharge tubes by E. A. Beavis. Forty years ago, the gases used were mostly nitrogen and carbon dioxide, and these required continual replenishing. It was only when the rare gases, argon, neon, helium, etc., were experimented with that it was found possible to obtain a reasonably permanent luminous discharge. These gases are not subject to absorption to anything like the same extent as the commoner gases. Neon at a suitable pressure gives more visible light and has a lower electrical resistance than the other permanent gases and hence a greater length of tubing can be operated for a given voltage. Neon has a cheerful red glow, argon gives a faint lavender colour and has little luminosity, and helium has a whitish glow. Combinations of various gases and vapours with neon and the use of coloured glass tubes have enabled many striking and pleasing coloured effects to be obtained. The positive column extending to the anode forms the main region of luminosity in the tube. By mixing traces of impurity in the gas, it is possible to obtain narrow cords of light which move within the tube and give rise to the type of discharge known as the 'ripple neon'. Sometimes also the column of light splits up into rows of coloured discs which often rotate round the axis of the tube. These effects are known as 'striations'. Alternating current is used for operating commercial tubes. As the voltage absorbed under running conditions is about 200 volts per foot of tube, it is usually divided up into a number of sections each supplied by a separate transformer.

Banting Research Foundation, Toronto

THIS foundation arose out of the desire to commemorate the discovery of the active principle of the islets of the pancreas by Dr. F. G. Banting in 1921-22, and has received wide financial support in Canada. It has now been in active operation for six and a half years, though in the first two years the full capital sum was not available and the number of grants made were few. The capital sum now amounts to about 700,000 dollars and the number of individual grantees has steadily increased. The total number of grants made during the period is 92. These have been distributed to 63 workers in the following universities: Alberta 4, Saskatchewan 2, Dalhousie 8, Queen's 2, Western Ontario 2, Manitoba 16, McGill 26, Toronto 30 and 2 non-university.

Some fifty papers have already appeared in scientific publications, while a further fifteen are in press or ready for publication. Several pieces of work are not as yet complete. In accordance with its charter, the Foundation also aids in the support of the Department of Medical Research, University of Toronto (Dr. F. G. Banting) and from this source numerous papers on silicosis, the action of vitamins and other topics have appeared. During the past year twenty workers received grants from the fund. The Foundation, which is the only one in Canada giving support to medical research, has proved a valuable aid and stimulus to such research in that country. The world economic depression has increased the demands upon the Foundation, the trustees of which would welcome a larger revenue. Correspondence should be addressed to the Banting Research Foundation, Toronto, Canada.

Reptile Skins in Commerce

A FEW years ago the use of the skins of reptiles in the manufacture of shoes was regarded as a whim of the moment, but now the view is strongly held by the leather trade and by technical experts in the industry that the skins are established as a raw material for leather production on as permanent a basis as goat, calf and sheep skins. This is the view expressed by the sub-committee appointed by the Imperial Institute Advisory Committee on Hides and Skins (*Bull. Imp. Inst.*, 31, No. 2, 160; 1933). The change in outlook has taken place since 1926, when reptile skins were employed only in the making of luxury articles; now they are used for the mass-production types of shoes, as well as for bag and fancy leathers. Some of the advantages of reptile leather are that it is hard-wearing, stronger than sheep, goat or even calf skins; it shows great variety of pattern and design; and it takes colour readily. But the demand has been telling upon reptile populations in various tropical countries. In 1932, India exported 2½ million reptile skins; in 1931, more than two million came from the Dutch East Indies; and serious depletion has occurred in the stock of the North American alligator, the edible terrapins of the United States, and the green turtle, the last being valued as food. An exhibition of reptile skins and their products will be opened at the Imperial Institute on February 12 at noon by Lieut.-Col. J. Colville, Parliamentary Secretary to the Department of Overseas Trade.

Eton College Natural History Society

IT is encouraging to find that in the public schools of Great Britain there is no sign of declining interest in field studies. The expeditions held on holidays and half-holidays by the Eton College Society are excellent as introductions to natural history, and may lead to the more individual interest which is revealed in the lists of records, of lectures, and of museum preparations mentioned in the annual report for 1932-33. The report is enlivened by photographs taken by the members, and a list of Lepidoptera from the Eton district, by Brigadier-General B. H. Cooke, should be useful as a check-list for youthful collectors.

Destructive Earthquakes in 1933

SCIENCE SERVICE, Washington, D.C. (Mail Report, December 28, 1933) has issued a list of 39 earthquakes in 1933 that were strong enough to be recorded by distant seismographs. Of these, only five caused the loss of many lives. The most destructive was the Sanriku (Japan) earthquake of March 3, by which 1,560 persons were killed in addition to 956 others missing. The Long Beach (California) earthquake of March 10 was responsible for the loss of about 120 lives, the Kos earthquake of April 23 for about 100, the West Sumatra earthquake of June 24 for about 70, and the Chinese earthquake of August 25 for about 100. The Baffin's Bay 'earthquake' of November 20 would no doubt have added to the number had it not occurred in an uninhabited region. The total number of persons killed by earthquakes in 1933 is thus less than 3,000, or less than one-half the number killed on the roads in Great Britain, and much less than the average number (about 14,000) killed by earthquakes every year (NATURE, 126, 214; 1930).

Early Students' Laboratories

WHEN Lord Kelvin opened the laboratories of University College, Bangor, in 1885, he gave an address on scientific laboratories which was printed in NATURE of March 5, 1885, p. 409. He stated that the physical laboratory he started in an old wine cellar in the University of Glasgow on his appointment as professor of natural philosophy in 1845 was the first one intended for students' practical work, and that the first chemical laboratory for a similar purpose was that of Prof. von Liebig at Giessen, founded "not many years after 1831". In the November issue of the *Review of Scientific Instruments*, Prof. P. C. Ricketts brings forward evidence that both physical and chemical laboratories for the regular use of students were provided at Rensselaer by Amos Eaton when he became professor of chemistry and experimental philosophy there in 1824, and that "the instruction was extremely systematic and continuous".

Microscopes and their Accessories

WE have received from Messrs. W. Watson and Sons, Ltd., 313 High Holborn, London, W.C.1, a copy of the new edition of their microscope catalogue. A number of microscope stands of varying complexity are listed, and ranging in price from £4 to £100, together with ranges of objectives, eye-pieces, sub-stage fittings, etc. Several pages are devoted to a description of the principles of construction adopted by Messrs. Watson. The limb, carrying the body at one end and the sub-stage at the other, is machined from a solid casting, ensuring basic alignment throughout, and that the stage bracket is truly at right-angles to the body and sub-stage. Similarly, the tube, rib and objective fitting are machined from a solid metal billet, instead of being in three pieces as formerly, so that the risk of separation of parts is abolished, and enduring parallelism between the mechanical and optical axes is ensured. Water

immersion objectives, a new low-power binocular, and new dark-ground condensers also find a place in the catalogue.

Plan for Exploring Soviet Far North in 1934

AT a recent session of the Scientific Council of the All-Union Arctic Institute, plans were adopted for expeditions to the far north during this year. The plans include extensive exploration of the great northern sea route. The *Moscow Daily News* reports that particular attention is to be paid to the little-known Laptev and Eastern Siberian seas. Geological expeditions will aim at creating a fuel base for ships navigating the great northern sea route and at discovering ores of non-ferrous and rare metals. Their attention will therefore be concentrated on Novaya Zemlya, the eastern part of the Chukotsk peninsula and Northern Land, where indications of oil, coal and ores have been found. Geodetic expeditions with an aeroplane at their disposal will carry out preparatory work for compiling the first 1:1,000,000 map of the Soviet Arctic, to be published in 1937. Five new permanent research stations will be added to the existing twenty, and a new laboratory for the study of magnetic phenomena will be erected near the estuary of the Kolyma. Attention is to be paid to the study of reindeer and polar dog breeding. Special breeding farms are to be organised in order to facilitate communication between the stations along the northern sea route.

Pumps at the Science Museum

THE plan now being followed at the Science Museum, South Kensington, is to publish handbooks of two kinds; one containing historical notes, and the other containing details of the exhibits. Some time ago we directed attention to the new volume of "Historical Notes on Pumping Machinery" and we now have pleasure in referring to the new "Descriptive Catalogue". Like the former, this has been prepared by Mr. G. F. Westcott. The notes placed alongside the exhibits in the Science Museum have long been known for their fullness and their accuracy, and the "Descriptive Catalogue" contains more than five hundred of these notes together with many excellent illustrations. The pumping machinery collections are divided into about twenty groups and the exhibits range from the most primitive baling appliances to large turbo-blowers and the mercury vapour vacuum pumps of Gaede and Langmuir. The price of the new volume is 3s. 6d., so that for 6s. the reader can obtain both handbooks, which together contain more precise information on pumps of all kinds than can, we believe, be found in any other publication. The compiling of such catalogues involves a very great amount of research and Mr. Westcott is to be congratulated in having brought his task to a successful conclusion.

Medals of the Institution of Chemical Engineers

AT the twelfth annual corporate meeting of the Institution of Chemical Engineers on February 16, presentation will be made of the Moulton medal, the

Junior Moulton medal and prize of books, and the Osborne Reynolds medal, all of which were instituted in 1929. The Moulton medal, which commemorates the chemical engineering work of the late Lord Moulton at the Department of Explosives Supply, is awarded for the best paper of each year presented before the Institution. Papers by non-members of the Institution are eligible for this medal. For 1933 the award is made for the following papers: "The Mechanical Properties of some Austenitic Stainless Steels at Low Temperatures", by Messrs. E. W. Colbeck, W. E. MacGillivray and W. R. D. Manning; and "The Mechanical Properties of Metals at Low Temperatures. (2)—Non-Ferrous Materials", by Messrs. E. W. Colbeck and W. E. MacGillivray. The Junior Moulton medal is given for the best paper of the year read before the Graduates and Students Section of the Institution. Only papers by graduates and students of the Institution are considered for this medal and prize. For 1933 the award is made for the paper: "The Solvent Extraction of Sulphur from Sicilian Ores", by Dr. E. H. T. Hoblyn. The Osborne Reynolds medal commemorates the fundamental investigations of the late Prof. Osborne Reynolds, and is awarded for meritorious service for the advancement of the Institution. For 1933 the award is made to Mr. H. W. Cremer. Mr. Cremer acted as honorary secretary of the Institution during the illness of the late Prof. J. W. Hinchley in 1931, and was appointed to succeed Prof. Hinchley in that office on the latter's death.

Announcements

H.R.H. THE PRINCE OF WALES has consented to become patron of the London School of Hygiene and Tropical Medicine, with which is incorporated the Ross Institute.

THE Catherine Wolfe Bruce gold medal of the Astronomical Society of the Pacific for the year 1934 has been awarded to Prof. Alfred Fowler, Yarrow research professor of the Royal Society and professor of astrophysics in the University of London (Imperial College of Science), for his distinguished service in the field of astronomy.

THE council of the Institution of Electrical Engineers has made the twelfth award of the Faraday medal to Sir Frank E. Smith, secretary of the Department of Scientific and Industrial Research. The Faraday medal is awarded either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution. Dr. R. Thury, of Geneva, has been elected an honorary member of the Institution.

MR. C. S. WRIGHT, superintendent of the Admiralty Research Laboratory at Teddington, has been appointed as from July 8 to be director of scientific research, Admiralty, in succession to Dr. C. V. Drysdale.

PROF. HANS FISCHER, professor of organic chemistry and *Privatdozent* in plant physiology in the Bavarian Technical High-school, Munich, will deliver the fourth Pedler lecture before the Chemical Society on Thursday, February 22, at 8 p.m., in the lecture theatre of the Royal Institution. The title of Prof. Fischer's lecture will be "Chlorophyll". Admission to the lecture will be free without ticket.

A CONFERENCE on "Problems of Potato Growing" will be held at the Rothamsted Experimental Station, on Tuesday, February 20, at 11.30 a.m. The chair will be taken by Capt. J. Mollett, chairman of the Potato Marketing Board. Papers on problems in potato cultivation will be read by Drs. G. H. Pethybridge, R. T. Leiper, H. E. Woodman, E. M. Crowther, and Mr. H. V. Garner. Further information can be obtained from the Secretary, Rothamsted Experimental Station, Harpenden.

WITH the issue on January 5, the *Deutsche Medizinische Wochenschrift* entered the sixtieth year of its existence. It contains several important articles, notably one on rheumatic diseases by Prof. Aschoff, and another by Prof. Heine on inflammatory conditions of the iris, with an excellent coloured plate.

A VOLUME of "Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge during the Academical Year 1932-1933" (Cambridge University Press, 1933) has been issued, the summaries having been approved by the examiners or by the student's supervisor. By this means, the nature of research work which might otherwise be overlooked for a time is made easily accessible, and copies of the dissertations can be consulted if desired in the University Library or at the University Registry.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An agricultural chemist at the Imperial Institute of Agricultural Research, Pusa—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (Feb. 12). A curator of the Wakefield Museum and Art Gallery—The Town Clerk, Town Hall, Wakefield (Feb. 17). A borough engineer to the Metropolitan Borough of Hackney—The Town Clerk, Town Hall, Hackney, E.8 (Feb. 17). An inspector in connexion with agricultural and horticultural education and research—The Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, S.W.1 (Feb. 26). A temporary veterinary officer to the Lancashire County Council—The Clerk of the County Council, County Offices, Preston (Feb. 28). A bacteriologist and clinical pathologist at Queen's Hospital, Birmingham—The House Governor (March 5). A City bacteriologist to the City Council and professor of bacteriology in the University of Liverpool (joint appointment)—The Registrar, The University, Liverpool (April 14). An assistant in the Museum at the Royal Botanic Garden, Edinburgh—The Regius Keeper.

Letters to the Editor

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Mass Excretion of Oestrogenic Hormone in the Urine of the Stallion

In earlier investigations¹ it was shown that the largest quantities of oestrogenic hormone (folliculin—s. oestrin) are excreted in the urine of pregnant mares (100,000 mouse units per litre). I found this also to be the case in other equines (ass, zebra) during pregnancy, whereas, in the non-pregnant state, the excretion of hormone both in equines and in other mammals is very small, at most 0.5 per cent in comparison with that of the gravid animal. Curiously enough, as a result of further investigations, it appears that in the urine of the stallion also, very large quantities of oestrogenic hormone are eliminated. (The first determinations indicating the high content of oestrogenic hormone in the urine of the stallion were made by Dr. E. P. Häussler in the scientific laboratory of Hoffmann-La-Roche in Basle.) According to my analyses, the amount of hormone varies between 10,000 and 400,000 m.u. per litre of urine; the differences appear to have some relation to the origin of the animals. 37 litres of urine obtained from four stallions were rendered acid to congo-red by the addition of mineral acid, boiled for five minutes and subjected to exhaustive extraction with benzol. In this way I found a hormonal content of 170,000 m.u. per litre, which can very well be regarded as an average value. The stallion therefore excretes 1,700,000 m.u. of oestrogenic hormone per diem.

These quantities of oestrogenic sex hormone in the urine of a male animal are particularly high when compared with other values as shown in the accompanying table:—

	Per litre (m.u.)	Per diem (m.u.)
Stallion	170,000	1,700,000
Mare	200	2,000
Pregnant mare ..	100,000	1,000,000
Sexually mature woman	30-200	45-300
Pregnant woman ..	10,000	15,000

On the basis of my earlier experiments, the urine of pregnant mares is now generally employed as the standard material for the preparation of oestrogenic hormone. The urine of the stallion, which is always procurable, will now also be available as a standard material for the oestrogenic hormone. A stallion produces 62 gm. of hormone in a year.

I found this mass excretion of hormone only in the male and not in the female horse. The determination of the hormone content, therefore, makes hormonal recognition of sex possible in the urine of a horse. In this connexion we find the paradox that the male sex is recognised by a high oestrogenic hormone content. If on examination, only 1 m.u. or even less hormone is found in 1 c.c. of horse's urine, the feminine sex may, as a result, be recognised. If 10 or more m.u. of oestrogenic hormone per c.c. of horse's urine are found, the masculine sex may be deduced.

In the urine of the castrated horse (gelding), I discovered only very small quantities of hormone,

less than 0.3 per cent of the amount in the urine of the stallion. Similarly the young, sexually immature stallion (colt) excretes only very small quantities of hormone (about 0.2-0.5 per cent). These results appear to me to show that the testes of the horse must be held responsible for the production of the large quantities of hormone. By means of acetone-alcohol extraction I was able to demonstrate the presence of 23,100 m.u. in the two testes of a stallion, together weighing 350 gm. *These values show that the testis of the horse is the richest tissue known containing oestrogenic hormone.* According to my analyses, the hormonal content of both testes of the stallion is more than 500 times as great as that of both ovaries of a sexually mature woman and about 300 times as great as that of both ovaries of a sexually mature mare. The two testes of the horse, together weighing 350 gm., contain four to five times as much hormone as a human or horse's placenta weighing 500 gm. In contradistinction to the testis, the epididymis of the stallion contains no hormone (less than 10 m.u. in an epididymis weighing 5.4 gm.). In the faeces of the stallion I found quantities varying from 1,000 to 10,000 m.u. per kgm. The blood contains less than 800 m.u. per litre.

The mass excretion of oestrogenic hormone in the urine of a male animal is, according to the experiments I have so far carried out, a peculiarity of the equines. Thus, I found for the male zebra, 36,000 m.u., the Gravy zebra, 40,000 m.u., the ass (stallion), 3,300 m.u., and the kiang (Asiatic wild ass), 3,300 m.u. per litre of urine; whereas for the bull and the dromedary (stallion) less than 330 m.u. per litre of urine were found.

Similarly the high hormone content of the testes is to be found only among the Equidae. In the two testes of a bull, together weighing 420 gm., less than 21 m.u. were found, that is, less than 0.09 per cent compared with horse's testes (horse's testes, 66,000 m.u. per kgm., bull's testes, less than 50 m.u. per kgm.).

It should be pointed out that the male sex hormone—as tested by the comb of a cock—is not excreted in increased quantities in the urine of the stallion. Gonadotropic hormone, prolan, and corpus luteum hormone are not excreted at all.

As is well known, oestrogenic hormone is readily soluble in all organic solvents. If human urine is shaken up with any solvent not miscible with water (ether, benzol), most of the hormone passes into the solvent. On the other hand, as I have already shown², the hormone in the urine of the pregnant mare cannot thus be extracted with these solvents. If, however, the urine is first made acid (to congo-red) with mineral acid and boiled for 5 minutes, then the hormone can be extracted with ether or benzol. As regards stallion's urine, I made the following observations:— If the untreated urine be shaken up with ether or benzol, hormone can be extracted, but only from 5 to at most 25 per cent is taken up by the ether. The main quantity of hormone can only be extracted if it is acidified and boiled for several minutes before extraction with ether or benzol. The hormone can be almost completely extracted from testicular tissue simply by treatment with ether or benzol. The alteration in solubility of the hormone described occurs, therefore, in the animal outside the testes.

The oestrogenic hormone which is excreted in the urine of the stallion shows so far exactly the same biological properties as are known in the case of the female sex hormone (follicular hormone, folliculin, oestrin). For example, growth of uterine muscle and

proliferation of the uterine mucosa are enormously stimulated by even small quantities of stallion's urine. After five daily injections each of 0.5 c.c. of stallion's urine, the weight of the uterus of a young rabbit weighing 1200 gm. rose from 0.47 gm. to 1.8 gm. On introducing larger quantities of urine (twelve daily injections each of 3 c.c. of stallion's urine) the weight of the uterus rose from 0.47 gm. to 5.48 gm. and the weight of the vagina from 0.15 gm. to 2.48 gm. The uterine musculature showed a great increase in muscle cells (hyperplasia), but especially great was the proliferation or what might be more correctly termed the hyperproliferation of the uterine and vaginal mucous membranes. After the injection of stallion's urine there was a retardation of testicular growth in the infantile male rat (antimasculine reaction).

In such chemical properties as have hitherto been observed, the oestrogenic hormone in stallion's urine corresponds with follicular hormone, in which connexion attention is invited to its solubility described above. We are now occupied with the exact characterisation of the hormone.

The details of the investigations and the importance of the reported findings in relation to the biology of the sex hormones will be discussed in a comprehensive publication.

I take this opportunity of expressing my best thanks to Sir Peter Chalmers Mitchell for the gift of material and to Dr. Bernard Homa, of London, for the translation.

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Jan. 10.

¹ *Klin. Wochenschr.*, No. 49, 2285; 1930.
² "Die Hormone des Ovariums und des Hypophysenvorderlappens" (The Hormones of the Ovary and of the Anterior Pituitary Lobe). Springer, 1930, pp. 85 and 90.

A Source of Error in Photometry

In the course of spectroscopic work in this Institute, a source of error in photographic microphotometry has been discussed, which under certain conditions, especially in the case of band spectra, may be rather serious. It is well known that the use of a wide photometer slit causes an error in the determination of the maximum blackening of a spectral line on the plate, the line appearing broader and less intense in the centre than by correct measurement with a narrow slit. It is, however, easily overlooked that an error arises also in the integral intensity of the line, and since the matter, so far as we know, has not been dealt with in the photometric literature, it may be of interest to publish some calculations of the error under various conditions.

For the sake of simplicity, we will assume that the blackening on the plate and the intensity of light are proportional, so that their integrals are equivalent. For the distribution of intensity in the spectral line we choose the Gaussian function $i = i_0 e^{-k^2(\nu - \nu_0)^2}$ (i = intensity, ν = frequency, k = constant). The blackening S is as usual defined by $S = \log J_0/J$.

The curve S in Fig. 1 represents the actual blackening on the plate, the curve J in Fig. 2 is the photometer curve of the line when using an infinitely narrow slit. Using a slit of the width d means taking the mean J' of the function J in the interval $\nu \pm d/2$. It is easily seen that the integrals of the curves J and J' in Fig. 2 are equal, that is, the area a is equal to the sum of the areas b . But when we calculate the blackening S' from the formula $S' = \log J'/J_0$, the

area a will have a greater weight than the areas b , so that the area A in Fig. 1 becomes larger than the sum of the areas B . The integral of S' will always be smaller than that of S .

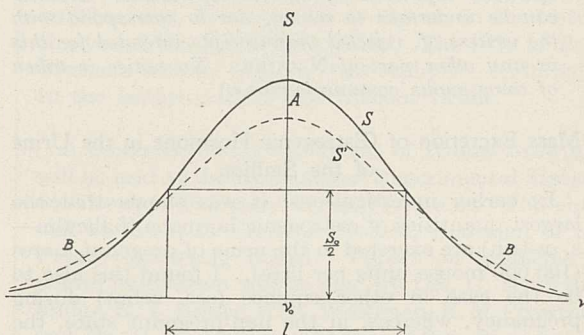


FIG. 1.

There are two factors which, under the chosen conditions, influence the magnitude of the error, namely, the maximum blackening S_0 and the ratio

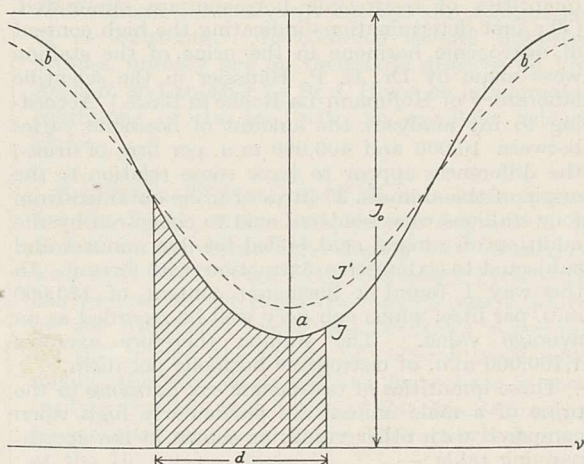


FIG. 2.

$p = d/l$ (l is defined in Fig. 1). In the table given below, the error $\int_{-\infty}^{+\infty} (S - S') d\nu$ is given as a percentage of $\int_{-\infty}^{+\infty} S d\nu$ for different values of S_0 and p . Since the mathematical treatment of the problem leads to insoluble integrals, the values of the error have been obtained by a graphical method and are, therefore, not very accurate.

$S_0 \backslash P$	0.364	0.455	0.909
0.155	0.24	0.41	1.9
0.398	1.1	1.7	5.2
0.699	1.6	2.5	8.6

The tabulated values of the error may be very roughly taken together in the formula $\Delta = 16.S_0.p^2$, though Δ is of course in reality a much more complicated function of both S_0 and p .

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Radiative Collisions of Neutrons and Protons

It has recently been shown by Lea¹ that the passage of neutrons through paraffin wax and through liquid hydrogen gives rise to a gamma radiation of $1-6 \times 10^8$ e. volts energy, as well as recoil protons. As pointed out by Lea and Chadwick, the energy of these rays corresponds roughly to that which would be emitted in the radiative combination of a neutron and a proton to form a diplon. We have therefore calculated the probability of such a radiative collision on the assumption that the neutron behaves as a fundamental charge-free particle throughout the collision, so that the radiation arises only from the acceleration of the proton by the field of force of the neutron. A dipole moment may then be associated with the system and the calculation carried out in the usual manner². The result is that, for the range of energies involved in the experiments, combination should not take place more frequently than once in every 1000 collisions (the effective radius for diplon formation is about 2×10^{-14} cm.). This is much smaller than the observed frequency of about 1 in 4 collisions. We have also calculated the probability of a proton radiating in the impact without binding taking place, and find it to be even smaller. These results do not depend appreciably on the form of interaction assumed between neutron and proton.

It is of interest to note that if we assume that the neutron is a complex particle consisting of a proton and an electron, and that there are exchange forces between the neutron and proton of the type suggested by Heisenberg³, then we obtain a much smaller probability of combination (of the order of one effective collision in 10^6), for with this model the dipole moment of the neutron-proton system vanishes⁴. In view of the discrepancy between theory and observation, and also in view of the different efficiencies to be expected for the process according as the neutron is or is not a fundamental particle, it is clearly important to obtain additional information about the nature of the neutron-proton collision.

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¹ NATURE, 133, 24, Jan. 6, 1934.

² Mott and Massey, "The Theory of Atomic Collisions", p. 229.

³ Z. Phys., 77, 1; 1932.

⁴ Mott and Taylor, Proc. Roy. Soc., A, 138, 665; 1932.

Remarkable Optical Properties of the Alkali Metals

In a recent communication, Zener¹ has given an interesting interpretation of the peculiar optical properties of the alkali metals discovered by Wood², differing from that which I previously suggested in these columns³. A closer consideration of the problem has led me to the conviction that the viewpoint of Zener, although not fully accounting for all the observed facts in its original form, can serve as a suitable basis for the discussion of the phenomena in question if modified in the following way:

Zener starts from the assumption that the conduction electrons of the alkali metals are practically free. In the absence of temperature agitation of the lattice, they will then have only the one sharp resonance frequency, $\nu = 0$, and no resonance frequencies corresponding to quantum jumps from

the occupied to the unoccupied stationary states. As stated by Zener, the dielectric constant of the metal at frequency ν is in this case given by

$$\epsilon = 1 - \frac{Ne^2}{\pi m \nu^2},$$

where N is the number of conduction electrons per unit volume, e the electronic charge and m the electronic mass. The electrical conductivity σ , giving the current in phase with the electric vector of the radiation, on the other hand, is zero for all frequencies except for $\nu = 0$, where it becomes infinite. The metal will hence be totally reflecting, even at perpendicular incidence, for all frequencies for which $\epsilon < 0$, that is, below the frequency ν_0 given by

$$\nu_0^2 = \frac{Ne^2}{\pi m}. \quad (1)$$

Zener tries to account for the results of Wood, according to whom the transparency of thin films of the alkali metals, in going towards shorter wavelengths, becomes greater by a factor of the order 100,000 within a rather narrow frequency interval in the ultra-violet, by means of this phenomenon of total reflection, finding from (1) values of ν_0 which agree rather well with Wood's experimental data. The difficulty with this interpretation is that actually the alkali metals are by no means totally reflecting in the visible region, the coefficient of reflection in the case of potassium⁴, for which the high transparency begins at about 3000 Å., decreasing from about 90 per cent at 5000 Å. to about 10 per cent at 2500 Å. Wood's results must therefore with certainty be ascribed to a change in the coefficient of extinction rather than to a change in the reflecting power.

Now such a change in the extinction coefficient can be obtained on the same fundamental assumptions as introduced by Zener, if it be remembered that the resonance frequency $\nu = 0$ is not infinitely sharp but suffers a broadening due to the impacts of the conduction electrons with the metallic lattice, which the temperature agitation of the latter brings about. Specialising formulae which I have given elsewhere⁵ for the case of free electrons, the half breadth δ of the resonance line $\nu = 0$ is found to be

$$\delta = \frac{Ne^2}{2\pi m \sigma_0}, \quad (2)$$

where σ_0 is the electrical conductivity for constant fields, while σ and ϵ are given by

$$\sigma = \frac{\sigma_0 \delta^2}{\nu^2 + \delta^2}, \quad \epsilon = 1 - \frac{2\sigma_0 \delta}{\nu^2 + \delta^2}.$$

The index of refraction n and the coefficient of extinction κ are found from σ and ϵ by means of the relations⁶

$$n^2 = \frac{1}{2} (\sqrt{\epsilon^2 + 4\sigma^2/\nu^2} + \epsilon),$$

$$\kappa^2 = \frac{1}{2} (\sqrt{\epsilon^2 + 4\sigma^2/\nu^2} - \epsilon).$$

In the table at the end of this letter I have computed the values of σ , ϵ , n and κ for potassium in the interesting region of wave-lengths, using $\sigma_0 = 1.35 \times 10^{17}$, which leads to $\delta = 4.11 \times 10^{12}$ according to (2). As may readily be seen, there exists a critical frequency below which n is abnormally small, while above it κ practically vanishes; the critical frequency with great approximation is equal to ν_0 as given by (1).

The vanishing of κ above ν_0 explains Wood's results. Below ν_0 , the values of n and κ may be compared with a few direct experimental determinations. In the case of potassium⁷, for wave-lengths 6650 Å., 5890 Å., 4720 Å., n has the values 0.066, 0.068, 0.070, κ the values 1.77, 1.50, 1.00. The values of κ agree fairly well with the computed values, the values of n are indeed exceptionally small but still larger than the computed values by a factor 10. The discrepancies must evidently be ascribed to the fact that the electrons are not completely free as assumed. If the electronic transitions, made possible by the binding, cause σ to be about 10 times as large as in the accompanying table, values of n agreeing more closely with experiment will be obtained, while the general behaviour of n and κ discussed above is not obliterated as in the case of other metals having a σ about 1000 times as large (for example, silver⁸).

$\nu \times 10^{-14}$	λ (Å.)	$\sigma \times 10^{-12}$	ϵ	n	κ
4	7500	14.3	- 5.94	0.0147	2.44
5	6000	9.13	- 3.43	0.0099	1.85
6	5000	6.34	- 2.08	0.0074	1.44
7	4286	4.66	- 1.26	0.0059	1.12
8	3750	3.57	- 0.793	0.0052	0.855
9	3333	2.82	- 0.370	0.0051	0.608
10	3000	2.28	- 0.107	0.0070	0.326
11	2727	1.88	+ 0.087	0.294	0.0058
12	2500	1.58	+ 0.233	0.483	0.0027
13	2308	1.35	+ 0.345	0.597	0.0017

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¹ C. Zener, *NATURE*, **132**, 968, Dec. 23, 1933.

² R. W. Wood, *NATURE*, **131**, 582, April 22, 1933. *Phys. Rev.*, **44**, 353; 1933.

³ R. de L. Kronig, *NATURE*, **132**, 601, Oct. 14, 1933.

⁴ "Int. Crit. Tables", **5**, 253.

⁵ R. de L. Kronig, *Proc. Roy. Soc., A*, **133**, 255; 1931. See eqs. (6), (9) and (10).

⁶ R. de L. Kronig, *Proc. Roy. Soc., A*, **124**, 409; 1929. See eqs. (6) and (7).

⁷ "Int. Crit. Tables", **5**, 249.

⁸ R. de L. Kronig, *Proc. Roy. Soc., A*, **124**, 409; 1929. See fig. 2.

Diffusion of Water in a Zeolite Crystal

It has long been known that minerals of the zeolite family show remarkable properties which indicate that certain constituents of the crystal lattice are movable. The exchangeability of cations

lattices contain wide meshes, through which a migration of matter may very well be assumed to take place¹.

I have made an attempt to study this migration quantitatively. For this purpose I have chosen an optical method, which makes a direct observation of the migration possible. The reversible dehydration and the substitution of the water of constitution with other substances bring about characteristic changes in the optical properties of the zeolites. The refractive index, the extinction angle, and the double refraction may change considerably.

When studying the rehydration in moist air of partially dehydrated crystals of heulandite between crossed nicols in the polarising microscope, Rinne, Gaubert^{2,3} and others have observed a diffuse black band, parallel to the surface, slowly migrating from the surfaces towards the interior of the crystal. The position of the black band is dependent upon the angle between the crossed nicols and the crystal axes. For any value of this angle, those parts of the crystal that have a water content corresponding to this extinction angle will appear black. No quantitative study of the phenomenon has, however, been made so far.

I have been able to confirm these observations. When using monochromatic light and strongly dehydrated crystals, I have observed as many as seven bands, the number depending upon the degree of dehydration, the thickness of the crystal, and the wave-length of the light. These bands (except that nearest the edge, which evidently is identical with the above mentioned extinction angle band) do not move when the nicols are turned and are evidently due to the change in double refraction known to accompany the dehydration. Each band corresponds to a water content with a double refraction giving a phase difference of $n\lambda$. If we know the exact relation between water content and extinction angle or double refraction, a very detailed analysis of the distribution of water in the crystal after different times of diffusion can be made, for example, by measuring the position of all the bands with an ocular screw micrometer. The extinction angle band can be used only for the highest water content, since the angle is independent of the change in water content, except for the last few per cent entering the crystal. In all other cases the double refraction bands have to be used.

Of course all quantitative measurements must be made in a vacuum. Heulandite crystals, carefully selected to secure material as optically homogeneous and free from cracks as possible, were ground to thin

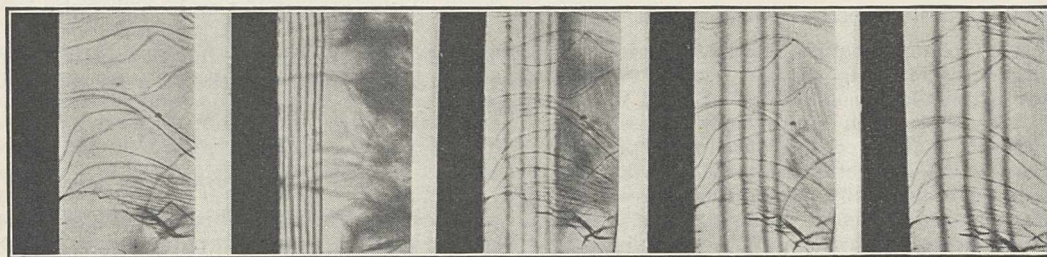


FIG. 1.

and the possibility of driving out the water of constitution and substituting it with other substances in a reversible way without spoiling the crystal can be understood only by such an assumption. X-ray structure determinations have shown that zeolite

plates parallel to the cleavage plane. Such a crystal was placed in a specially constructed vacuum micro-cuvette, which could be connected to an evacuated container with air-free water, kept at constant temperature in a thermostat. The cuvette could be heated

to any desired temperature with a small, closely fitting electric oven. The temperature of the crystal was measured with a thermocouple.

Sorption isobars of water in heulandite at different pressures and temperatures were determined with a sorption balance apparatus to be described elsewhere. By varying the temperature of the crystal and the water vapour pressure in the cuvette, the crystal could thus be given any accurately known water content, and the corresponding changes in the optical properties could be determined.

Diffusion experiments were made in this apparatus with crystals dehydrated by different amounts. When the crystal had attained equilibrium, the stopcock to the water container was opened, and water vapour of a constant, accurately known pressure was let in. Observations were made in monochromatic light from a Pirani sodium lamp. Fig. 1 shows a series of photographs from such an experiment.

The measurements show that the displacement of each band is proportional to the square root of time,

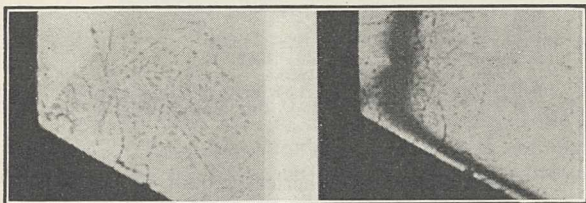


FIG. 2.

in agreement with the requirements of the general diffusion equation $\delta c/\delta t = \delta/\delta x (D \frac{\delta^2 c}{\delta x^2})$ (Boltzmann⁴). Calculation of the diffusion constant D from the observations on each band shows that there is a strong drift of D with the concentration. At 20° C. in a direction normal to the face t (Des Cloiseaux notations), the constant varies from 3.2×10^{-7} to 8.9×10^{-7} cm.² sec.⁻¹, while the concentration increases from 12.0 to 17.5 per cent. The diffusion shows a strong anisotropy, being immeasurably small normal to the cleavage plane and showing in this plane a minimum value normal to the face c (Fig. 2). The ratio between the maximum and minimum values in this plane corresponding to the 'diffusion ellipse' is 12.5.

It is planned to study the diffusion of other gases, and also to use other zeolites, in the first place some of those for which complete X-ray structure determinations have been made. Investigations of this kind bear some relationship on the well-known surface diffusion studies^{5,6}. In both cases the diffusing molecules meet vacant lattice points in their path.

A detailed report of the investigation and a discussion of the results will appear shortly.

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¹ W. H. Taylor and collaborators, *Z. Kristallog.*, **74**, 1; 1930: A, **84**, 373; 1933.

² F. Rinne, *Verhandl. Sächs. Akad. Wiss.*, **72**, 12; 1920.

³ P. Gaubert, *Bull. Soc. Franc. Mineral.*, **52**, 162; 1929.

⁴ L. Boltzmann, *Ann. Physik.*, **53**, 959; 1894.

⁵ M. Volmer, *Trans. Far. Soc.*, **23**, 359; 1932.

⁶ I. Langmuir, *Phys. Rev.*, **44**, 423; 1933.

Weiss Constant of Paramagnetic Ions in the S -State

THE influence of crystalline and molecular fields on the magnetic behaviour of paramagnetic ions has formed the subject matter of several theoretical papers by Bethe, Van Vleck and others¹. In the case of ions in the S -state (for example, Mn^{++}), the susceptibilities of which are due wholly to the spin moments of their electrons, the theory leads to the following result: the Weiss constant θ , appearing in the well-known relation $\chi = C/(T - \theta)$, is zero; that is, the susceptibilities of these ions conform to the simple Curie law of inverse dependence on absolute temperature. This result has been fully verified experimentally by Jackson² and others in the case of manganous salts in the solid state. But, for these salts in aqueous solution, in which state one would, *a fortiori*, expect this result to hold true, the experimental data at present available³ do not follow this rule; they yield large values for θ , namely, 24–28 for the ion in $MnCl_2$, and 22–27 for the ion in $Mn(NO_3)_2$.

I have therefore made some extensive measurements with aqueous solutions of these salts, of various concentrations, from room temperature to about 98° C. In all cases I find that the susceptibility of the Mn^{++} ion obeys the simple Curie law; the maximum value of θ obtained in these measurements was less than 3.

The Curie constant, C , of the Mn^{++} ion, obtained in these measurements, was 4.19 per gm. ion in $MnCl_2$ solutions, and 4.11 per gm. ion in $Mn(NO_3)_2$ solutions. These correspond to 28.8 and 28.5 Weiss magnetons respectively, as against previous values of 28.1 for solution and 29.0 for solid.

A detailed report of this work, which was carried out under the guidance of Prof. K. S. Krishnan, will be published in the *Indian Journal of Physics*.

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¹ Van Vleck, "Theory of Electric and Magnetic Susceptibilities", Chap. xi.

² *Proc. Roy. Soc., A*, **140**, 695; 1933.

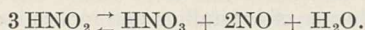
³ See "Int. Crit. Tables", **6**, p. 351. (In Table 13, the signs prefixed to the values of θ for the manganous salts should be positive.)

Photo-Oxidation of Nitrite to Nitrate

THERE is considerable difference of opinion regarding the possibility of the oxidation of nitrites by oxygen to nitrates. Berzelius reported that when aqueous solutions of alkali nitrites are boiled in air, they absorb oxygen with the formation of nitrates. G. Lunge and E. Frémy, J. Lang¹ and others showed that aqueous solutions of nitrites pass into nitrates. According to R. Abegg and H. Pick², oxygen of the air oxidises a solution of silver nitrite to silver nitrate. On the other hand, E. Divers³, Sir P. C. Rây⁴, C. Russworm⁵, M. Oswald⁶, and others observed no oxidation of solutions of nitrites in air. C. Matignon and G. Marchal⁷ reported that an aqueous solution of sodium nitrite is not oxidised by prolonged contact with oxygen, under a pressure of 50–55 atmospheres, even in the presence of a catalyst. But when the pressure is raised to 175 atmospheres and temperature to 395°–530°, solid sodium nitrite is almost completely oxidised to nitrate.

The formation of nitrates from nitrites in acidic solution is easily explained from the point of view that

the solution of nitrous acid undergoes the following change :

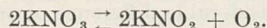


In presence of air, the nitrous acid may be completely converted into nitric acid. This seems to be the explanation of the observation of A. Müntz⁸ regarding the conversion of nitrites to nitrates in soil, in presence of carbonic acid and air. Dhar⁹ and collaborators have shown that solutions of sodium nitrite can be appreciably oxidised to sodium nitrate by passing air in presence of inductors like ferrous hydroxide, sodium sulphite, etc., and the amount of oxidation increases with the increasing concentrations of the inductor and the nitrite solution and with the time for which air is passed. W. P. Jorissen and C. van den Pol¹⁰ and W. Reinders and S. I. Vles¹¹ could not detect any oxidation of sodium nitrite by oxygen in presence of sodium sulphite because they did not take sufficient sodium sulphite and the contact with oxygen was not long enough.

Recently we have observed that dilute solutions of sodium nitrite or potassium nitrite, when exposed to sunlight and air, are oxidised to nitrate. The velocity of the photochemical oxidation is greatly accelerated by the presence of titanium, zinc and iron oxides (TiO_2 , ZnO and Fe_2O_3). Titanium oxide seems to be the best photosensitiser. The following are some of the results obtained by us :

Concentration of nitrite	Volume exposed	Sodium Nitrite			
		Time of exposure	Catalyst	Per cent nitrite unchanged	Amount of nitrogen obtained after exposure
N/525	100 c.c. \equiv 0.00132 gm. nitrogen	100 hours	5 gm. TiO_2	0	0.00126
"	"	"	5 gm. Fe_2O_3	0	0.00126
		Potassium Nitrite			
N/112.4	100 c.c. \equiv 0.00620 gm. nitrogen	100 hours	5 gm. Fe_2O_3	0	0.00618

Warburg¹² and Villars¹³ studied the photodecomposition of solutions of potassium nitrate in ultra-violet light. Dhar and Sanyal¹⁴ observed the slow decomposition of nitrates in sunlight. The photodecomposition of potassium nitrate is a slow reaction and has a low quantum yield in ultra-violet light and tropical sunlight. It seems, therefore, that in presence of light, the following equilibrium is obtained :



It appears that in dilute solutions and in presence of an excess of oxygen, practically the whole of the nitrite is oxidised to nitrate in light. From the foregoing observations it seems clear why discordant results regarding the oxidation of nitrites to nitrates by different workers were obtained. Experiments done in laboratories having more diffused light probably resulted in greater oxidation of the nitrite.

In publications from this Laboratory¹⁵, it has been shown that amino acids can be readily oxidised to ammonia in presence of air and light. Also, ammonia and its salts are oxidised to nitrites in presence of surfaces like titanium and zinc oxides, sterilised soil, etc., in the complete absence of bacteria, when exposed to air and sunlight. We have now observed that nitrites can also be oxidised photochemically to nitrates in the absence of bacteria. It appears, therefore, that the important processes of ammonification, nitrification and the conversion of

nitrite to nitrate taking place in soil, which have been ascribed so far solely to bacterial activity, can be induced in presence of sunlight. Hence we are of the opinion that these processes can be photochemical rather than bacterial, specially in tropical countries where the number of bacteria is small, being mostly killed by the high temperature of the soil during the summer months.

N. R. DHAR.

S. P. TANDON.

N. N. BISWAS.

A. K. BHATEACHARYA.

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India.
Dec. 7.

¹ Compare Mellor, "Inorganic and Theoretical Chemistry", vol. 8, 459, 477.

² *Z. anorg. Chem.*, **51**, 1; 1905.

³ *J. Chem. Soc.*, **75**, 111; 1899.

⁴ *ibid.*, **93**, 997; 1908.

⁵ *Pharm. Centrbl.*, **40**, 518; 1899.

⁶ *Ann. Chim. Phys.*, (9), **1**, 32; 1914.

⁷ *C. R.*, **170**, 232; 1920.

⁸ *ibid.*, **112**, 1142; 1891.

⁹ *J. Phys. Chem.*, **29**, 376; 1925; **34**, 2749; 1930.

¹⁰ *Rec. Trav. Chim. Pays-Bas.*, **44**, 805; 1925.

¹¹ *ibid.*, **44**, 1; 1925.

¹² *Sitzb. Preuss. Akad. Wiss.*, 1228; 1918.

¹³ *J. Amer. Chem. Soc.*, **49**, 326; 1927.

¹⁴ *J. Phys. Chem.*, **29**, 926; 1925.

¹⁵ *Soil Science*, **31**, 379; 1931. **35**, 281; 1933. *J. Indian Chem. Soc.*, **10**, 287; 1933. *ibid.*, Sir P. C. Ray number, 81; 1933.

Anisotropy of Spherical Sound Waves

THE amplitude of vibrations on the wave surface of a spherical light wave may, or may not, be homogeneous. According to the classical electromagnetic theory of light, for a spherical wave emitted by a linear oscillator, the intensity is at a maximum in the direction perpendicular to the axis of the oscillator, and at a minimum in the direction of prolongation of the axis.

It is interesting to find experimentally whether the distribution of intensity of a spherical sound wave is homogeneous or presents any analogous anisotropy.

To test this, the intensity of sound emitted during spark discharges is measured by means of a Rayleigh disc suspended in the stream of the sound wave. The discharge is produced in a circuit which consists of an alternating current transformer with four Leyden jars joined in parallel with a spark gap, which is formed by two thin steel rods placed at several millimetres distance along a straight line. The steel rods are 2 mm. in diameter. This small size was adopted in order to diminish any possible disturbance due to massive solid obstacles placed in the path of the sound wave. The transformer is used instead of an induction coil, because the latter needs a mechanical interrupter which produces undesirable noises when it is working. The spark gap is mounted on a rotating table provided with a scale, such that the gap can rotate around its centre and its orientation can be determined accurately from the scale.

Observations were made of the deflections of the disc for different orientations of the spark. The deflections were proportional to the intensity of the incident sound wave. Hence the relative intensities around a great circle on the spherical wave surface can be determined. Special attention was paid to making the discharge as uniform and constant as possible. A large number of observations was carried out. Some typical results when the gap is 6 mm.

in length and the disc is placed at a distance of 68 cm. from the spark are given below.

θ	0	90	180	270	360
d	0.803	1.09	0.80	1.07	0.81
I	1.00	1.36	1.00	1.33	1.01

θ = the angle between the direction of observation and the direction of the spark.
 d = the deflection of the Rayleigh disc.
 I = the relative intensity of sound.

These results show definitely that the intensity of spherical sound waves emitted by a spark is distributed anisotropically on the wave surface: the intensity is a maximum in the direction perpendicular to the direction of the spark and a minimum in the direction of prolongation of the spark.

The experiments are being continued with different methods of measuring the intensity of sound, and a more detailed report will appear shortly.

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L. K. SU.

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Dec. 5.

Crystal Structure of Copper Sulphate

WE have been able to determine the structure of copper sulphate pentahydrate, which was the first crystal used by Friedrich and Knipping to diffract X-rays. The unit cell has dimensions:

$$a_0 = 6.12 \text{ \AA.}, \quad b_0 = 10.7 \text{ \AA.}, \quad c_0 = 5.97 \text{ \AA.},$$

$$\alpha = 82^\circ 16', \quad \beta = 107^\circ 26', \quad \gamma = 102^\circ 40',$$

and contains two molecules of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. The only symmetry possessed by the crystal is a centre of inversion.

The copper atoms lie on the centres of symmetry at (0 0 0) and $(\frac{1}{2} \frac{1}{2} 0)$ and the sulphur atoms on the general position (0.01, 0.29, 0.64). Each copper atom is surrounded by an octahedron consisting of four water molecules and two oxygen atoms, suggesting that there are direct bonds from copper to oxygen. This differs from structures like $\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$ and $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$, in which the bonds joining the groups are between water and oxygen¹. That the two octahedra are not equivalent is the explanation of the dehydration to $\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$ and then to $\text{CuSO}_4 \cdot \text{H}_2\text{O}$.

The odd water molecule touches two oxygens of different SO_4 groups and two waters of different octahedra, and would seem to play an important part in holding the structure together. The structure satisfies all the generally accepted requirements of inter-atomic distances.

The copper and sulphur positions were obtained from rotation photographs of copper sulphate and copper selenate crystals, and the oxygen and water positions from a double Fourier synthesis projecting on to (001).

We have to thank Prof. W. L. Bragg for allowing us to make the necessary measurements with the X-ray spectrometer at Manchester. We hope to publish further details elsewhere.

C. A. BEEVERS.

H. LIPSON.

George Holt Physics Laboratory,
 University of Liverpool.

Jan. 3.

¹ *Z. Krist. (A)*, **82**, 297; 1932. **83**, 123; 1932.

The so-called Terminal Parenchyma Cells in the Wood of *Terminalia tomentosa*, W. and A.

IN the literature dealing with European and American timbers, frequent mention has been made of the presence of terminal parenchyma cells in the wood of *Fraxinus excelsior*¹, *Populus* sp.², *Betula lutea*³ and *Acer sachharum*³. There can be no doubt about the validity of these statements, for they were based on intensive study of these timbers both in the field and in the laboratory.

While dealing with Indian timbers, Brown⁴ has mentioned the presence of terminal parenchyma cells in the wood of *Terminalia tomentosa*, W. and A. I have done the same on one occasion⁵. But none of these statements was based on the results of studying wood taken out periodically from a living tree and actually finding out whether these parenchyma cells were terminal or not. From the examination of the timber of this species in the laboratory, some of the parenchyma cells appeared to be distributed in the same way as the terminal parenchyma cells in the wood of *Fraxinus excelsior*, *Betula lutea*, etc., and they were, therefore, described as terminal.

During the last three years, however, while studying the formation of growth rings in the wood of *Terminalia tomentosa*, W. and A., I have found that the so-called terminal parenchyma cells are not really formed as the last tissue of the annual ring, but are the first type of cells formed at the beginning of the growth season. So, instead of being terminal, they are actually initial.

So far as my information goes, no textbook has mentioned this type of parenchyma distribution in any wood. Details of this investigation will soon be published. Meanwhile, it would be interesting to know whether anyone else has noticed this type of parenchyma cell distribution in any wood.

K. A. CHOWDHURY.

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 Dehra Dun, India.

Dec. 14

¹ Chalk, L. and Rendle, B. J., "British Hardwoods, their Structure and Identification" (*For. Prod. Res. Bull.* No. 6, p. 12; 1929).

² Jeffrey, E. C., "The Anatomy of Woody Plants" (University of Chicago Press, p. 51-52; 1917).

³ Lodewick, J. E., "Seasonal Activities of Cambium in some North-Eastern Trees" (*Tech. Bull.* 23, Syracuse University, N.Y., p. 29, 31).

⁴ Pearson, R. S. and Brown, H. P., "Commercial Timbers of India", vol. 1, p. 520; 1932.

⁵ Chowdhury, K. A., "The Identification of Important Indian Sleeper Woods" (*For. Bull.* No. 77, p. 14; 1932.)

White Cats and Deafness

MRS. BAMBER's recent article in the *Journal of Genetics*¹ on the correlation between white coat colour, blue eyes and deafness in cats is of importance and interest. It may perhaps be supplemented by a brief note on the same subject.

Mrs. Bamber states: "It has long been recognised that blue-eyed white cats are often deaf, whereas white cats with yellow or greenish eyes have normal hearing." She records the existence of a white, blue-eyed male cat which is not deaf. Another case is that of a cat with one blue and one yellow eye, which is "completely deaf on both sides."

I have at present a male, polydactylous, white cat with yellow eyes, which is completely deaf on both sides. This animal completes the possible combination of eye colour, deafness and normal hearing. As yet this animal is too young to breed. It is hoped,

however, that he may, in the near future, be tested genetically.

In the meantime the correlation between blue eyes and deafness is certainly not a perfect one. If the two characters are due to a similar physiological or genetic agent, it seems certain that its effects are sufficiently variable to enable them to operate in either the eyes or the ears, to the exclusion of the other location.

C. C. LITTLE.

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¹ Bamber, R. C., *J. Genetics*, 27, 407-413; 1933.

Spawning Date of the Common Frog

IN a former communication¹ I announced certain conclusions on the effect of the weather upon the spawning date of the common frog, *Rana temporaria*. Since then, a number of new facts have come to light.

Although wet days and spawn days are not associated, rainfall affects the date of spawning. The effect, parallel to the temperature effect previously reported, is due mainly to the total rainfall of the month prior to spawning.

These conclusions are confirmed by the relation which exists between the altitude of a pond and its spawn date. In south-west England, spawning is, on the average, earlier the higher the pond observed. In the Midlands and in south-east England, the same is true but the effect is much less. This distribution, both altitudinal and geographical, is the same as that of orographical rainfall.

The view that the weather is acting directly on the frogs themselves conflicts with my observations on migration. Although frogs hibernate in a variety of situations, they arrive at a particular breeding pond from different directions simultaneously, although this pond may differ considerably in its spawn date from another close by. There is, moreover, a difficulty in accepting a long period rainfall effect acting directly on frogs hibernating under water. The pond seems to be the unit for both spawning and migration, probably two aspects of one problem.

The observations suggest that spawning is dependent on pond periodicity. It is known that the periodicity of pond plants is affected by temperature and especially rainfall, which acts by the washing of phosphates from the soil into the pond². Atkins, in the paper cited, found that ponds with streams running into them developed their algal maxima earlier than the others, due to the increased phosphate supplies, and I found, from the results of a postal questionnaire, that ponds without streams tended to be without frogs.

The link between algal (or other plant) periodicity and spawning is being sought in the production of odour by the water plants. The smell of standing water is a problem of water-works technology, with a large literature, which has received little attention from workers on the migration of terrestrial animals breeding in the water. The odours are, in general, not those of decay, but are due to essential oils secreted by the water plants, plankton, etc., and are markedly periodic in their occurrence.

An endeavour was made last season to see whether plankton was responsible by asking a number of

observers to send me samples of the water of their ponds, from which I concluded that planktonic organisms are not concerned. An attempt is being made this spring to correlate phosphate changes in the water with spawning.

The form of the generalised curve showing the progressive changes in the number of ponds in an area having spawn is deducible from some simple assumptions on the mechanism, and the reasoning shows that the date on which the maximum number of ponds develop the postulated effect will not be coincident with the date on which the maximum number of spawn reports occur, but will be later.

A detailed account will be published later.

I wish to thank those phenological observers who took so much trouble in the postal scheme, and the Royal Meteorological Society for data courteously supplied.

R. MAXWELL SAVAGE.

19 Derwent Avenue,
N.W.7.
Jan. 6.

¹ Savage, *NATURE*, 131, 587, April 22, 1933.

² Atkins, *J. Marine Biol. Assoc. U.K.*, 13, 119.

A Recent Sedimentary Volcanic Tuff

ON November 3, 1931, during a trawling survey of Falkland Island waters, the R.R.S. *William Scoresby* made a haul with a commercial trawl in 98 m. of water on a position 45° 56' S., 66° 24' W. situated in the Gulf of San Jorge, off the Patagonian coast.

The contents of the trawl consisted mainly of several bushels of slabs, 5-10 cm. thick, of a compact clay-like rock. Its colour was greenish-grey changing to olive-buff when dry. Under the microscope, the rock is seen to consist of some very finely divided 'clay' substance, too finely divided to be identified by means of the polarising microscope, but a much more abundant constituent is colourless volcanic glass in flakes varying in size from 0.15 mm. downwards. With this are birefringent grains of feldspar (varying in size from 0.06 mm. in diameter downwards) and a very few green grains resembling glauconite. The colourless glass and the feldspar are similar to the material which forms the dust clouds emitted by volcanic eruptions in the Andes and has on occasions travelled the whole breadth of the Argentine Republic. In dust collected at Buenos Aires after the eruptions in the Andes in 1932, the particles ranged from 0.2 mm. downwards for the colourless glass, and from 0.1 mm. downwards for the chips of feldspar and other minerals. There seems no doubt that the rock has been formed by the deposition in the sea of volcanic dust wind-borne from the Andes. If so, it is an excellent example of the mode of deposition of some of those sedimentary volcanic tuffs which have long been known among deposits of volcanic origin.

The associated fauna was very meagre, consisting almost entirely of an alcyonarian of the genus *Renilla* together with a few polychaetes.

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GEORGE RAYNER.

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Jan. 18.

Quaternary Intermetallic Compounds

INVESTIGATORS of metallic systems by thermal and X-ray methods have found many binary intermetallic compounds; they have found, however, only a few ternary and no quaternary compounds. If a metal or metals of one class (zinc, tin, cadmium, mercury) reacts in mercury at ordinary temperature with one of another (copper, iron, cobalt, nickel, manganese), many binary and ternary compounds result¹.

Recently we have succeeded in getting three of the first class to unite with copper to form reasonably stable quaternary compounds, the analysis of which by the volumetric processes of the laboratory presented no difficulty. Seven of them were obtained by the reaction between zinc and the simplest ternary compound which forms in mercury, namely, SnCu_3Hg_7 . Their approximate empirical formulae are: $\text{Sn}_4\text{Cu}_{12}\text{Zn}_4\text{Hg}_3$, $\text{Sn}_5\text{Cu}_{15}\text{Zn}_5\text{Hg}_9$, $\text{SnCu}_3\text{ZnHg}_6$, $\text{SnCu}_3\text{ZnHg}_9$, $\text{Sn}_4\text{Cu}_{12}\text{Zn}_4\text{Hg}_{45}$, $\text{Sn}_4\text{Cu}_{12}\text{Zn}_7\text{Hg}_{21}$ and $\text{Sn}_4\text{Cu}_{12}\text{Zn}_7\text{Hg}_{33}$. Four others have been prepared by the reaction between tin and the simplest binary compound which forms in mercury, namely, ZnCu . Their approximate empirical formulae are: $\text{Zn}_8\text{Cu}_8\text{SnHg}_7$, $\text{Zn}_6\text{Cu}_4\text{SnHg}_9$, $\text{Zn}_{40}\text{Cu}_{40}\text{Sn}_5\text{Hg}_{14}$ and $\text{Zn}_{40}\text{Cu}_{40}\text{Sn}_{12}\text{Hg}_{21}$. Cadmium forms ternaries with copper and mercury without difficulty but not with copper and zinc or with copper and tin. Quaternaries or quinaries including cadmium cannot, in consequence, be so prepared.

Ternary and quaternary compounds formed in mercury, so far as the work has gone, may be regarded as derived from known compounds of mercury and copper in which other metals of the *B* sub-group of the Periodic Classification partly replace the mercury, an atom of the quadrivalent tin counting as two divalent atoms of mercury; zinc, cadmium and mercury being equivalent. Thus SnCu_3Hg_7 , $\text{SnCu}_3\text{ZnHg}_6$ and $\text{Sn}_4\text{Cu}_{12}\text{Zn}_7\text{Hg}_{21}$ may be regarded as derived from CuHg_3 , a compound which has been prepared in mercury but otherwise is unknown in metallurgy. (The corresponding CuZn_3 , however, is well known.) Similarly, $\text{Sn}_5\text{Cu}_{15}\text{Zn}_5\text{Hg}_9$, $\text{Zn}_{40}\text{Cu}_{40}\text{Sn}_5\text{Hg}_{14}$, and the ternaries (not mentioned above) $\text{Zn}_2\text{Cu}_5\text{Hg}_6$ and $\text{Zn}_4\text{Cu}_5\text{Hg}_4$, may be regarded as derivatives of Hg_8Cu_5 , which has been prepared in mercury. (The corresponding Zn_5Cu_5 and Cd_5Cu_5 are well known in metallurgy.)

If this process of derivation is legitimate, our work is brought into line with that done by thermal and X-ray methods. In addition to the binary compounds which form easily in mercury or by other methods, there is the possibility of a large number which do not. Their existence, possible and actual, has enabled us to confirm and extend considerably the rules connecting the numbers of valency electrons and atoms which were put forward first by W. Hume-Rothery²; namely, for compounds between such metals as tin, zinc or cadmium and metals like copper, silver or iron, there are characteristic ratios of valency electrons to atoms of 3 : 2, or 21 : 13 or 7 : 4, that is to say, for 21 electrons there may be 14, 13 or 12 atoms in the compound. We find for a given number of electrons there are ranges of atoms. For copper united with a divalent metal of the *B* sub-group there may be for 42 electrons 21, 22, 23, 24, 25, 26, 27 or 28 atoms; for 18 electrons 12, 13, 14, 15 or 16 atoms. In tin-copper compounds, for 42 electrons there may be 14, 15, 16, 17 or 18 atoms, for 28 electrons, 12, 13, 14, 15 or 16 atoms and for

21 electrons, 12, 13 or 14 atoms. It would thus appear that the total number of valency electrons—18, 21, 28 or their multiples—is even more characteristic of an intermetallic compound than the ratio of electrons to atoms.

In reckoning valency electrons, metallurgists count copper and silver as having each one electron, zinc, cadmium and mercury as having each two electrons, and lead and tin as having each four. To fit transition metals like iron, cobalt and nickel into the schemes, they regard their atoms as contributing no valency electrons to the compound. Our results show, however, that in certain compounds (mainly when these metals are in excess) iron, cobalt, nickel, manganese, and possibly other transition and pre-transition metals of the Periodic Classification, may be regarded as having each one electron; in other compounds (mainly when the *B* metal is in excess) the transition metal acts as if it had no electron. Thus, in SnFe_5 , iron acts as if it had one valency electron; in $\text{Zn}_{21}\text{Ni}_5$, nickel acts as if it had no valency electron.

My former pupil, Mr. R. P. Lawrence, has helped me in this work.

A. S. RUSSELL.

Christ Church,
Oxford.
Jan. 17.

¹ Russell, Cazalet, Irvin, Lyons, Kennedy and Howitt, *J. Chem. Soc.*, 841, 852, 857, 2340; 1932. *NATURE*, 125, 89, Jan. 18, 1930.

² *J. Inst. Metals*, 35, 295; 1926. *Annual Reports of Chemical Society*, 27, 294; 1931.

Passage of Hydrogen through Steel

INVESTIGATIONS have recently been carried out by Dr. J. M. Bryan and myself at the Low Temperature Research Station, Cambridge, on the relative rates of corrosion by dilute solutions of citric acid of different samples of mild steel sheets such as are used in the manufacture of tin-plate. In these tests an attempt was made to eliminate edge-corrosion by making the steel sheet the bottom of the corrosion chamber. This was done by cutting off the bottoms of glass bottles, grinding the edges and coating them with pure vaseline to prevent leakages, and applying the sheet. The whole was clamped up tightly in a suitable frame, the sheet itself being in contact on its outer side with a pad of filter paper resting on a wooden block. The chamber thus formed was connected to a gas burette so that the hydrogen formed through the action of the dilute acid could be measured, and the whole apparatus was held at 25° C.

It was found after a given period that the loss in weight of the sheet indicated that the hydrogen-equivalent of the steel dissolved was far in excess of the hydrogen actually collected. This excess was greater than could be accounted for through solution of the hydrogen in the corroding medium, and it appeared therefore that the hydrogen was either absorbed by the metal in considerable quantities or else passed through it and was evolved freely on the outer side. That the latter was more probable was supported by the fact that blisters appeared on the outer side of some of the specimens, showing that the gas passed, at any rate, nearly through the metal and could exert considerable pressures inside it.

A further experiment was therefore carried out in which the metal sheet was clamped so as to form a diaphragm between two flanged hemispherical glass

vessels each of which was connected to a gas burette by means of an outlet tube. The upper vessel contained the corroding medium which was in contact with the metal and the lower one contained air. The air in the headspace of the upper chamber and in the solution was replaced by nitrogen and the whole apparatus was set up in a room held at 25° C.

Both the upper and lower burettes soon began to register an increase in volume. That in the upper one was the more rapid at first, but slackened later, and when the apparatus was taken down after two days, there was about 30 c.c. of hydrogen on either side, leaving about 9 c.c. (calculated from the loss in weight of the sheet) to be accounted for by absorption into the metal and by solution in the citric acid. I should be glad to know whether the passage of hydrogen through steel under similar conditions to the above has been recorded.

T. N. MORRIS.

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Jan. 12.

Interaction of Radio Waves

THE phenomenon recently reported by Tellegen¹ whereby the new broadcasting station at Luxembourg appears to interact with that portion of the carrier wave of the Beromunster station which is received in Holland, can be explained by taking into account the effect of such a powerful station (200 kw. and $\lambda = 1190$ m.) on the mean velocity of agitation (u) of the electrons in the ionosphere. Any change in u will produce a change in v , the frequency of collision of an electron with molecules, and hence a change in the absorbing power of that part of the ionosphere in the vicinity of the station. Since this change depends on the magnitude of the electric vector in the disturbing wave, it follows that the absorbing power of this part of the ionosphere will vary in accordance with the modulation frequency of the station, and so the modulation will be impressed in part on any other carrier wave which may traverse this region.

We have examined these points quantitatively with the help of data obtained by Townsend and Tizard² on the motions of electrons in air, and have arrived at the following conclusions.

The amount of modulation of a carrier wave produced by a disturbing station of power P and modulation frequency f is approximately proportional to P and inversely proportional to f . There is thus introduced a distortion of the original modulation, at the expense of the higher frequencies of modulation.

The variation of the impressed modulation with the wave-length of the disturbing station is more complicated, being roughly proportional to $1/\{v^2 + (p - \omega)^2\}$ where $p = 2\pi c/\lambda$, $\omega = H_p e/cm$ and H_p is the component of the earth's magnetic field perpendicular to the electric vector of the disturbing wave. It is clear that the quasi-resonant state ($p = \omega$) can exist only in very localised regions of the ionosphere, and will contribute little to the total impressed modulation, which may be received over the whole path of the wave in the absorbing regions of the ionosphere. The disturbance will therefore be greatest when ω is small, that is, when the entire electric vector of the wave lies in the direction of the earth's magnetic field. The magneto-ionic

theory shows that under European conditions this can occur only for that part of the wave's path which is roughly horizontal. In such circumstances ω will always be small for waves much longer than 214 m.

We have examined the magnitude of the disturbance which would be experienced at Eindhoven when listening to the Beromunster station, and find that it would become appreciable for values of air pressure in the absorbing regions near those generally accepted. The disturbance experienced is proportional to v^2 , so that we should expect increased disturbance at times when the sky wave is weakened by increased absorption, for example, around sunrise and sunset, and in the daytime if signals be audible.

It is to be anticipated that the Warsaw station will also exhibit the effect in just appreciable intensity if careful investigation be made. It is not to be expected, however, that the very long wave high-power telegraph stations, such as Rugby or Nauen, could produce the effect, for such long wave-lengths are probably reflected at a level in the ionosphere below that which absorbs waves of broadcasting frequencies. Neither would such a station appreciably influence the reception of other very long wave stations, since most of the received signal on these wave-lengths is due to the ground wave.

The details of our investigation will be published elsewhere in the near future, together with a discussion of the possibility of utilising the phenomenon to derive further information about the ionosphere.

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D. F. MARTYN.

Commonwealth Radio Research Board,
Sydney.
Nov. 29.

¹ NATURE, 131, 840, June 10, 1933.

² Proc. Roy. Soc., A, 88, 336; 1913.

Audibility of Auroras and Low Auroras

I WAS much interested in the article "Audibility of Aurora and Low Aurora" by F. T. Davies and B. W. Currie which appeared in NATURE of December 2, because I once witnessed an aurora and heard the swishing sounds referred to.

During the winter of 1908-1909, while attending Trinity College at Hartford, Conn., I observed a magnificent aurora. The light effects gave me the impression that the atmosphere was filled with fog, and that someone was illuminating it by playing a searchlight back and forth. The effect was very striking because the display was so close to the ground that I seemed to walk right through the illuminated fog.

The sound which I heard is exactly described by the word swishing. I do not believe I could say the swishing sound was in unison with the flickering of the lights because the sight was so new and strange that I did not observe it from the point of view of a scientist. All that I can say is the swishing sounds were heard while the lights were changing.

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Jan. 4.

Research Items

Clay Heads from Ashanti. Capt. R. P. Wild describes and figures in *Man* for January two heads of baked clay from Fomena, Ashanti, which were obtained by Mr. E. A. Burner, of the Political Service, from Nana Kobina Fori, the Omanhene of Adansi, whose capital town is Fomena. Kobina Fori, whose age is estimated at somewhere in the neighbourhood of eighty years, states that although these heads are not now made, he remembers them being made by an old woman when he was a boy. According to his evidence, they were placed on the graves of chiefs, elders, councillors and queen mothers, that is, the most prominent members of the Adansi tribe. At certain times offerings were made to the spirits which were supposed to have taken up their abode in the heads. For this purpose a baked clay ladle was required. The heads are well fired and are made of a fairly fine clay. They are hollow and almost life size. From the absence of the beard and the smaller head it is probable that one of the two heads represents a woman. The features of both heads are rather refined in comparison with the usual cast of countenance in the Ashanti race. This supports the statement that they are meant to represent chiefs, elders, etc., as the ruling classes of the Ashanti show distinct signs of refinement. The side view shows the typical long face of the Ashanti, but with an unnatural flattening of the back from the nape of the neck upward, giving an almost vertical profile. This may be due to artistic license. The conventional representation of the hair is interesting, it being rendered by whorls, cylinders and hollow balls. Kobina Fori stated that human hair (perhaps the hair of the deceased) was inserted in the holes in the cylinders and balls. The faces had been coated with red clay after firing, red being the mourning colour of the Ashanti. Facial markings, it is suggested, may be intended to counterfeit the cicatrices of an Akim slave as a disguise against evil spirits.

Cancer Mortality in the Australian Commonwealth. Deaths from cancer in the Commonwealth of Australia for 1931 per 100,000 of mean population were for males 105, females 97, persons 101 (Dr. M. J. Holmes, *J. Cancer Res. Com. Univ. Sydney*, 5, No. 3, 168; 1933). These rates show a considerable increase on those of the previous year and affected all States except Western Australia. The age-grouping of the population has, however, been altering since 1921, and the proportion of the population in the age-groups 45-64 and over 65 years is now larger than in a standard population, that is to say, a larger proportion of the population reach the 'cancer age' than formerly. Correcting for this, an actual diminution in the cancer mortality in the age-groups below 65 years has become evident in recent years, the rate for 1931 being lower than that for 1921 and for 1911. This diminution may justly be attributed, at least in part, to the efficacy of modern treatment. The mortality rate for sarcoma remains at about the same figure that it was twenty-five years ago.

Golgi Apparatus in Protozoa. Joyce C. Hill (*J. Roy. Micr. Soc.*, 53, Part 3, 1933) states that the Golgi apparatus in the Sporozoa agrees with that in the Metazoa in its reactions to osmic acid and resembles it in general structure and in juxta-nuclear position. During division, the Golgi elements are drawn to each

nucleus in approximately equal numbers as in dictyokinesis in Metazoa. There appears therefore to be a true Golgi apparatus in the Sporozoa but there is no such certainty for the other groups. In Amoeba, Brown describes globules with clear centres and dark rims which impregnate with osmic acid and may represent the Golgi apparatus, but no definite decision is expressed in the absence of silver impregnation, juxta-nuclear position or indication of dictyokinesis. Though there is evidence that in some flagellates and ciliates the parabasals and excretory apparatus show resemblances to the Golgi apparatus of Metazoa, "yet we can point to no cell inclusions which are similar in all and agree with all the criteria for the metazoan Golgi bodies. Possibly in some cases, e.g. *Opalina*, the Golgi apparatus is in a somewhat elementary condition, and the parabasal apparatus may also represent a not wholly differentiated Golgi apparatus."

Fungi causing Human Blastomycosis. A very interesting paper entitled "Observations on Fungi isolated from Cases of Blastomycosis cutis and Blastomycosis pulmonalis in North America and Europe. Remarks on Blastomycetin" appears in the *Journal of Tropical Medicine and Hygiene* of October 16. The authors are Sir Aldo Castellani and Prof. Igino Jacono, who publish photographs to show the almost terrifying severity of blastomycetic ulcers upon the human skin. The fungi which cause the diseases have been studied with a detail worthy of Sir Aldo Castellani's great resources. The present paper describes the cultural and microscopical characters of the organisms, but further work on inoculation is also in progress. Representatives of the genera *Torulopsis*, *Monosporium*, *Glenospora*, *Geotrichum*, *Phialophora*, *Acrotheca* et al. have been studied, and most of the species have been described for the first time. Tests have been made with monovalent and polyvalent blastomycetin, in order to see if it has any value for diagnosis.

Absorption of Calcium by *Terminalia glabra*, W. and A. Mr. B. L. T. de Silva, of the Department of Botany, University College, Colombo, in a communication to the Editor, directs attention to the remarkable manner in which *Terminalia glabra*, W. and A., accumulates calcium from the soils of the Miocene limestone of northern Ceylon. The water is usually softer in this area from wells near these trees, and the villagers in the dry zone burn the bark of the tree as a source of lime. In this region the ash of the leaf was 57-61 per cent CaO, of the bark 83-91 per cent. *Terminalia glabra* is a deep-rooted tree and may thus remove calcium from the deeper layers of soils whilst its leaves, rotting in the surface layer, may make this layer richer in lime than the leached surface soil out of the range of these falling leaves. Mr. de Silva cites figures of analyses of surface soils in support of this conclusion.

New Zealand Beech Timbers. Mr. Parkham, of the Cawthron Institute, Nelson, has published an interesting paper entitled "New Zealand Beech Timbers: Their Structure and Identification" (*New Zealand J. Sci. Tech.*, 14, No. 4, pp. 233-40; 1933). Beech forests are the dominant associations forming the subantarctic rain forest of New Zealand, and extend from the East Cape district, in the North

Island, down the mountain chains to Cook Strait, and so, too, in the South Island to Foveaux Strait. The object of the author's research is to describe the anatomical structure of the secondary wood in order to facilitate the identification of timbers after conversion. The species included in the scope of the present report are *Nothofagus Menziesii*, *N. Fusca*, *N. truncata*, *N. cliffortioides* and *N. Solandri*. The paper contains interesting data concerning the reactions of these beeches during seasoning, their supply, and a variety of commercial purposes for which they are suited. The author points out that there is a great tendency to warping, which is less marked in the silver beech (*N. Menziesii*). For some years silver beech timber has been exploited to a considerable extent locally, the annual production being about 8,000,000 superficial feet. It is used mainly for general building and constructional purposes, for box-making (butter boxes and cheese crates), for cooerage, farm implements, vehicle body-building, furniture, interior finishing and fixtures, and for turnery (Ward, 1929). The author comments on the fact that up to the present very little research has been carried out on these lines, Engler (1899), Solereder (1908) and Garrett (1924) being the only authorities who have published works dealing with this subject. Mr. Parkham stresses the importance of maintaining the large areas of beech forest which at present exist in New Zealand, both because of the necessity of perpetuating a forest covering on the water-sheds of the many rivers and streams, and also because of the potential commercial value of such areas (see NATURE, 131, 787, June 3, 1933).

Geology of the Society Islands. Bulletin 105 of the Bernice P. Bishop Museum (1933) is devoted to a report on the geology of Tahiti, Moorea and Maiao by Howel Williams, who paid a two months' visit to the Society Islands five years ago. The group presents an evolutionary series where volcanic cones may be studied in all stages of erosion and where the encircling reefs are revealed in all stages of development. A valuable summary is given, supplemented by many original observations, of the geomorphology and petrology of the Islands. Discussing the recent movements of the South Sea islands, the author presents evidence that the Pacific floor of this region has been stable for a prolonged period. Maximum proved uplifts are 250 ft. for the Marquesas, 800 ft. for the Austral Islands, 230 ft. for the Tuamotus and 554 ft. for the Cook Islands; there is no indication of uplift for the Society Islands, save the relative change due to the recent fall in ocean level. The supposed evidences of submergence based on a study of drowned valleys are regarded as invalid, the effects of a rise of ocean-level following its fall during the glacial period being regarded as providing an adequate explanation. Local tilting is no more than is to be expected in islands of volcanic origin. The report is a well-illustrated and fully documented account of a group of islands that still offers a host of problems of fascinating interest.

Water-logging the Punjab. The problem of water-logging due to the general rise of the water-table over a large area is discussed by Dr. E. McKenzie Taylor and others in "An Investigation of the Rise of Water-Table in the Upper Chenab Canal Area, Punjab" (Research Publication, vol. 1, No. 4, Punjab Irrigation Research Institute). Statistical examination of the figures for well levels, rainfall and irrigation discharge show a

high correlation between rise of water-table and monsoon rainfall, but no correlation between rise of water-table and the amount of irrigation water supplied. The rise of water-table and the increase of irrigation are mutually exclusive. Dr. Taylor concludes that the rise of water-table can be controlled by the rapid surface removal of monsoon rainfall and recommends for this purpose the construction of storm-drains. Since these deal with surface water they need be of no great depths and would be cheap to construct and maintain. Deep seepage drains in the subsoil would also be of use, but would prove costly and do not appear to be a practical solution in an area of rising water-table which is not already water-logged. In short, they are not a prevention but merely a cure. Surface drains, on the other hand, should lead to a permanent fall in water-table.

Effect of Temperature on Energies of Photoelectrons. The *Physical Review* for December 1 contains two papers by Du Bridge and Hergenrother and by Roehr, on the energy distribution of photoelectrons from molybdenum at different temperatures. In the former paper, the normal component of the velocity of emission was studied by applying a retarding potential between a flat emitter and a parallel plate electrode; in the latter paper the total energy distribution was studied by placing the emitter at the centre of a spherical collecting electrode. The emitter was heated by an intermittent current and arrangements were made so that the photocurrent was collected with the heating current off. The results were analysed in the light of the theoretical work of Du Bridge based on a Fermi-Dirac distribution of the velocities of the electrons. The fit obtained between theoretical and experimental curves was satisfactory. The accuracy of the classical determination of h by the application of Einstein's photoelectric equation is brought into question, since these determinations involve an extrapolation of the tail of the photocurrent-retarding potential curve, which is now shown to depend on temperature. It appears, however, that the shape of the curve is such that simple extrapolation yields results which all differ by the same amount from the theoretical values at absolute zero of temperature, and the photoelectric determinations of h are probably unaffected by the temperature effect.

Sulphides of Zirconium. The information on the sulphides of zirconium was in an unsatisfactory state and the preparation of three definite compounds, ZrS_2 , Zr_3S_5 and Zr_3S_3 , by Pichon (*Bull. Soc. Chim.*, 53-54, 1269; 1933) has confirmed the existence of the first compound and added two new sulphides to the group. The method of preparation was to act on zirconium oxide at a high temperature with hydrogen sulphide. By heating first at 1100° - 1200° and then raising the temperature to 1700° , a fused crystalline mass of Zr_3S_5 is obtained. On heating this at 900° - 1300° in hydrogen sulphide, the black disulphide ZrS_2 is produced; and Zr_3S_3 on heating at 1400° for two hours in a cathode ray vacuum, or in hydrogen for one hour at 1700° , yields the brown Zr_2S_3 . All the products are crystalline. Evidence of the existence of Zr_3S_4 was also obtained. The chemical properties of the substances were examined and it was found that the action on numerous reagents was less pronounced with the compounds containing less sulphur.

Auroras, Electric Echoes, Magnetic Storms

By SIR JOSEPH LARMOR, F.R.S.

RECENT reports by E. V. Appleton and his associates, Norwegian and other¹, have brought out the complex connexions between the optical and magnetic phenomena of the upper atmosphere. The considerations that follow touch only the fringe of this interesting subject: but it may be permitted to record them before they pass out of memory.

Assuming waves short enough to permit analysis by ray-propagation, there would be two paths of transit from one place to another not too distant, one straight across, the other by reflection from what has been appropriately termed a ceiling aloft. This latter is represented by a caustic surface, belonging to the source supposed of coherent periodicity, at which all the rays are turned back tangentially: none can get across it, unless the medium is discontinuous consisting for example of banks of reflecting ionic clouds. Some frequencies have no ceiling, or one only of limited extent. The numerical densities (N) of electrons at the apices of the ray paths, which practically lie along the caustic, are determined at once by the optical law of refraction, that $\mu \sin z$ is constant along a ray; for the directional angle z to the zenith is $\frac{1}{2}\pi$ at the apex, so that the value of μ there is $\mu_0 \sin z_0$ for the position of the observer. Unless the direction of emission is at very small angle (z_0), μ is thus a moderate fraction of the initial value μ_0 , about unity, at the level of emission. Either then N at the apex is a moderate number, rather less than for vertical reflection as *infra*, or else z_0 is very small so that all the rays that reach the ceiling start off nearly vertically and bend sharply, or else the analysis by rays is not applicable to the lengths of waves concerned.

It has been found, without doubt, that rays are returned straight back along the vertical path, the highest point of the gradually sloping caustic surface being as above overhead. Its exact position can scarcely be determined: but certainly the plane for which μ vanishes—the velocity of propagation there becoming infinite or the medium optically rigid—which is readily estimated, lies beyond the caustic. The familiar formula for frequency $p/2\pi$ and electrons of mass m ,

$$\mu^2 = \mu_0 - \frac{4\pi N e^2 c^2}{m p^2}, \quad \frac{p}{c} = \frac{2\pi}{\lambda}, \quad \frac{e}{m} = \frac{7}{4} \cdot 10^7, \quad e = \frac{3}{2} \cdot 10^{-20},$$

gives, for N per cubic cm. and λ in cm., $\mu^2 = 1 - \frac{1}{5} 10^7 N \lambda^2$. Thus for waves of the order of 300 metres, μ^2 would vanish when N has risen to the moderate value $\frac{1}{7} 10^5$, and for 30 metres to $\frac{1}{7} 10^7$. The intensity of ionisation which thus arrests propagation by waves is small, perhaps much beyond expectation. This does not, however, mean that a cloud of ions, of diameter more than a few wave-lengths, would collapse by any essential instability. Vanishing index means that the medium is electrically absolutely rigid for these lengths of waves, so that disturbances of such length could not get into it at all, would be turned back or in part smothered: infinite index, as *infra*, would mean that it is flaccid, with like results: this now holding good whether treatment by rays is applicable or not, thus in this rough estimate avoiding the complexities of gyro-radiational analysis, as exemplified in S. Goldstein's work². If radiation of various wave-lengths is sent up from the source,

each constituent is turned back before the stratum for which N has the limiting value (inversely as λ^2) is reached. This is the foundation on which is based the exploration of atmospheric strata by vertical radiation, as initiated and extensively carried out by Appleton and his colleagues, uncertainties regarding oblique reflections thus not entering into the estimates.

Carrying the analysis further: in a magnetic field H_0 , in the simplest case for the two cyclic waves ($+H_0$ and $-H_0$) travelling directly along H_0 , the expression for μ^2 involves in the denominator $m p^2 + e H_0 p$ instead of $m p^2$. One of the two waves becomes obliterated by μ^2 trending to infinite value, so that the velocity fades to nothing at a stratum where p or $2\pi c/\lambda$ has fallen to $\frac{1}{4} 10^7 H_0$, which for values of H_0 of the order of the earth's magnetic field would be when λ is more than half a kilometre. The radiation which gets through is then solely the conjugate cyclic component. Here N does not occur at all in this estimate: but that could not mean that even a very sparse distribution of electrons would prohibit one set of component waves if the impressed field H_0 (or rather $H_0 \lambda$) were great enough. It means that there could not be cyclic radiation of this kind with what few electrons there may be present playing a part in it; this is because in circular orbits such as they would have to follow the centrifugal reaction $m p^2 r$ could not adapt itself to compensate the electrodynamic force $e H_0 r$, and therefore such participating orbits could not subsist: but when the number of ions is small cyclic radiation can travel in the ordinary manner, only slightly disturbed by their irregular motions.

Specially close connexion of magnetic storms and the Aurora Polaris with anomalies in wireless radiation is reported by Appleton. This contrasts, of course, with the extremely subordinate influence of magnetic fields on the short waves of physical optics, except for ferromagnetic metals. A conceivable presumption would be that the aurora is due to lasting local pulsations on a large scale, so of long period, excited somehow by a local cause large enough and of abrupt type, produced conceivably by arrest high up of an ionised torrent from outside sufficiently concentrated to require relief by propagation in waves: the incidence of such long undulations on the molecules of the lower rarified atmosphere could produce the light of the banded auroral curtains. As these bands lie along the direction of the magnetic field this would imply facility of spiralling transmission along that direction. Probably also it has been already explored whether the auroral light shows traces of circular polarity.

Long ago the ascription of terrestrial magnetic changes to electric currents circulating in the upper atmosphere was in favour³, until the recognition that all currents are made up of convections of ions disturbed that view by the high electron densities implied. Yet there seems no help for it if atmospheric ionic views are to be persevered with: thus in recent careful discussion, S. Chapman⁴ has not been deterred from densities even up to 10^{10} electrons per cubic centimetre in positions very far up in the abnormal atmosphere. The superior mobility of the negative electrons is there the dominating influence, for compensating positive must be present.

An arresting feature of Prof. Appleton's pairs of fragmentary graphs, giving heights of reflection in terms of frequency, as directly observed, such as may be on his view connected with the two cyclic components into which the radiation is split by the earth's magnetic field, is that though of irregular form, they show rather close repetition of features, differing mainly by a shift along the axis of frequency. This suggests search for an analytical correspondence between them, which it is not hard to pursue for the simplest illustrative case of radiation along the direction of the magnetic field H_0 . The co-ordinates of the graphs are p , giving the frequency $p/2\pi$ of the waves, and the altitude z of the reflecting layer estimated by the rough criterion of vanishing index μ . More generally, N being some assigned function of z , the graph may relate to any constant value of μ or c/c' . The equation of propagation (cf. my "Math. and Phys. Papers", vol. 2, p. 651, as alone here accessible) is, if φ denotes the single complex electric variable $P + iQ$ and d/dt is $i\varphi$,

$$-\frac{d^2\varphi}{dz^2} = Kc^{-2}p^2\varphi + \frac{4\pi cNp^2}{mp^2 - 4\pi cH_0p}\varphi$$

This type of differential equation is familiar for other modes of waves, and has been tractable for some special forms of N as expressed in terms of z . When, however, N changes not too rapidly with z , a simple harmonic type $e^{pt}e^{-nz}$, so that $d^2\varphi/dz^2$ is $-(\mu/c)^2\varphi$, is a first approximation and, φ dividing out, gives μ^2 in terms of p and N . Transition is made to the conjugate wave train by change of sign of H_0 . To explore correspondence of the types indicated, we restrict to the case of μ nearly vanishing, when

$$N = \frac{Km}{4\pi ec^2} \{(p + p_0)^2 - p_0^2\},$$

where p_0 is $2\pi cH_0/m$, being half the critical frequency above described. Only in the circumstances of short waves is p_0^2 small compared with p^2 and roughly can be neglected: then N is determined by $p + p_0$, and the graph for (N, p) is merely displaced opposite ways from a central position by adding $+p_0$ or $-p_0$ to the abscissa p according to the sign H_0 . But the actual graphs belong to long waves.

In the next simplest case, when the magnetic field H_0 is transverse to the waves (*loc. cit.*, vol. 2, p. 655, where some misprints are to be set right), the displacement of the graphs now involving $(p_0/p)^2$, would be large for a magnetic long wave. (The condition for μ to vanish then takes a simple form $Lp = \pm N$.) The actual case, that of field oblique, along the line of magnetic dip, would be nearer the former: though intricate, it may possibly be worth the trouble of exploring, if that has not already been done by Goldstein (*loc. cit.*). Down to the higher atmospheric density of the auroral levels the incident electron streams could scarcely penetrate.

As Appleton originally suggested, and is confirmed by Ratcliffe's records, the upper reflection is probably due to an independent layer, and both reflections can be split by the magnetic field in a manner to which this analysis applies.

By good fortune, however, the magnetic complications here described appear largely to compensate themselves. A cyclic wave-train of dextral chirality going up would be returned as a train of the same chirality, in absence of a magnetic field: imposing the earth's magnetic field would affect them in opposite ways: thus so far, if there is no error here,

the magnetic delays in ascent and return should cancel, provided they are along the same path, so that there would be no delay on this ground in reception between the two cyclic components of a wave-train: the actual delay would arise from their reflection being at different levels, and would afford a measure of the interval, and thence of the difference in electron density. The conjugate cyclic polarisations, each *received* reversed, would remain as a test whether the splitting of the beam is of magnetic type.

A reflecting layer would have to be fully established in a fraction of a wave-length, thus rather abruptly for short waves. Thus it would have to fade away more gradually above to avoid thin-plate phenomena: this and the much larger density N that must be attained notwithstanding for short waves may provide clues for exploration.

The unexpected result, that whether a magnetic field be present or not, a quite small density of ions entirely upsets the optical elasticity of space as regards long waves, provides a cause preserving ionised gaseous clouds of astronomical size, for example in the interiors of stars, from rapid dissipation or dispersal in bulk; in fact saves an ionised region from lapse to uniformity by internal radiation.

The description⁵ of a recording apparatus developed by J. A. Ratcliffe and E. L. C. White has just attracted my notice. The automatic photographic records, of which examples are printed, convey a sense of actuality to which mere verbal description could scarcely attain. The continuous run shows the intervals of time during which double reflections are present, and the heights, sometimes very great, from which they appear to arrive. We may thus know in time as much about the earth's upper atmosphere as we seem to know about that of the sun. The abrupt changes in vertical atmospheric structure recorded in crossing sunset and sunrise meridians agree closely with the early suspected cause of the related disturbances in long-distance signalling.

As regards the rather uncertain concept of group-velocity (cf. *loc. cit.*, vol. 2, p. 546), so familiar for a long time in hydrodynamics, it is an affair, as Hamilton first described it, of an *unlimited* train of regular waves with humps of increased amplitude at intervals, which travel through the waves with a velocity of their own, dp/dn as against p/n for the basic waves. These humps do not constitute a train of waves of the same type, for their average amplitude would be null, though they could be receivable as in wireless practice by different apparatus. It may not be too wild to imagine a permanent train of waves sent out and encountering a dispersive region in which the group velocity approaches zero owing to very sharp curve of dispersion, so that these humps remain nearly stationary, but when the train on which they ride is terminated, they relieve themselves by propagation forward and backward: but in any case these are scarcely the circumstances of the alleged echo of long delay.

V. M. Slipher reports regular occurrence of flashes of auroral spectrum at sunrise and sunset. One can conceive an upper stratum ionised by the solar radiation, and a lower by the long electric waves that can disturb electric reception.

These long atmospheric waves would be indicated by disturbed electric reception, but they would not affect the magnets; that would be due to the vast exciting torrents of solar electrons flashing past the earth and partly arrested aloft. They would require a compensating fall into the sun (perhaps spiralling

in the sun's rather strong magnetic field) and, as it would be at slower velocity, there would be a solar electric charge. Yet, as I understand, G. E. Hale could not find any trace of Stark effect of resulting solar electric field: which would be adequately explained if the electric charge, being of course a surface sheet, lies outside the layer which emits the light. The penetration of the cosmic radiation, if it carry a charge, or part of it, into the earth has been in like manner assigned as a cause maintaining the earth's electric charge⁶: by the usual estimate it would have to replenish the static charge of the earth every ten minutes. The spatial density of compensating charge falling back into the sun would be considerable if it fell slowly: but there is scarcely ground for connecting the fixed spectral lines of some double stars with an atmosphere of that kind. This principle of emission in one mode and compensating absorption in another, is far-reaching: thus it is the foundation of the Einstein theory of radiation by projected and absorbed 'photons'.

The characteristic feature of the modern spectral theory, expressing itself in sporadic transitions

between energy levels, is that, while it aims at inclusion of the Hamiltonian dynamical analysis, each line has its own configuration of the source, without any overtones such as were a necessary part of a vibrational theory. The equation of Hamilton-Jacobi and the related one of Schrödinger would belong not to an atom but to a cosmos, thus coming into line towards the various universal modes of statistics. In asymptotic limit⁷ (λ large) the two schemes, Hamilton's (generalised) rays and Schrödinger's potential, come into agreement.

¹ NATURE, 132, 340, Sept. 2, 1933.

² Proc. Roy. Soc., 1928.

³ cf. Phil. Mag., Jan. 1884; "Math. and Phys. Papers," vol. 1, p. 28.

⁴ Terrestrial Magnetism, 1931-33.

⁵ Proc. Phys. Soc., Feb. When this was written I had not seen their records for short waves, and their cyclicity in the magnetic field, which is not very far from vertical, in Phil. Mag. for July. Clearly there is much to be learned here.

⁶ cf. Kollhörster, H., NATURE, 132, 407, Sept. 9, 1933.

⁷ cf. Dirac's "Quantum Mechanics," p. 121; G. D. Birkhoff, Proc. Nat. Acad., March 1933, p. 339; also Levi-Civita, Bull. Amer. Math. Soc., Aug. 1933. An early attempt toward such correlation is in the writer's "Papers", vol. 2 (1928), p. 809.

Anniversary of the Asiatic Society of Bengal

ON January 15 the Asiatic Society of Bengal celebrated the 150th anniversary of its foundation by an afternoon conversazione in the Indian Museum, and a banquet in the evening followed by a special anniversary meeting. The conversazione was attended by the Mayor of Calcutta and about five hundred of the leading citizens of Calcutta. It took the form of a garden party on the lawn of the Museum and special and interesting collections of exhibits, consisting of paintings lent by the Academy of Fine Arts, copies of old documents from the Imperial Records Department, mostly of the eighteenth century and some concerning the Asiatic Society, paintings of plants from the Botanical Survey, Javanese and Siamese sculptures lent by Dr. S. K. Chatterji, chemical and physical demonstrations arranged by the University College of Science and Technology, prehistoric and tenth century finds from the Archaeological Survey, fossils, crystals and economic products from the Geological Survey, birds of Bengal lent by Dr. S. C. Law, demonstrations of the prevention and treatment of disease arranged by the School of Tropical Medicine and Hygiene, medals and coins by His Majesty's Mint, Kaffir attire, fish, Crustacea and insects from the Zoological Survey.

The banquet was honoured by the presence of His Excellency Sir John Anderson, Governor of Bengal, who is the patron of the Society, and took place in its one hundred and twenty-six year old hall, surrounded by portraits and busts of former members who have made history in Bengal. Ninety-three members and guests were present, including the consular representatives of France, Germany, Holland, Sweden and the United States of America, the Archbishop of Calcutta, the Hon. Sir M. N. Roy Chowdhury, Sir David Ezra, the Hon. Nawab K. G. M. Farouqui, Sir C. C. Ghose, the Hon. Sir A. K. Ghuznavi, Lord Sinha, the Hon. Sir B. P. Singh Roy, and Sir Jadu Nath Sircar. The toast of the guests was proposed by the president of the Society, Dr. L. L. Fermor, to which M. J. Delacour, of the National Museum of Paris replied, and also proposed the Asiatic Society, but speeches were brief, in view of the meeting afterwards.

At the special anniversary meeting, His Excellency the Governor took the chair and the president delivered his anniversary address, outlining the history of the Society, and naming the distinguished contributors to its publications, more especially in the last half century. He pointed out that many of the specialist departments and institutions founded in India originated from the Asiatic Society, in particular the Indian Science Congress, and mentioned the proposals which had been made for the formation of an Indian Academy of Sciences to affect co-ordination between these various interests in the sphere of science.

Following the president's address, congratulatory messages were read from His Excellency the Viceroy, the Mayor of Calcutta, the League of Nations, Prof. C. Rockwell Lanman, Sir George Grierson and Sir Thomas Holland (honorary fellows). Seven addresses were read, from the British Museum, the Linnean Society, the Zoological Society of London, the Batavian Society of Arts and Sciences, the Indian Institute, Oxford, the Schopenhauer Society, Frankfurt, and the Prussian Academy of Sciences. Congratulations were presented by 26 delegates from 58 learned institutions, and in all 19 countries were represented—Australia, Austria, Belgium, Ceylon, Canada, France, Federated Malay States, Germany, Great Britain, Hungary, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, Tasmania, United States and India.

Twelve honorary anniversary members were elected—six in letters and six in science: Prof. Arthur Christensen of Denmark, Prof. Taha Husain of Cairo, Sir John Marshall, lately Director-General of Archaeology in India, H.R.H. Prince Damrong Rajahubhab of Siam, Dr. Rabindranath Tagore, Dr. J. Van Kan, law member of the Council of the Viceroy of the Dutch East Indies, Sir Sidney Burrard, lately Surveyor-General in India, Prof. Albert Einstein, Sir Sven Hedin, Prof. Alfred Lacroix, Dr. Henry Fairfield Osborn and Lord Rutherford.

In his speech, His Excellency the Governor stressed the vigour of the Society in spite of its age, its permanence since the days of the French Revolu-

tion, and the esteem in which it is held abroad, as manifested by the spontaneous tributes received from all over the world. He directed attention to the traditional connexion of the ruling princes of India with the Society, and hoped that this tradition might be widened, to the benefit of scholarship, by the inclusion in the Society's list of members of the name of every substantial ruler in the country.

His Excellency paid special tribute to three members of the Society, Sir Rajendranath Mookerjee, Mr. John Van Manen (general secretary) and Dr. S. L. Hora (honorary secretary of the Celebration Committee).

Research in the British Post Office

WHEN the State purchased the telegraphs in Great Britain in 1869, the number of electrical workers in the whole country could almost be counted on the fingers. To-day the engineer-in-chief of the Post Office controls a staff of about 30,000 and maintains plant of a value of 130 million pounds. Starting from the needle instruments, skilled Post Office experimentalists developed the Wheatstone transmitter and receiver; instruments capable of operating up to 300 words per minute.

Capt. B. S. Cohen, the engineer of the Post Office Research Station at Dollis Hill, in a paper read to the Institution of Electrical Engineers on February 1, said that these instruments still stand unsurpassed to-day in their design, workmanship and performance. It was not until 1912 that a research section was established. During the War period, the thermionic valve was perfected and at one stroke opened a boundless vista of possibilities in the way of universal telephone communication. The paramount necessity was to obtain the closest co-ordination between the research and the operating organisations. Without full access for research purposes to the working telegraph and telephone plant, the work of the research engineers would have been immensely increased. The Research Station at Dollis Hill was started in 1921 by using ex-army huts, and the permanent buildings were completed last year. Much excellent work has been done at this station which could not have been done elsewhere.

To the research workers at Dollis Hill the increase in the volume and weight of road traffic brought with it a new problem. There are apparently under the streets an ever-increasing number of cracked gas mains. Modern road surfaces make it difficult for this gas to escape into the open and so it sometimes accumulates in Post Office cable ducts and man-holes, involving a serious hazard. The research engineers have developed a simple form of gas detector for general issue to Post Office workmen. The detector operates in a way somewhat similar to a photographic exposure meter. It utilises a filter paper moistened with a few drops of palladium chloride solution and will indicate the presence of 0.05 per cent of carbon monoxide, the dangerous constituent of coal gas.

The capital value of automatic switching apparatus installed in exchanges is now very large, and great precautions against corrosion have to be taken. Sir Robert Hadfield has said that the corrosion of iron and steel alone costs the world 700 million pounds per annum. Experiment shows that the life of galvanised iron stay wire is proportional to the thickness of the galvanising. In some parts of south

Lancashire, the normal life of a stay wire is little more than two years. It is now possible to estimate the life of any particular grade of wire in a given area.

In long telephone lines the 'echo' used to be very troublesome but the engineers have invented, using valves only, a very efficient echo-suppressor. A non-reflecting room at the Station has linings of cotton-wool one foot thick. This room has a totally silent background of noise. It is especially useful for listening tests where the threshold of hearing has to be found.

University and Educational Intelligence

CAMBRIDGE.—At St. John's College, one Strathcona research studentship of the annual value of £150 and two Strathcona exhibitions of the annual value of £40 are offered for competition amongst research students who are graduates of any university other than Cambridge. The election of a candidate not yet a member of the College is subject to his being accepted by the University as a research student proceeding to the Ph.D. degree and to his commencing residence in October 1934. Candidates must make application to the Senior Tutor, St. John's College, not later than July 1.

LONDON.—Dr. G. P. Wright has been appointed as from March 1 Sir William Dunn professor of pathology tenable at Guy's Hospital Medical School. Since 1931, Dr. Wright has been assistant lecturer in morbid anatomy and curator of the Museum at University College Hospital Medical School and also pathologist to the Hospital.

It is expected that the new British Postgraduate Medical School at Hammersmith will be opened to students in October next. It has been given recognition as a School of the University for a period of two years, as a temporary measure.

OXFORD.—In presenting Miss Ethel Bellamy for the honorary degree of M.A. on January 30, the Public Orator, Mr. C. Bailey, took occasion to remind Convocation of the distinguished services rendered by that lady and other members of her family in the cause of astronomy, and particularly in the important part taken by the Oxford Observatory in the photographic survey of the heavens. In consideration of the recent help accorded to the Vatican Observatory towards the completion of that work, the Pope has bestowed on Miss Bellamy a decoration of silver.

ST. ANDREWS.—The Court has agreed to institute a lectureship in bacteriology in the University and has appointed Mr. James F. Murray, who has hitherto been assistant to the professor of bacteriology, to the lectureship as from February 1; Mr. A. B. Stewart has been appointed to succeed Mr. Murray as assistant in the Department.

THE booklet on the new buildings of the University of London, edited by T. Ll. Humberstone and published by the Dryden Press (see NATURE, June 24, 1933, p. 903) has been withdrawn from publication and replaced by a similar book containing also a report of the stone-laying ceremony by the King on June 26. This is published by Mr. William Rice, 3 Ludgate Broadway, E.C.4, at 2s. 6d.

Science News a Century Ago

Ericsson's Caloric Engine

In 1833 John Ericsson, the famous Swedish engineer, patented a form of hot air engine and his invention formed the subject of a lecture by Faraday on February 14, 1834, at the Royal Institution. Referring to this lecture, the *Mechanic's Magazine* said that "after the very favourable opinion we expressed of this invention it gave us no ordinary pleasure to hear it so well spoken of by so eminent authority, in all matters of science, as Dr. Faraday. He pronounced the theory on which the engine was constructed to be philosophically correct, and the arrangements for turning it to a practical account to be at once novel and ingenious, but expressed some doubts as to whether sufficient provision had been made for preserving that regular alternation of pressure which is necessary to keep the pistons in motion". In Church's "Life of John Ericsson", (vol. 1, p. 75) it is said: "Just as Faraday was preparing to appear upon the platform he came to the conclusion that he had made a mistake as to the principle of the expansion of air upon which the action of the machine depended. He accordingly commenced his lecture, greatly to the disappointment of Ericsson, by the announcement that he was unable to explain why the engine worked at all". According to the *Mechanic's Magazine*, Ericsson was not at the lecture owing to illness.

Great Lenses in One Piece

"At the meeting [on February 14] of the Royal Society of Edinburgh . . . three splendid polyzonal lenses were exhibited by permission of the Commissioners of the Northern Lighthouses. One of these was made in Paris; another in London; and the third in Newcastle. The diameter of the outer zone of two of these lenses is 2 feet 6 inches, and that of the London instrument is three feet. Their focal distance is about three feet. At the desire of Mr. Robinson, the Secretary, a single argand burner was placed in the focus of one of the lenses, but the effect was feeble, as this instrument requires a powerful light. By exposing it to the rays of the sun it suddenly melts pieces of copper and other metals placed in its focus. The Newcastle lens is made of one piece of highly polished glass. Buffon, nearly a century ago, first suggested the idea of a polygonal burning glass; but the construction of this instrument has till now been considered beyond the skill of the artist, and the method of building them in separate pieces was afterwards suggested and practised . . . in this country and in France. Messrs. Corkton, however, the plate glass makers of Newcastle, at length triumphed over the difficulties which so long retarded the execution of Buffon's project. These lenses are about to be removed to Gulland Hill, where their effect will be fully tried, along with the light invented by Lieut. Drummond, from the experiment rooms of the Northern Lighthouse Board." ("Annual Register", 1834.)

Liverpool and Manchester Railway

In the *Mechanic's Magazine* of February 15, 1834, is an article on the half-yearly report of the Liverpool and Manchester Railway, for July-December 1833. There had been a very considerable increase in traffic and a dividend of 9 per cent had been declared.

The total number of passengers booked had been 215,071 and the total quantity of goods carried 98,247 tons, beside 40,134 tons of coal. The number of trips of 30 miles performed by locomotives with passengers had been 3,253 and with merchandise 2,587. The figures showed an increase in the number of passengers of 32,248 and an increase in the weight of goods of 11,405 tons. The winter had been very wet and stormy, there had been great difficulty in keeping the railway in good order and the boisterous weather and the dirty state of the rails had impeded the passage of the trains; "assistant engines had frequently been required to ensure their progress even on the level parts of the way". Among other items mentioned was that gas coke was being tried in the engines in the place of Worsley coke at a cost per ton of less than a half.

Death of Lionel Lukin

On February 16, 1834, Lionel Lukin, one of the pioneers of the lifeboat, died at Hythe, Kent, at the age of ninety-one years. Born at Dunmow, Essex, on May 18, 1742, Lukin became a London coach-builder having premises in Long Acre, where he continued in business until more than eighty years of age. Fertile in invention and with scientific leanings, he invented an adjustable bed for invalids, a raft for rescuing persons from under ice and a rain gauge. For a long period he kept a daily meteorological record. His experiments with boats were begun in 1784, when he altered a Norway yawl and tested it on the Thames. The following year he obtained a patent for his "unsubmersible boat". His claims included a method of construction for either sailing or rowing boats which would neither upset in violent gales nor sink if accidentally filled with water. He proposed to fit projecting gunwales, either hollow or filled with cork, together with watertight compartments at the stem and stern and under the seats, which would contain air or cork. His invention was submitted to many distinguished men and was tried at Ramsgate and Margate. He had, however, to contend with seafaring prejudices and his boats were in little request. A description of them was published by him in 1790. Lukin's invention was almost contemporary with that of the Shields boat-builder, Henry Greathead (1757-1816), through whose work lifeboats were introduced in the north of England.

Royal Society Fellowship, 1834

One hundred years ago there was practically no restriction as regards the number of fellows that might be elected in the course of the regular meetings of the Royal Society. A statute, enacted in 1831, provided that no election for fellows or for foreign members should take place excepting on the first ordinary meetings of the Society in December, February, April and June. This remained in force until 1835, when it was repealed. In 1847 the plan of electing fifteen fellows annually became the rule, and in 1930 the number was increased to seventeen. The following were elected in February 1834: Capt. Francis R. Chesney, Thomas Copeland, Sir Edward Cust, James Horne, John Russell Reeves, Lieut.-Col. William H. Sykes, John Waterhouse. No foreign members were elected during the year 1834.

The custom of holding no meeting on the anniversary of the death of Charles I lapsed after January 30, 1834.

Societies and Academies

LONDON

Royal Society, February 1. A. K. DENISOFF and O. W. RICHARDSON: The emission of electrons under the influence of chemical action. This paper starts by summarising some general conclusions reached from experiments on the reaction between K_2Na and 22 different gases. A more refined and detailed experimental investigation than has hitherto been carried out with phosgene is then given. This is followed by a discussion of the low energy part of the spectrum, the determination of the true zero on the volt scale and of E_m (maximum energy found from the energy distribution curves) and its relation to E_c (energy of corresponding elementary chemical reaction responsible for E_m). The last section confirms the equation $E_m = E_c - \phi$ (work function of the metal) for the particular case of $COCl_2$. SIR ROBERT ROBERTSON, J. J. FOX and A. E. MARTIN: Two types of diamond. From an observation that a diamond failed to give a prominent absorption band at 8μ in the infra-red region of the spectrum where a great number of diamonds gave this, a similar exploration was undertaken in the ultra-violet region, where a difference in absorption in the same sense was found. More examples were found and two types were recognised, the more common or opaque Type 1 (band at 8μ and complete absorption at λ 3,000), and Type 2 (no band at 8μ and complete absorption at λ 2,250). Other properties were investigated. Type 2 was found to be more isotropic optically than Type 1, but there was no difference in specific gravity, refractive index and dielectric constant between the types; or in the Raman effect, which gave one fundamental frequency at $1,332\text{ cm.}^{-1}$ for both types. From the complete band system in the infra-red (to 17μ) and the new carbon bands found about λ 3,000 in the ultra-violet, together with the Raman frequency, a picture is sketched of the various modes of vibration of carbon against carbon in the diamond structure, for which the frequency of the fundamental vibration is also calculated. While most diamonds give some response to light when the passage of the dislodged electrons is assisted by an applied potential, some diamonds (of Type 2) generate a current without the application of any voltage. When these diamonds have been activated by light of λ 2,300 they acquire a condition in which light of certain wave-lengths can quench the photo-conductivity while others augment it.

PARIS

Academy of Sciences, December 26 (*C.R.*, 197, 1705-1784). The president announced the death of Charles Porcher, *Correspondant* for the Section of Rural Economy. E. JOUGUET: The theory of critical phases. The generality of the properties of zero area. CHARLES NICOLLE, JEAN LAIGRET and MME. HELENE SPARROW: Vaccination by the digestive tract in the ape against exanthematic typhus. EDMOND SERGENT, ETIENNE SERGENT and A. CATANEI: "Malaria houses" and the "instinct to return to their feeding ground" in the mosquito. In malarial localities, the disease appears year after year in certain houses whilst neighbouring houses escape. Experiments are described which tend to prove that the mosquito has no instinct to "retour à la pâture" and hence some other explanation must be sought for malaria houses. CHADENSON: The extension of

the Bolzano-Weierstrass theorem to certain functional ensembles. W. SIERPINSKI: The hypothesis of the *continu* and Baire's property. TH. H. J. LEPAGE: Certain exterior differential forms and the variation of double integrals. TCHANG TE-LOU: The electric ignition sparks in internal combustion motors. Turbulence in the motor cylinder causes multiple sparks and it is inaccurate to consider the explosion as the result of a single spark. There is no reason to suppose that turbulence suppresses the sparks. EMILE MERLIN: The existence of osculating orbits remaining elliptical in the problem of two bodies with decreasing mass. AL. PROCA: Solutions of the Maxwell equations for a vacuum. ANDRÉ GUILBERT: The possibility of obtaining a variable yield of direct current generators the exciter of which is controlled by phenomena of transversal reaction. RAYMOND LAUTÉ: The determination of the atomic weight of molybdenum. The method chosen was the reduction of molybdc oxide to the metal by heating in hydrogen. The preparation and purification of the molybdc oxide are given in detail. The value found is 96.01 ± 0.01 . RENÉ VAN AUBEL: The gold-bearing zone of the eastern Urega (Kivu, Belgian Congo). G. SCHNEIDER and L. MORET: A new hypothesis on the origin of the thermo-mineral springs of Aix-les-Bains (Savoie). V. FROLOW: Analysis of the levels of the Niger and the Nile. R. DELABY, R. CHARONNAT and M. JANOT: The variations of a hot spring: the Dames de Plombières spring. Study of variations in radioactivity (water and evolved gases), temperature and total solids. The radioactivity showed the most marked variations. A. DAUVILLIER: Cosmic activity and solar activity. Observation of the cosmic rays at Scoresby Sound during the Polar Year. The experimental results are discussed from the point of view of the author's theory of the origin of the cosmic rays (*C.R.*, 193, 348). PH. JOYET-LAVERGNE: The diagnosis of sex through the characters of sexualisation. W. BESNARD and P. J. KORDA: The action of luminous and ultra-violet radiations emitted by special lamps on the growth and reproduction of some aquatic plants. Studies on the best type of lighting for maintaining the life of plants. ROBERT GARNIER and SÉBASTIEN SABETAY: The analytical constants of Bulgarian attar of roses. E. MIÈGE and M. SIMONET: The caryological study of the *durum* types appearing in the cross *Triticum vulgare* var. *alborubrum* with *T. vulgare* var. *oasicolum*. S. NICOLAU, P. POINCLOUX, L. KOPCIOWSKA and G. BALMUS: The morphological study of the peripheral blood in the experimentally poisoned rabbit: megamononucleosis. RAYMOND JACQUOT: Is cow's milk an equilibrated food for all mammals? Cow's milk is a food best utilised in the larger animals. It produces growth in certain mammals (calf, pig), keeps others in good condition (rat), but with the hedgehog, although the milk is easily digested, it is badly utilised and the animals die of protein starvation. A. TRILLAT: Experiments in anaphylaxy produced by air infection. A. and R. SARTORY, J. MEYER and ERNST: The inhibiting influence of radium on growth of the rootlets of *Lens esculenta*: the minimum preventive dose and time of irradiation. G. VIAUD: Phototropism of *Daphnia*. Laws of the positive tropistic movement. PH. L'HÉRITIER and GEORGES TEISSIER: The study of a population of *Drosophila* in equilibrium. PAUL WINTREBERT: The intervention of the egg in the deposit and constitution of the tube envelopes in amphibians (*Discoglossus pictus*).

N. KOBOZIEFF: The genotypical constitution of mice with normal tails born of parents without tails or with short tails. D. BACH and D. DESBORDES: The paradoxical action of the mycelium of *Aspergillus repens* on ammonium nitrate. Increase of the medium in ammonia. N. BEZSSONOFF and A. DELIRE: The identification of vitamin C and of its derivatives present in biological media. E. BRUMPT: Experimental researches on myiasis in batrachians, produced by the fly *Lucilia bufonivora*. F. VLÈS and A. DE COULON: Therapeutic attempts with amino-acids to produce spontaneous cancer in mice. ANDRÉ KLING: Contribution to the study of the chemical processes intervening in the production of acute œdema of the lung after contact with certain corrosive gases.

LENINGRAD

Academy of Sciences (C.R., N.S., No. 2, 1933). B. SEGAL: A theorem analogous to Waring's theorem. Every integer from a certain point onwards is the sum of $2(n^2 2^n - 1)$ or less terms of the form $[x^e]$, where x is integral. D. IVANENKO: Constituent parts of atomic nuclei. If the conception of a proton consisting of neutron and positron is accepted, this leads to the conclusion that the neutron is equal to a proton plus an electron. This does not require an assumption of the complexity of heavy particles, at least not in the sense of macroscopic mechanics. On the contrary, both particles are considered as different quantum states of a single primary particle. It is assumed that both protons and neutrons are stable. M. ROMANOVA and A. FERCHMIN: The hyperfine structure of the red line of cadmium (6438), and the green-yellow (5649) and green (5562) lines of krypton. Two intense satellites (-0.0034 Å. and $+0.0035$ Å.) and a diffused weak line ($+0.0092$ Å.) were found in the red line of cadmium. For the green line of krypton five strong satellites and four weak ones were observed, and for the yellow-green line of krypton there are four strong satellites and three weak ones. N. ZELINSKIJ and N. I. SHUKIN: Hydration of the furan nucleus by catalytic osmium. By passing sylvan (α -methylfuran) at 80° - 82° C. over the osmium deposited on asbestos, the authors obtained the tetrahydro-sylvan, not differing from that synthetically prepared by Lipp. A. GRUNBERG, A. FILIPPOV and I. JASVONSKIJ: The occurrence of gallium in the sulphide ores of Ridder in the Altai. The gallium was found mainly in the zinc-blende. A method is offered for separating gallium from the ore. A. A. RICHTER, V. RANCAN and M. PEKKER: Control of "yarovisation". With the view of working out the external diagnostic methods for registering the changes in the internal state of the yarovised seed, the authors studied the enzymotic indices, the indices of the respiratory process, of the concentration of hydrogen ion and of the deficiency of buffer capacity, as well as the absorption of dyestuffs by the albumino-lipoid complex of cells in connexion with the yarovisation. V. NOVIKOV, A. GRETCHUSHNIKOV, J. BARMENKOV and A. NOSOV: The process of assimilation and formation of cautchouc in tau-sagiz. The conditions most favourable for a maximum rate of assimilation and for the formation of cautchouc are bright sunny days and a soil humidity of 60 per cent of the full capacity, which assures a water content in leaves not lower than 77 per cent. A. TARANEC: Some new fresh-water fishes from the Russian Far East. Descriptions of two new subspecies and a new species of the genus

Salvelinus, a key to the Pacific species of the genus, a description of *Cottus mimetus volki*, sb-sp.n. and notes on *Aboma lactipes*, Hilg. and *Chloea castanea*, O. Shang. are given. S. HELLER and V. KUNIN: Origin of ridges of sand. Fixed ridges of sand such as observed, for example, in some parts of the Baltic littoral, on the east side of Lake Chad, in the Karakum desert, and on the right bank of the Nile in Egypt must be regarded as a result of the activity of flowing water.

ROME

Royal National Academy of the Lincei, communications received during the vacation. E. ALMANSI: Deformations of elastic strips (8). U. BROGGI: An application of Newton's series. MARGHERITA PIAZZOLLA-BELOCH: Solution of a problem of aero-photogrammetry. I. OPATOWSKI: Biharmonic functions as products analogous to Lamé's products, and lines of force of Newtonian fields (2). F. TRICOMI: Further reference to a note on: Integration of a differential equation encountered in electro-technics. Reply is made to criticisms of the author's earlier paper on this question. J. C. VIGNAUX: A generalisation of the summation of Le Roy's divergent series. C. DEI: Sensitiveness and accuracy of the measurement of the internal resistance of triodes. The three methods of Miller, Appleton and Lo Surdo are discussed separately. A. BARONI: Lithium alloys (2): X-ray analysis of the system lithium-cadmium. Thermal analysis of this system substantially confirms Grube, Vosskübler and Vogt's results (1932) but not those of Tammann (1910). X-ray analysis allows of the identification of (1) the compound Li-Cd which exhibits monometric structure of the CsCl type and with the value 3.32 Å. for the side of the unit cell, and (2) the compound LiCd_3 , which is probably also monometric, with the unit cell side 8.62 Å. and with eight molecules in the cell. X-ray analysis does not, however, indicate the compound Li_3Cd found in thermal analysis. A. FERRARI and C. COLLA: Rhodionitrites of ammonium, potassium, rubidium, caesium, thallium, barium and lead. The crystal structure of these compounds is of the potassium cobaltinitrite type and the side of the unit cell has the values (all ± 0.02) 10.91, 10.63, 10.83, 11.30 and 10.91 Å. respectively; for the corresponding cobaltinitrites the values are 10.81, 10.44, 10.73, 11.15 and 10.72 Å. Barium and lead rhodionitrites prove to be anhydrous, the water they retain at moderately high temperatures being wholly zeolitic in character; the unit cells are cubic (possibly pseudo-cubic) and the values of the side are 10.70 Å. and 10.53 Å. respectively. These compounds are isomorphous with those of the univalent metals; the anions occupy the same positions in the two classes of lattice, but with the bivalent metal compounds the cations occupy only one half of the number of positions occupied in the other case. P. PRATESI: Condensation products of isatin with pyrroles (pyrrole blue) (2). R. REDINI: Geology of Monte Pisano and the Apuan Alps. S. SORRENTINO: Cenomanian outcrop in the high valley of the river Salso. V. FAMIANI: Food value of germinating grain. In experiments on growing albino rats, germinating grain showed a nutritive value superior to that of dormant grain. M. CALCINAI: Hæmatic modification of inflammation. In experiments with rats, it was found that endoperitoneal injection of lactic acid (as sodium salt) modifies and accentuates the local inflammation produced by croton oil.

Forthcoming Events

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

Monday, February 12

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Dr. R. Greene: "The Food and Health of the Mount Everest Expedition".

UNIVERSITY COLLEGE, LONDON, at 5.—Dr. H. R. Ing: "Chemical Structure and Pharmacological Action" (succeeding lectures on February 19, 26, March 5, 12 and 19).*

UNIVERSITY COLLEGE, LONDON, at 5.30.—A. M. Hocart: "The South Seas, the Organization of the People".*

NEWCASTLE-UPON-TYNE ASTRONOMICAL SOCIETY AND UNIVERSITY OF DURHAM PHILOSOPHICAL SOCIETY, at 7 —(at Armstrong College, Newcastle).—Abbé G. Lemaître: "Evolution in the Expanding Universe".*

ROYAL SOCIETY OF ARTS, at 8.—Sir Robert Davis: "Deep Diving and Under Water Rescue Work" (Thomas Gray Lectures. Succeeding lectures on February 19 and 26).

Tuesday, February 13

ROYAL COLLEGE OF SURGEONS, at 4.—Sir Cuthbert Wallace: "The Hunterian Oration".

PHARMACEUTICAL SOCIETY, at 8.30—(at 17, Bloomsbury Square, London, W.C.1).—Prof. E. Mellanby: "The Influence of Some Nutritional Factors in Disease".*

Wednesday, February 14

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, at 2—(at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1).—Annual General Meeting.

R. C. Ching: Presidential Address.

Sir Leonard Hill: "Infra-Red Rays and Comfort".

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritsch: "Certain Aspects of Algal Biology" (succeeding lectures on February 21, 28 and March 7, 14).*

Thursday, February 15

ROYAL SOCIETY, at 4.30.—Dr. J. C. Stimson: "The Electrical Condition of Hot Surfaces" (5).

Prof. G. I. Finch and B. W. Bradford: "The Electrical Condition of Hot Surfaces" (6).

Prof. G. I. Finch and A. W. Ikin: "The Catalytic Properties and Structures of Metallic Films" (2).

S. F. Boys: "Optical Rotatory Power. A Theoretical Calculation for a Molecule Containing only Isotropic Refractive Centres".

CHEMICAL SOCIETY, at 8.—Discussion on "Some Aspects of the Electronic Theory of Valency", to be opened by Prof. J. E. Lennard-Jones.

Friday, February 16

INSTITUTION OF CHEMICAL ENGINEERS, at 11.—Annual Corporate Meeting to be held at the Hotel Victoria, Northumberland Avenue, London, W.C.2.

At 11.45. The Right Hon. The Viscount Leverhulme: "Chemical Engineering and the Edible Fat Industry" (Presidential Address).

At 2.15. Prof. C. H. Lander: "Modern Methods of Attacking Heat Transmission Problems".

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting. Sir Thomas Holland: Presidential Address.

ASSOCIATION OF ECONOMIC BIOLOGISTS, at 3—(at the Imperial College of Science and Technology).—Annual General Meeting.

Prof. W. B. Brierley: "Viewpoints in Applied Biology" (Presidential Address).

UNIVERSITY COLLEGE, LONDON, at 5.30.—Sir Arthur Eddington: "The Constitution of the Stars" (Rickman Godlee Lecture).*

ROYAL INSTITUTION, at 9.—Dr. Allan Ferguson: "Surface Tension".

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Report of the Reinforced Concrete Structures Committee of the Building Research Board, with Recommendations for a Code of Practice for the use of Reinforced Concrete in Buildings. Pp. iv+69. (London: H.M. Stationery Office.) 1s. 3d. net.

Scottish National Development Council. Economic Series No. 9: Report of Committee on the Chemical Industry in Scotland. Pp. 80. (Glasgow: Scottish National Development Council.) 6d. net.

A Report on the Museums and Art Galleries of Australia, by S. F. Markham and Prof. H. C. Richards, of the Carnegie Corporation of New York, and A Report on the Museums and Art Galleries of New Zealand, by S. F. Markham and W. R. B. Oliver, of the Carnegie Corporation of New York. Pp. v+113+13 plates. (London: Museums Association.)

Geography Teaching in relation to World Citizenship. By the Geography Panel of the League of Nations Union Education Committee. Pp. 31. (London: League of Nations Union.) 4d.

Department of Scientific and Industrial Research. Report for the Year 1932-33. (Cmd. 4483.) Pp. iv+189. (London: H.M. Stationery Office.) 3s. net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1521 (T. 3292): An Application of Prandtl Theory to an Aircrew. By C. N. H. Lock. Pp. v+41+11 plates. 2s. 3d. net. No. 1539 (T. 3275): Abstract—Flow Past Circular Cylinders at Low Speeds. By Dr. A. Thom. Pp. 2+2 plates. 3d. net. No. 1540 (F. M. 87): Abstract—Convection of Heat from Isolated Plates and Cylinders in an Inviscid Stream. By Dr. N. A. V. Piercy and Dr. H. F. Winny. Pp. 2. 2d. net. No. 1553 (Strut. 133a): Summary of the Present State of Knowledge regarding Sheet Metal Construction. By H. L. Cox. Pp. 20. 1s. net. (London: H.M. Stationery Office.)

OTHER COUNTRIES

University of Arizona Bulletin. Vol. 4, No. 3 (Biological Science Bulletin No. 1): Arizona Cacti. By William Palmer Stockwell and Lucretia Breazeale. Pp. 116. (Tucson, Ariz.: University of Arizona.) 25 cents.

University of California Publications in American Archaeology and Ethnology. Vol. 33, No. 4: Clan and Moiety in Native America. By Ronald L. Olson. Pp. iii+351-421. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 80 cents.

Reprint and Circular Series of the National Research Council. No. 105: Doctorates conferred in the Sciences by American Universities, 1932-1933. Compiled by Callie Hull and Clarence J. West. Pp. 63. 50 cents. No. 106: A History of the National Research Council, 1919-1933. Pp. 61. 50 cents. (Washington, D.C.: National Academy of Sciences.)

Smithsonian Institution: United States National Museum. Bulletin 165: The Bryozoa Fauna of the Vincentown Limesand. By Ferdinand Canu and Ray S. Bassler. Pp. v+108+21 plates. (Washington, D.C.: Government Printing Office.) 20 cents.

Cornell University Agricultural Experiment Station. Bulletin 561: Buying for the Household as practiced by 368 Farm Families in New York, 1928-1929. By Marion Fish. Pp. 92. Bulletin 563: A Study of the Food Habits and Health of Farm Families in Tompkins County, New York. By Nancy Booker Morey. Pp. 83. Bulletin 565: Costs and Returns in Producing Apples in the Newfane-Oleott Area, Niagara County, New York, 1926-1928. By T. E. La Mont. Pp. 87. Bulletin 568: Costs and Returns in Producing Potatoes in New York in 1929. By F. L. Underwood. Pp. 122. Bulletin 571: Studies in Plant Propagation—The Influence of Chemicals, of the Medium, and of the Position of the Basal Cut, on the Rooting of Evergreen and Deciduous Cuttings. By L. C. Chadwick. Pp. 53. Bulletin 573: Nut Growing in New York State. By L. H. MacDaniels. Pp. 24. (Ithaca, N.Y.)

Zoologica. Vol. 9, No. 16: The Fishes of Barro Colorado, Gatun Lake, Panama. By C. M. Breder, Jr. Pp. 565-572. (New York City: New York Zoological Society.)

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